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Utility Spots

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Utility Spots

Science Policy, Knowledge Transfer and the Politics of Proximity

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1. Introduction.

Situating Science Policy in Space

What's the *use*? Who *benefits*? Questions that many academic researchers today face, have to face, whenever they apply for funding, justify their work in institutional reviews or discuss their findings in the public realm. For some, such questions are reason for elaborate laments about the lost purity of science, while others had already embraced them within their methodology. At the same, activist groups, politicians from the entire spectrum and anti-science sceptics have been asking similar questions for decades. How we think about and act on the *usefulness* of scientific research has epistemological and political implications: what knowledge consists of, how it comes about and to what ends. The practical organisation of research ultimately corresponds to these assumptions and beliefs, and determines what kind of (relevant) research is possible. These organisational issues are often discussed in terms of *how* and *why*: how to orient researchers to societal concerns, involve diverse actors, or disseminate results to diverse publics; and why, as contribution to what public values or in response to what socio-political demand? Instead of merely analysing different meanings of the utility, relevance or value of research, I set out to expose the practical conditions for different political epistemologies of useful research. In particular, I will accentuate a spatial dimension, or the *where* question.

Because for knowledge to matter, it matters where you are. To be of use, knowledge typically has to move, from a protected environment of production into the more chaotic real world. The way in which knowledge travels depends on historically grown environments of scientific institutions, industries and education systems. The transfer of knowledge within and between environments is shaped by many spatial factors: from architectural designs, physical proximity and material infrastructures to city planning, regional development and geopolitics. And not only knowledge travels: also organisational models for research circulate. From Solomon's House to Silicon Valley, scientifically or economically less advanced continents, nations, regions and cities have copied success stories from afar. Whether, in a hundred years' time, spatial paradigms of valuable research will be located in Shenzen or Nairobi, on Antarctica or Mars, will depend on how we think about, and will determine how we organise, useful scientific research. In this dissertation, I aim to integrate concepts of utility and spatiality of organised scientific research.

Science policy is the political realm for discussion and decision-making about the organisation of scientific research with societal value. As a coherent, coordinated and politicised activity it is a phenomenon typical of the late modern Western world—the United States and Western Europe between 1950 and 2000. Where at the start of this period prominent (natural) scientists, humanities scholars and industrialists ran the show, by the turn of the 21st century, they had to share space with ministers and civil servants, policy experts, strategy consultants and well-informed activists. Science policy is typically concerned with the pay-off from public investments in scientific research at universities, polytechnics and research institutes.[1] This has also created epistemic demands: to collect facts about the amount and effectiveness of research, to study the economic impact and socio-ethical consequences of results, and to understand how this ultimately contributed to societal change and economic growth. In response, academic fields like innovation studies, technology assessment and science policy studies emerged. Specialists in these fields subsequently actively participated in the spread of concepts, models and spatial paradigms of organised, useful scientific research.

1 To be sure, when I speak of scientific research, I primarily mean academic research in a broad sense, like the Dutch '*wetenschap*' or German '*Wissenschaft*'. That is, it denotes the knowledge production that takes place within institutes of higher education and includes researchers from all disciplines. What is real 'science' and proper 'research' are themselves historically contested categories, as will become clear in both the historiographical and historical parts of this dissertation.

It is those spatial paradigms that his dissertation puts centre stage to develop an alternative approach to the intertwined histories of science policy, science studies and universities. The central question answered in this dissertation is: *in which ways do spatial models of knowledge production shape and reproduce the concepts and politics of the utility of scientific research in the late-modern Western world?* I will generate answers to this question in three historical reconstructions of Dutch developments (in an Atlantic context) between 1950 and 1990. In each case, specific places of exchange serve as focal point, respectively the Technical-Physical Service in Delft, the Netherlands Institute for Advanced Study in Wassenaar and the Bio-Science Park in Leiden. Before I turn to these concrete localities, I will ground my spatial approach to useful research in existing debates in the historiography of organised research in the US and Europe. I will highlight themes related to utility and spatiality in this body of scholarship. In the concluding chapter, the results from the historical studies will be employed to shed new light on current concepts and practices of useful research. More specifically, I reflect on the consequences of a spatial perspective for the understanding of a recent controversy in Dutch science policy over value creation from knowledge, or 'valorisation'. It will become clear that both real and imagined spatial models of research structure science policy debates (and vice versa). In conclusion, I will push this reflection beyond the empirical limitations of history to explore the potential of spatial proximity and speculations in fiction and the future.

In the remainder of this methodological introduction, I construct an epistemological perspective on the usefulness of scientific research, which will serve as a conceptual basis for the historically focussed subsequent chapters (sections 1.1, 1.2 and 1.3). To add the spatial dimension to this perspective, I also conduct a review of historical, sociological and philosophical studies of the spatial, geographical and architectural aspects of the production and circulation of scientific research (sections 1.4, 1.5 and 1.6). My contribution to these debates is the combination of the epistemological and spatial perspectives on (useful) scientific research (section 1.7). To this end, I coin the concept *utility spot,* which highlights the spatial arrangements that mediate the travel and translation of knowledge. Lastly, I introduce the science policy concept of valorisation in relation to this analytic framework, which raises several philosophical and historical questions (section 8). In later chapters I survey historical examples of utility spots, which exist in both real and virtual forms, expose political epistemologies and underpin the societal legitimation of science. This is, therefore, a historical-epistemological study of the spatial organisation of the societal value of research.

1.1 The Study of the Utility of Scientific Research

Utility is ambiguously ubiquitous in university research: it is everywhere, and nowhere. From the early days of modern science onwards, scientists have stressed the actual and potential usefulness of their work as part of legitimisation attempts directed to patrons and the public. Often simultaneously, we find that utility is banned from concepts, practices and places of research. In contradistinction to purely cognitive attempts at understanding the world, it is regarded as an extra-scientific phenomenon: as concern or value *excluded* from research practice, as possibility *after* an investigation or experiment is finished, as application or use *outside* the place of production. Also in philosophical, sociological and historical studies, the usefulness of scientific research is distinguished from, or opposed to, virtues such as autonomy, truth and purity.[2] Whereas an engaged scientist or science activist might argue strongly in favour of one of the extremes, most reflective studies conclude that it is more interesting (and truthful) to describe the ideology and organisation of scientific research as the result of the relations, conflicts and tensions between these different goals. Or, as Peter Dear has argued, the practice and ideology of modern science is a culturally specific and historically contingent *hybrid* of the age-old dichotomy between *theoria* and *praxis*, or 'natural philosophy' (objective understanding of an external world) and 'instrumentality' (tools to control nature for desired purposes).[3]

Whereas utility, instrumentality and power suggest that scientific practices take place within dense networks of social relations, the values of freedom, curiosity and truth have been apprehended throughout history to defend, for science, the exclusion of practical interests and isolation from societal relations.[4] This raises the epistemological question whose values, goals and interests are allowed to inform the conduct and organisation of academic research. Epistemology examines the nature of knowledge and the methods by which we can obtain true justified beliefs about the world. But the study of knowledge has, in the last half century, expanded from the philosophical examination of propositions and theories to include also the historical, sociological and anthropological analysis of the practices and consequences of knowledge production. It is with this broader field of 'science studies' that I engage in this dissertation. The difference between epistemology and science studies can be understood as a shift from a normative to a descriptive approach. Utility is rarely discussed in classical epistemology and much of analytic philosophy of science, as these fields are primarily concerned with the appropriate validation of knowledge claims. The diverse field of science studies moves beyond justification of assertions and science as a body of propositions,

2 Robert Proctor, *Value-Free Science? Purity and Power in Modern Knowledge* (Cambridge, MA: Harvard University Press, 1991); Torsten Wilholt and Hans Glimell, "Conditions of Science: The Three-Way Tension of Freedom, Accountability and Utility," in *Science in the Context of Application* (Springer, 2011), 351–370; David Kaldewey, *Wahrheit Und Nützlichkeit: Selbstbeschreibungen Der Wissenschaft Zwischen Autonomie Und Gesellschaftlicher Relevanz* (Bielefeld: transcript Verlag, 2014).

3 Peter Dear, "What Is the History of Science the History of? Early Modern Roots of the Ideology of Modern Science," *Isis* 96, no. 3 (2005): 390–406; Peter Dear, "Science Is Dead; Long Live Science," *Osiris* 27, no. 1 (2012): 37–55.

4 Wilholt and Glimell, "Conditions of Science"; Kaldewey, *Wahrheit und Nützlichkeit*; Jon Agar, "2016 Wilkins-Bernal-Medawar Lecture The Curious History of Curiosity-Driven Research," *Notes and Records: The Royal Society Journal of the History of Science* 71, no. 4 (2017): 409–29.

theories and evidence, towards an understanding of science as a social-material practice. The empirical study of knowledge production, distribution, use and destruction has epistemological implications: the economic, political, social and material conditions as well as consequences are considered an integral part of the practice of scientific research. In the following, I review economic, policy and conceptual approaches to utility in the broad field of science studies in relation to which I will develop a historically sensitive, empirically informed account of utility.

Within economics, utility prompts first of all associations with utilitarianism and utility functions. For my current purpose, however, it is not required to discuss the semantic multiplicity of utility in economic discourse.[5] Of more relevance are economic studies that seek to quantify the (macro-economic) benefits of scientific research.[6] In traditional neo-classical approaches to the economics of science the legitimisation of publicly funded research is as a remedy to market failure: scientific knowledge is non-rival and non-excludable information that industries will need in order to develop new products, but that they will not create themselves or share with competitors. The results of publicly funded scientific research, on the other hand, ideally circulate freely as 'economically useful information'.[7] In this 'informational' approach, scientific knowledge functions as a public good in support of economic growth. This abstract description might suffice for the justification of science and innovation policy, but it provides a very limited conception of useful research. In response, evolutionary approaches to the economics of science have presented a more realistic, embodied view of knowledge and its role in innovation. Michel Callon has stressed, for example, that for knowledge to be useful absorptive capacity (developed through education and training) is at least as important as the public disclosure of results.[8] Also 'tacit' knowledge, skills and networks have been identified as important factors in innovation processes. Empirical support for these two main strands in the economics of science is typically gathered through econometric studies, surveys and case studies.[9] Ultimately, they share an approach to the utility of scientific research in terms of the (possible) application of 'basic' research, 'key' industrial innovations and rates of return to relate public investments to economic growth.

The economic study of the utility of scientific research is dominated by the goal of finding proof for causal relations between monetary in- and output. Avoiding the suggestion of a linear model of the relations between science and society—where knowledge flows only from left to right—becomes almost impossible. Although a similar flaw haunts many policy studies that seek to map the usefulness of university research beyond the economic realm, most recent evaluation methods

5 D. W. Haslett, "What Is Utility?," *Economics & Philosophy* 6, no. 1 (1990): 65–94; Amartya Sen, "Utility: Ideas and Terminology," *Economics & Philosophy* 7, no. 2 (1991): 277–83.

6 Richard R. Nelson, "The Simple Economics of Basic Scientific Research," *Journal of Political Economy* 67, no. 3 (1959): 297–306; Ammon J. Salter and Ben R. Martin, "The Economic Benefits of Publicly Funded Basic Research: A Critical Review," *Research Policy* 30, no. 3 (2001): 509–32; Philip Mirowski, *Science-Mart: Privatizing American Science* (Cambridge, MA etc.: Harvard University Press, 2011), 41–83.

7 Salter and Martin, "The Economic Benefits of Publicly Funded Basic Research," 511.

8 Michel Callon, "Is Science a Public Good?," *Science, Technology, & Human Values* 19, no. 4 (1994): 395–424.

9 Salter and Martin, "The Economic Benefits of Publicly Funded Basic Research," 513.

for the societal impact of scientific research explicitly denounce linearity as property of this process.[10] Instead, they take alternative epistemological models for the study of the relations between science and society. Interaction models acknowledge that recurrent and reciprocal relations between researchers and external agents are important for the agenda-setting, production and dissemination of research.[11] Often, such methods prescribe strictly distinguished roles for different actors. Others break the wall between internal and external actors further down, by using an integration model of knowledge production which describes (and prescribes) participatory or co-production research processes.[12] Still, as most evaluation methods arise in response to a political or societal demand for more (evidence of the) usefulness or value of publicly funded scientific research, their main concern is comparability. This requires standardisation of the research process, and therefore lacks attention for contextual and historical situation of particular practices. Studies of the evaluation of the usefulness of research reflect policy developments as well as conceptual changes in the broader field of science studies, but do not themselves provide the tools to reflect critically on the concept of usefulness as such—either in theory or in history.[13]

In abstract, epistemological terms utility encompasses a multitude of concepts, practices and policies that are geared at actors and institutions other than direct academic peers: from societal relevance and knowledge transfer to societal impact and valorisation. These interactions between heterogeneous actors around the practice of research do not so much alter the precise values and facts produced in research (which a naïve relativism might hold), but do shape what research is possible and, importantly, considered valuable. This meta-scientific analytic level of utility has received some philosophical attention. Philip Kitcher and Joseph Rouse both speak of the 'significance' of science in distinction to its truth.[14] Scientists namely do not produce arbitrary truths, but rather pursue knowledge that they deem relevant, important or useful. Both Kitcher and Rouse have tried to describe how modal judgments about significance—what knowledge is considered possible and valuable—shape the practice of research.

Rouse, for example, argues that a research project at all stages (from plan and data collection to publication and dissemination) derives its significance not just from shared beliefs and values of a (research) community, but also from its place within, and transformation of, 'enacted narratives that constitute a developing field of knowledge'.[15] Scientific achievements become important as contributions to a shared enterprise which opens up options for further inquiry. The significance of research is not static, as it depends on the continuous reformulations, both contestations and reinforcements, of these narratives. In a relatively similar fashion, Kitcher designs

10 Reijo Miettinen, Juha Tuunainen, and Terhi Esko, "Epistemological, Artefactual and Interactional–Institutional Foundations of Social Impact of Academic Research," *Minerva* 53, no. 3 (2015): 257–77; Trisha Greenhalgh et al., "Research Impact: A Narrative Review," *BMC Medicine* 14, no. 1 (2016): 78; David Budtz Pedersen, Jonas Følsgaard Grønvad, and Rolf Hvidtfeldt, "Methods for Mapping the Impact of Social Sciences and Humanities—A Literature Review," *Research Evaluation* 29, no. 1 (2020): 4–21.

11 Barry Bozeman and Daniel Sarewitz, "Public Value Mapping and Science Policy Evaluation," *Minerva* 49, no. 1 (2011): 1–23; Claire Donovan and Stephen Hanney, "The 'Payback Framework 'Explained," *Research Evaluation* 20, no. 3 (2011): 181–183; Pierre-Benoît Joly et al., "ASIRPA: A Comprehensive Theory-Based Approach to Assessing the Societal Impacts of a Research Organization," *Research Evaluation* 24, no. 4 (2015): 440–53.

12 M.O. Kok and Albertine J. Schuit, "Contribution Mapping: A Method for Mapping the Contribution of Research to Enhance Its Impact," *Health Research Policy and Systems* 10, no. 1 (2012): 21; Sarah de Rijcke et al., "Evaluative Inquiry: Engaging Research Evaluation Analytically and Strategically," *Fteval Journal for Research and Technology Policy Evaluation*, no. 48 (2019): 176–182.

13 Jorrit P. Smit and Laurens K. Hessels, "The Production of Scientific and Societal Value in Research Evaluation: A Review of Societal Impact Assessment Methods," *Research Evaluation* (2021).

14 Philip Kitcher, *Science, Truth, and Democracy* (Oxford University Press, 2001), 63–82; Joseph Rouse, *Engaging Science. How to Understand Its Practices Philosophically* (Cornell University Press, 1996), 166–70. One could understand Ian Hacking's discussion of 'form' and 'content' of scientific research—which I discuss in chapter 2—in similar terms.

15 Rouse, *Engaging Science*, 168–70.

'significance graphs' to track why a particular epistemic item (be it a law, hypothesis, object etcetera) is considered possible and important at a certain point in history. With this approach he especially argues against context-independent approaches to the goals of inquiry, which appeal to either human curiosity or absolute truth. Instead, Kitcher stresses how current conceptions of significance are shaped by various values and contexts, both in the present and the past. This means that a project (and the questions, apparatus and categories it consists of) that appears 'fundamental' today, is possible only because of the more practical concerns and 'moral, social and political ideals' that motivated the research of predecessors.[16]

Implicit in Rouse's narratives and Kitcher's graphs is a limitation to scientific researchers as the main, and perhaps only, legitimate contributors to particular instantiations of the significance of research. The artificial exclusion of utility from research is one instance of the strict boundaries that have been drawn between science and society, and between content and context of research more generally. This rhetoric has typically been especially strong for scientific research carried out in a university environment: the ivory-tower metaphor endures, despite the multifarious relations with all kinds of actors and institutions.[17] Conceptual histories of research categories have, convincingly, demonstrated the contingency of rhetorical distinctions between useful and useless knowledge. Concepts like 'pure', 'fundamental', 'basic' and 'applied' do not so much describe different methodologies or epistemological categories, but rather mirror political issues with respect to the practical organisation of research and need to be embedded in larger discourses, narratives or imaginaries.[18] Ultimately, the advocates of the conceptual approach stress that language can play structuring and strategic roles in science and that science studies scholars have underappreciated this in favour of materiality and practices.[19] But turning to conceptual history seems to run into serious dangers itself: to disregard precisely the importance of practical, social and material aspects of scientific research. If those research concepts exist to *hide* complexity, as Bruno Latour argued, we should not replicate this reduction in our studies of them.[20]

In relation to the economic, policy and conceptual approaches to the utility of research, I renounce a limited view of utility of scientific research in terms of profits, products or applications. Rather, I propose to understand utility as a *meta-scientific* concept that directs the governance and politics of research. Meta-scientific concepts are *about* and *above* scientific research, not *of* a particular science; and they shape, as concept and practice, the organisation of scientific research.[21] Previous studies have demonstrated how such concepts, for example objectivity, purity or curiosity, structured both the legitimation discourse and the practical organisation of

16 Kitcher, *Science, Truth, and Democracy*, 86. This idea is very similar to the 'working worlds' concept that informs Jon Agar, *Science in the 20th Century and Beyond* (Cambridge, MA: Polity Press, 2012), 3–6.

17 Steven Shapin, "The Ivory Tower: The History of a Figure of Speech and Its Cultural Uses," *The British Journal for the History of Science* 45, no. 1 (2012): 1–27.

18 Sabine Clarke, "Pure Science with a Practical Aim: The Meanings of Fundamental Research in Britain, circa 1916 –1950," *Isis* 101, no. 2 (2010): 285–311; Robert Bud, "'Applied Science': A Phrase in Search of a Meaning," *Isis* 103, no. 3 (2012): 537–45; Graeme Gooday, "'Vague and Artificial': The Historically Elusive Distinction between Pure and Applied Science," *Isis* 103, no. 3 (2012): 546–54; David Kaldewey and Désirée Schauz, *Basic and Applied Research: the Language of Science Policy in the Twentieth Century* (New York: Berghahn Books, 2018).

19 Kaldewey and Schauz, *Basic and Applied Research*, 5–7.

20 Bruno Latour, *Science in Action: How to Follow Engineers and Scientists through Society* (Cambridge, MA: Harvard University Press, 1987).

21 Peter Galison, "Ten Problems in History and Philosophy of Science," *Isis* 99, no. 1 (2008): 111–124; Kaldewey and Schauz, *Basic and Applied Research*.

scientific research over time and between particular contexts.[22] Utility also requires to be taken seriously as historical category.[23] And as meta-scientific concept, utility is a more expansive concept of significance: it takes seriously also the interactions with 'non-scientific' actors in the historical understanding of the usefulness of a scientific field, project or expert, and the way in which this shapes what knowledge is possible. Utility ensues in the liminal space between academic and societal places and practices, and it is there that its promise and potential can guide the organisation of interactive and investigative practices; it is there that interactions between heterogeneous actors bring forth questions, issues and concerns, and enable the production, distribution and use of knowledge, or where utility shapes what research is possible. To avoid the pitfall of a too linguistic or idealistic approach, I will develop a spatial approach to take account of the practical effects of meta-scientific discourse: a study of concrete places of scientific research and societal exchange where utility concepts are turned to bricks and mortar.

Before I develop this approach, in the second half of this introduction, I will expand further on the historical, philosophical and sociological study of useful research. In section 1.2 I explore the historicity of utility as meta-scientific concept. To this end, I turn to the alleged progenitor of a 'modern' ideal of useful, publicly funded scientific research: Francis Bacon. The various historical interpretations of his philosophy of science allow me to expose how the historicity of utility also has epistemological consequences. In section 1.3 I illustrate how utility functions as organisational principle for scientific research, by comparing a diverse set of 'postmodern' concepts and models of useful research: technoscience, mode-2 knowledge production, post-normal science and responsible research and innovation (RRI). In these two steps, I draw the outlines of a historical epistemology of useful research that is required for the development of a spatio-historical approach to utility as meta-scientific concept.

1.2 Modern Ideals of Useful Research

'"Knowledge is power" contemplated philosopher Francis Bacon four hundred years ago. But what value does this have, if that knowledge does not reach society?'[24] In the late modern Western world it was not at all uncommon to open a science policy report, such as this Dutch government policy paper, with a reference to the seventeenth-century Lord Chancellor of England. So many twentieth-century participants in debates about knowledge utilisation have determined their stances by explicit or implicit reference to Bacon, or at least interpretations of him. Historians claimed that only with Bacon, 'utility

22 Lorraine Daston and Peter Galison, *Objectivity* (New York: Zone Books, 2007); Heather Douglas, "Pure Science and the Problem of Progress," *Studies in History and Philosophy of Science Part A* 46 (2014): 55–63; Agar, "2016 Wilkins–Bernal–Medawar Lecture The Curious History of Curiosity-Driven Research."

23 This connects to Ursula Klein's study of 'useful science' in nineteenth century Prussia: Ursula Klein, *Nützliches Wissen: Die Erfindung der Technikwissenschaften* (Göttingen: Wallstein Verlag, 2016).

24 Ministerie van Onderwijs Cultuur en Wetenschappen and E. A. A. M. Broesterhuizen, *Het kennisnetwerk: de technologische kennisinfrastructuur van Nederland* (Zoetermeer: Ministerie van Onderwijs, Cultuur en Wetenschappen, 1996), 4.

became the central norm' in natural philosophy or that the Baconian programme was the 'intellectual origin for the long period of economic growth initiated by the Industrial Revolution'.[25] Opposing that line of thought, one economist baptised Bacon as the representative of a, according to him, defunct, 'linear' model of technological progress as legitimation for state funding of science—a criticism that a medical scientist recently repeated in a pamphlet on 'Science 3.0'.[26] Still, many politicians, policymakers and journalists admired Bacon, as the 'first statesman' and 'father' of modern science, to whom science owed 'the principle of its method and the (imagined) bases of its organisation'.[27] In policy advice reports, researchers use Bacon's four-hundred-year-old utopian vision of a society based on useful research, *New Atlantis,* to argue for change in current research systems.[28] To put an end to this infinite list: there is a widespread tradition of all kinds of science commentators who view Bacon as, perhaps the most, influential spokesperson for a utilitarian ideal of science *and* find in him 'over and over … expression of the ideas of the day'.[29]

This last remark explains why I turn to Bacon to argue for the historical multiplicity of concepts of utility of scientific research. The appeal of his work can be found in the zealous defence of a new method for the study of nature. Bacon presented his philosophy consciously as a break away from scholastic and alchemic traditions, for which he displaced the focus from words to works, or from contemplation and deductive logic towards experimentation and induction. This proposal for a new method came with a new concept of knowledge—discovering the unknown rather than organising eternal truths—and a new, cooperative ethos for inquiry. Bacon developed most of these ideas in the political context of his position at the Court of King James I, and his main philosophical work *Novum Organum* (1920) was published by the king's printer, just shortly before his political career ended with an impeachment.[30] But, neither the historical figure of Francis Bacon, nor the details of his philosophical works are of interest here. Therefore, I will not participate in the advanced historical, philosophical and literary debate on Bacon's epistemological contributions about the experimental method, and its relation to his cultural vision of a new ethos and organisation for science. Instead, 'Bacon' is instrumental to my interest in the historically fluid concept of utility. I will thus not study utility 'according to Francis Bacon' but the multiplicity of utility through the multiple historical interpretations of Bacon's philosophy that appear in scholarly, policy and popular literature, or *utility concepts according to Francis Bacons*.

In the centuries following Bacon's lifetime, various Bacons have been invoked to defend developments in the organisation of science.[31] Depending on the particular socio-political context, Baconian utility could be rhetorically reconstructed

25 Proctor, *Value-Free Science?*, 262–63; Joel Mokyr, "The Intellectual Origins of Modern Economic Growth," *The Journal of Economic History* 65, no. 2 (2005): 285–88.

26 Terence Kealey, *The Economic Laws of Scientific Research* (Basingstoke: Palgrave Macmillan, 1996); Frank Miedema, *Wetenschap 3.0: van academisch naar postacademisch onderzoek* (Amsterdam: Amsterdam University Press, 2010), 110–11.

27 James Gerald Crowther, *Francis Bacon: The First Statesman of Science* (London: The Cresset Press, 1960); Jean-Jacques Salomon, *Science and Politics* (Cambridge, MA: MIT Press, 1973), 7–13.

28 Stephen R. Hanney and Miguel A. González-Block, "Four Centuries on from Bacon: Progress in Building Health Research Systems to Improve Health Systems?," *Health Research Policy and Systems* 12, no. 1 (2014): 56.

29 Sergio Sismondo, *Science Without Myth on Constructions, Reality, and Social Knowledge*, 1996, 146; Donald E. Stokes, *Pasteur's Quadrant: Basic Science and Technological Innovation* (Washington: Brookings Institution Press, 1997), 32.

30 Markku Peltonen, "Introduction," in *The Cambridge Companion to Bacon*, ed. by Markku Peltonen (Cambridge University Press, 1996), 5–16.

31 Brian Vickers, "Francis Bacon and the Progress of Knowledge," *Journal of the History of Ideas*, 53.3 (1992), 495–518; Antonio Pérez-Ramos, "Bacon's Legacy," in *The Cambridge Companion to Bacon*, ed. by Markku Peltonen (Cambridge University Press, 1996), 311–334; Graham Rees, "Reflections on the Reputation of Francis Bacon's Philosophy," *Huntington Library Quarterly*, 65.3/4 (2002), 379–94.

to serve progressive or conservative interests and communist or capitalist systems. The establishment of the Royal Society, for example, was at first explicitly legitimised with a socially progressive concept of useful science, but the cultural and political meaning of his methodology was dropped quickly by British experimentalists. In the French Enlightenment Baconian inquiry was again tied to radical reform of social institutions and values.[32] Such changes did not take place only between different contexts and periods: individual scientists too could transform their concept of utility to fit new circumstances. In the nineteenth century, German agricultural chemist Justus von Liebig first employed Bacon to pit useful 'science' (*Naturwissenschaft*) vis-à-vis useless speculation (of German Idealism) to find institutional support for his new brand of chemistry, but abandoned this ideal as soon as his science professionalised and found shelter in increasingly autonomous German universities. Instead of immediate utility, he now advocated the principles of a 'pure' science for its own sake (in line with the 'advance of human freedom' of German Idealism).[33] However, many nineteenth- and twentieth-century Marxists, utilitarians and pragmatists hailed Baconian utility as the generation of profitable truths and material technologies to improve the 'comfort of life', exemplified by artefacts and tools like gunpowder and the compass. Karl Marx and later Marxists praised Bacon's useful science because it implied the same goal as their philosophy: a rational, scientific society. Ambiguously, Bacon's utility could also stand for a liberal-democratic conception of social progress on the basis of the minimisation of the political and hope for the benefits from technological development. In the Cold War context, the true instantiation of Baconian utility was declared on both sides of the geopolitical boundary.[34]

Apart from different uses of utility over time—which demonstrate that it is a historical category itself—Bacon's utility has been situated in his own time in multiple ways. There are not only multiple Baconian utilities *over time*, but also *in his time*. In an authoritative study, Antonio Pérez-Ramos situated Bacon's epistemology and ethos of an 'active science' in a tradition of artisanal making to argue for two connotations of utility: the production of effects in nature and the occasional translation of this control into useful artefacts. The first 'internal' utility is a legitimate part of science, while the second 'external' utility cannot inform an experimenter what to do and is ultimately an 'ideological excrescence' because it is relative to a system of value.[35] Several scholars, such as Edgar Zilsel, Benjamin Farrington, Paolo Rossi and Carolyn Merchant, have precisely stressed the relevance of these systems of value to the practice, ethos and utility of science, in particular the rise of capitalist societies in Europe. According to them, Baconian utility cannot be untied from the political-economic context of

32 Richard Yeo, "An Idol of the Market-Place: Baconianism in Nineteenth Century Britain," *History of Science* 23, no. 3 (1985): 251–298.

33 Otto Sonntag, "Liebig on Francis Bacon and the Utility of Science," *Annals of Science* 31, no. 5 (1974): 373–386.

34 Ladis K. D Kristof, "Francis Bacon and the Marxists: Faith in the glorious future of mankind," in *Society and History: Essays in Honor of Karl August Wittfogel* (Berlin: De Gruyter, 1978), 233–57.

35 Antonio Pérez-Ramos, *Francis Bacon's Idea of Science: And the Maker's Knowledge Tradition* (Oxford University Press, 1988), 138–48.

an imperialistic, extractive capitalism based on colonialism, the expansion of overseas trade, the increase of commercial wealth and the progress of the mining industry. Competition, for example, broke the power of the guild tradition, and stimulated the 'inventive genius' of the artisans to commercialise new inventions. This subsequently informed Bacon's attack on the fruitlessness of theoretical knowledge and his estimation of the technical knowledge and cooperative aspects of artisanal traditions.[36] But in the context of early capitalism, this seemingly progressive 'operative' science—'man can only know what he does or what he himself constructs'—also corresponded to the exploitation of the natural environment: Bacon's utility transformed nature from teacher into slave, and man accordingly from servant to exploiter.[37] In later studies, the enabling role of science in the development of extractive capitalism has been related to post-colonial criticisms of the euro-centrism, imperialism, and violence of 'modern science'.[38] Bacon then re-emerges as conservative thinker, science as conservative enterprise, and its utility restricted to the political-economic powers that be.

This critical and pessimistic perspective on the so-called usefulness of modern science, pioneered by Theodor Adorno and Max Horkheimer and advocated by feminist and post-colonial scholars, might, however, be more of a reflection of current concerns than an accurate representation of Bacon's problem situation. There, utility did not appeal only to artisans, the upcoming merchant class and patriarchal power; his practical operative science also mirrored cultural and religious structures. The organised, controlled production of new truths has to be understood in relation to hermetic and alchemist traditions and is also defended by an Aristotelian defence of the 'pure pleasure of learning'; and his concept of utility is related to Christian conceptions of charity, but also invokes sexist imagery of the then current witch trials.[39] A recent historicist account synthesised these myriad Bacons to claim that he used the language of commerce to 'sell' science, as profitable investment, object of desire and useful instrument to imperial expansion.[40] Analogous to how, today, scientists can use any Bacon they need to sell their science.

The above selection of various Francis Bacons and utility concepts participated in the internalism/externalism debate that deals with the question whether the development of science is detachable from its social, political and cultural context. Ultimately, Steven Shapin reminds us, this is 'a vitally important contest over the *value* of science and scientists in an age of unreason'.[41] And so the multiple Bacons that emerged from the studies of philosophers, historians and literary scholars were mobilised, by scientists and policymakers, as resources in post-war arguments about the appropriate political control of scientific research. The idea of planning, organising and

36 Edgar Zilsel, "The Genesis of the Concept of Scientific Progress," *Journal of the History of Ideas* 6, no. 3 (1945): 325–49.

37 Carolyn Merchant, *The Death of Nature: Women, Ecology, and the Scientific Revolution* (San Francisco: Harper and Row, 1980).

38 Anshuman Prasad, "Provincializing Europe: Towards a Post-Colonial Reconstruction: A Critique of Baconian Science as the Last Stand of Imperialism," *Studies in Cultures, Organizations and Societies* 3, no. 1 (1997): 91–117; Dipesh Chakrabarty, "The Climate of History: Four Theses," *Critical Inquiry* 35, no. 2 (2009): 197–222.

39 Paolo Rossi, *Francis Bacon: From Magic to Science* (London: Routledge & Kegan Paul, 1968); Merchant, *The Death of Nature*, 73–91; Sarah Irving, "Rethinking Instrumentality: Natural Philosophy and Christian Charity in the Early Modern Atlantic World," *HOPOS: The Journal of the International Society for the History of Philosophy of Science* 2, no. 1 (2012): 55–76; Sorana Corneanu, "Francis Bacon on Charity and the Ends of Knowledge," in *Conflicting Values of Inquiry: Ideologies of Epistemology in Early Modern Europe: ed. Tamás Demeter* (Leiden: Brill, 2015).

40 Katherine Bootle Attie, "Selling Science: Bacon, Harvey, and the Commodification of Knowledge," *Modern Philology* 110, no. 3 (2013): 415–40.

41 Steven Shapin, "Discipline and Bounding: The History and Sociology of Science as Seen through the Externalism-Internalism Debate," *History of Science* 30, no. 4 (1992): 339–40.

controlling the pursuit of new and useful scientific knowledge can be based on 'externalist' ideas: when societal, political, cultural and economic factors have always shaped the development of science in the past, they can also do so now. From the internalist point of view, any interference that is not really 'scientific' is quickly seen as an infringement.

The modern ideology of science as a useful endeavour was thus always at stake in the post-war interpretations of Bacon's work. Utility appears as a fluid concept in two ways. First, utility is a historical category—it meant something different every time, to Bacon, his commentators, interpreters and advocates. Utility according to Bacon could mean things as diverse as individual profit-making from material technologies, the collective production of new effects, the instantiation of Christian charity or an instrument of hierarchical oppression. Second, utility can be an epistemological category, depending on the approach one takes to the study of (past) scientific thought and practice. Seemingly remote questions about whether modern science originated in 'the isolated scholar's study or the craftsman's collective workshop' ultimately have political-epistemological implications: what is considered rational conduct, and which elements are considered to be 'part of' scientific research.[42] Analogously, more recent conceptions of utility can be situated in their cultural, social and political-economic contexts.[43] Ultimately, utility appears as a historical-epistemological category, as a situated response to the question in what ways societal factors and actors do, and should, shape the dynamics of research.

1.3 Postmodern Concepts of Useful Research

Notwithstanding the multiplicity of utility, Bacon appears consistently as representative of modernity, a worldview in which boundaries regulate the relations between man and nature. Many philosophers and sociologists sought to overcome this dichotomy at the end of the twentieth century, moving towards post-, non- or a-modern approaches. These transcended the internalism/externalism opposition because they argued that the distinction between culture and nature was itself an anthropogenic construct. This intellectual trend coincided with a historical urgency for the epistemological question what the appropriate role for 'external' actors and interests was in (academic) knowledge production. In the post-war Western world, the social and material contexts of scientific practice changed radically. Laboratories grew in scale and number, instruments became bigger and more expensive, while the shrinking size of computers was inversely related to their growing importance. Research became teamwork, required more technical support staff, and the network of

42 Shapin, 350.

43 Aant Elzinga, "The Science-Society Contract in Historical Transformation: With Special Reference to 'Epistemic Drift,'" *Social Science Information* 36, no. 3 (1997): 435.

specialists spread over the globe, connected by the burgeoning internet.[44] The socio-political context of this 'big science' significantly shaped the types of knowledge that were produced. In the Cold War context, governments and industry needed new useful knowledge for national security and economic growth, while on the other hand societal coalitions aired concerns about the consequences and responsibility of scientific research. The 'scientification' of society and 'socialisation' of science prompted new epistemological approaches to scientific research that paid due to these changes.

Many studies that discussed the roles of 'external factors', like societal actors, public values and non-scientific interests, in the dynamics of scientific research were met with allegations of relativism. Taking external factors seriously namely conflicts strongly with a dominant discourse amongst scientists, interpreters and the public of the purity and value-free character of scientific research: a disinterested search for truth, dealing with facts and not with values.[45] Famously, Max Weber identified in 1917 the 'disenchantment'—or 'devalorization'—of the world, set in motion by the rise of experimental natural sciences, that separated issues of values strictly from matters of fact. It separated the conduct of science epistemically and practically from human affairs and action: scholarship focused on descriptions of 'the is', and abandoned any propositions of 'the ought'.[46] Not only was society banned from meddling in science; (in Weber's case, social) science could also not prescribe what to do in policy and practice. Proponents of the value-free ideal of scientific research then, embrace the thought that ideally economic, political or moral concerns play no or a very limited role in the conduct of scientific inquiry: definitely not in the methods, collection of data, and the evaluation of results and only potentially in the selection of topics and application of results. Similarly, early sociologist of science Robert K. Merton argued for an autonomous scientific community, regulated by (highly idealised) norms such as disinterestedness, universalism, and communism.[47]

However, this ideal has come under attack in a variety of ways.[48] Philosophers of science, for example, have convincingly shown that empirical data themselves do not always provide sufficient support for the confirmation or falsification of hypotheses. This problem, also known as the underdetermination of theory choice, entails that values are required to actually do research, both in theory and in practice. Although some have tried to maintain some 'purity' by limiting this to epistemic values, others have shown that social, ethical, political and aesthetic values can play a role as well.[49] Thomas Kuhn's history and philosophy of science shaped this scholarly debate to a large extent. His paradigm approach to past scientific revolutions allowed taking into account social factors in theory choice. David Bloor's 'strong programme' in the sociology of

44 Although this primarily applies to the natural, life and engineering sciences, also the social sciences and humanities experienced organisational expansion or had to relate to these general developments. In the later historical chapters, these historical themes will be discussed in more detail. See: Peter Galison and Bruce William Hevly, *Big Science: The Growth of Large-Scale Research* (Stanford University Press, 1992); Agar, *Science in the 20th Century and Beyond*.

45 Douglas, "Pure Science and the Problem of Progress"; Jorrit P. Smit, "Purity in an Impure World. Ernst Cohen's 'General Chemistry' in Early-20th-Century Netherlands" (Utrecht, Utrecht University, 2015).

46 Proctor, *Value-Free Science?*

47 Robert K. Merton, "The Normative Structure of Science," in *The Sociology of Science: Theoretical and Empirical Investigations*, ed. Robert K. Merton (Chicago: Chicago University Press, 1973).

48 Harold Kincaid, John Dupré, and Alison Wylie, *Value-Free Science: Ideals and Illusions?* (Oxford University Press, 2007).

49 Helen E. Longino, *Science as Social Knowledge: Values and Objectivity in Scientific Inquiry* (Princeton, NJ: Princeton University Press, 1990); James W. McAllister, *Beauty and Revolution in Science* (Cornell University Press, 1996); Heather Douglas, *Science, Policy, and the Value-Free Ideal* (Pittsburgh, PA: University of Pittsburgh Press, 2009).

scientific knowledge interpreted this radically and promoted the ‘symmetrical’ study of scientific consensus and controversy; that is, to explain truth and falsities with the same resources, including power, social interests and rhetoric.[50] It has been intensively debated to what extent these approaches lead to (social) relativism, but main proponents like Kuhn fiercely denied it.[51] And it should be noted that in Kuhn’s studies of paradigm shifts, as well as some sociological studies of controversies, the role of the social was strictly limited to an ‘internal’ scientific community.[52]

The value-free, pure and isolated image of science turns its practice and utility into a myth; a deus ex machina has to be invoked to explain the great impact of science on, and its orientation to, societal issues. Some of the later, ‘post-Kuhnian’ approaches did take external concerns and actors, as well as internal ones, into account in the study of science. Typically, they also described or proposed appropriate ways of (democratic) involvement of societal actors. But not all of them were also post-modern in a relativist sense. The finalization thesis, for example, complemented rather than fundamentally challenged the Kuhnian approach. Gernot Böhme, Wolfgang van den Daele and Wolfgang Krohn posited finalization in the 1970s to denote the ‘process through which external goals for science become the guidelines of the development of the scientific theory itself’.[53] Their hypothesis was that only ‘completed and differentiated’, or ‘post-paradigmatic’ fields of science could become regulated by non-theoretical, socio-political goals. This meant that principally (and historically) theoretical, or internal, developments had priority over, and were the prerequisite for, making knowledge useful.[54] Still, this shields a certain ‘basic’ process of research from judgments, concerns and considerations about usefulness. And involvement of non-scientific actors in the production of knowledge took place only on the abstract level of priority-setting between fields by the state (rationality of planning) or ‘afterwards’, at the application stage of the discovered true knowledge (in applied and finalized science respectively).

In the 1990s a constructivist-deliberative governance approach to the political-epistemological question of utility developed, often shaped by policy debates.[55] Concepts like ‘post-normal science’, ‘mode-2 knowledge’ and the more recent ‘responsible research and innovation’ are analytic categories and political interventions. They share a historical observation that the socio-political context has changed to such a degree—becoming more uncertain, risky and global—that ‘traditional’, internally oriented, science is disappearing. One of the underlying reasons would be that it no longer leads to sufficient or the right kind of utility.[56] Again, these approaches do not throw a realist baby out with value-free bathwater. Previous relations between science

50 Sismondo, *Science Without Myth*, 36–37; Hans Radder, “Philosophy and History of Science: Beyond the Kuhnian Paradigm,” *Studies in History and Philosophy of Science Part A* 28, no. 4 (1997): 633–55.

51 Thomas Kuhn, “Objectivity, Value Judgment, and Theory Choice,” in *The Essential Tension: Selected Studies in Scientific Tradition and Change* (Chicago: Chicago University Press, 1977), 320–39.

52 Isabelle Stengers, *The Invention of Modern Science* (University of Minnesota Press, 2000).

53 Gernot Böhme, Wolfgang Van Den Daele, and Wolfgang Krohn, “Finalization in Science,” *Social Science Information* 15, no. 2–3 (1976): 307.

54 Peter Weingart, “From ‘Finalization’ to ‘Mode 2’: Old Wine in New Bottles?,” *Social Science Information* 36, no. 4 (1997): 591–613.

55 Laurens K. Hessels and Harro van Lente, “Re-Thinking New Knowledge Production: A Literature Review and a Research Agenda,” *Research Policy* 37, no. 4 (2008): 740–60; Michiel van Oudheusden, “Where Are the Politics in Responsible Innovation? European Governance, Technology Assessments, and Beyond,” *Journal of Responsible Innovation* 1, no. 1 (2014): 67–86.

56 Silvio O. Funtowicz and Jerome R. Ravetz, “The Emergence of Post-Normal Science,” in *Science, Politics and Morality* (Springer, 1993), 85–123; Helga Nowotny, Peter Scott, and Michael Gibbons. “Introduction: Mode 2 Revisited: The New Production of Knowledge.” *Minerva* 41, no. 3 (2003): 179–194.

and its surroundings ('normal' or 'mode-1' science) are not completely denounced; but the proponents also do not criticise the reversal of this relation, after which utility considerations will increasingly direct research ('post-normal' or 'mode-2' science). Helga Nowotny, Peter Scott and Michael Gibbons argue for example that policy-relevant problems, stakeholder participation, and the context of application will increasingly direct research and lead to *socially robust* knowledge—rather than to a disinterested, curiosity-driven search for *true* knowledge. In the context of European science policy, René von Schomberg has advocated a similar social constructivist call for 'responsible research'. This comprises the involvement of 'all societal actors ... to ensure that the results meet the needs of the world we live in'.[57] Instead of centralised planning and prioritisation by the state, as proposed by finalization, scholars like Nowotny and policymakers like Von Schomberg promote decentralised engagement of 'external' actors in local practices of knowledge production. This external democratisation of research can take place in different political modes. Representative inclusion of societal actors, for example, is based on the idea that powerful social groups have determined for too long the kind of knowledge to be attained, so now also underrepresented standpoints (e.g. from working class, female or non-western perspectives) should be included in the direction and execution of research.[58]

Similar to this variety of constructivist-deliberative concepts, the approach known as *technoscience* describes the inclusion of societal actors in knowledge production. But it differs fundamentally in its perspective on the history of science: not the *practice* but rather the *interpretation* of processes of knowledge production is changing. Although the concreteness of practice has always been primary, in modernity it has been possible to 'purify' it into neat categories (nature / culture, science / technology, description / intervention). However, the obstinate manifestation of research objects as hybrids of nature and technology has made it increasingly impossible to maintain these strict boundaries.[59] To describe this reality more appropriately, Gilbert Hottois coined 'technoscience', a term that became popular amongst material-discursive constructivist approaches to science, nature and technology (from Bruno Latour's actor-network theory to Donna Haraway's cyborg feminism).[60] In a-modern interpretations of scientific practices also past science can thus be understood as technoscience, where the context of knowledge is conflated with its content.[61] The modern 'purification' of different categories and processes of science and society also made possible the distinction between internal and external factors in knowledge production. Latour therefore proposed to talk no longer of a strictly separated 'science' and 'society', but of weaker and stronger associations between

57 René Von Schomberg, "A Vision of Responsible Research and Innovation," in *Responsible Innovation: Managing the Responsible Emergence of Science and Innovation in Society*, ed. R. Owen, M. Heintz, and J. Bessant (London: John Wiley, 2013), 51–74; Oudheusden, "Where Are the Politics in Responsible Innovation?," 70.

58 Sandra Harding, *Is Science Multicultural? Postcolonialisms, Feminisms, and Epistemologies* (Bloomington & Indianapolis: Indiana University Press, 1998).

59 Gregor Schiemann, Hans Radder, and Alfred Nordmann, *Science Transformed? : Debating Claims of an Epochal Break* (Pittsburgh, PA: University of Pittsburgh Press, 2011).

60 Gilbert Hottois, "La technoscience : de l'origine du mot à ses usages actuels," *Recherche en soins infirmiers*, no. 86 (2006): 24–32; Latour, *Science in Action*; Donna Haraway, *Simians, Cyborgs, and Women: The Reinvention of Nature* (New York: Routledge, 1991)..

61 John V. Pickstone, *Ways of Knowing: A New History of Science, Technology, and Medicine* (University of Chicago Press, 2001).

heterogeneous elements. The success, or usefulness, of technoscience is a result of the reciprocal shaping of the social and the natural world.[62]

This actor-network approach studies knowledge production in terms of translation networks in which scientific claims start as 'fictions' that develop the status of 'fact' only if they receive sufficient interest from others.[63] Any new scientific claim can be stabilised by gathering a wide variety of allied 'actants'—including texts, devices, skills, institutions, and humans, from researchers and technicians to industrialists, politicians and activists. Stabilising a claim, or making it reliable, thus requires extension of the network. A strict boundary between the inside ('producers') and outside ('users') of research cannot be easily drawn in this view. The diversity of actors involved in knowledge production blurs the distinction between the activities of research and its distribution 'outside the laboratory'. Contrary to the above proposals for centralised and decentralised democratic governance of scientific research, the technoscientific move is first of all at the level of research, not of policy. Current science policies aiming to improve the societal value of research typically concern themselves with the relations between scientific and societal actors, which, from the technoscientific perspective, appear integral to the network that sustains the primary research process. This implies that one cannot simply distinguish between active producers and passive recipients of knowledge, or between internal and external values, interests and factors that shape research. More strongly than for the finalization or constructivist-deliberative accounts, this view might induce the relativist reproach that this makes the credibility of knowledge dependent on the views and fads of allied actants, be it industry, politicians or society. But the issue at stake is, I believe, not an either/or choice between disinterested objectivity and relativism, or between truth and utility. The premise is instead that overlapping, if not the same, heterogeneous actor-networks (that also include non-human actors) are the condition for knowledge to appear and function as true and useful.

Although originating from diverse practical and theoretical contexts, these post-modern concepts all blurred traditional distinctions between the inside and outside of science. Instead of a simple image of an autonomous practice of research, utility is included as relevant political-epistemic factor in knowledge production. Some theories of useful research claim that this has always been the case; some argue that an epochal break has occurred in the content and practice of science. With respect to knowledge transfer, this has invariably led to the denunciation of a linear model of innovation. Instead of a one-directional flow of pure, basic or fundamental knowledge to new applications, innovations, products and ultimately economic growth, much richer models of knowledge transfer have been proposed

62 Sergio Sismondo, *An Introduction to Science and Technology Studies* (Chichester: Wiley-Blackwell, 2010), 65–66.

63 Latour, *Science in Action*; Isabelle Stengers, *Power and Invention: Situating Science* (University of Minnesota Press, 1997); Michel Callon, "Four Models for the Dynamics of Science," in *Science and the Quest for Reality* (Springer, 1995), 249–292; Smit and Hessels, "The Production of Scientific and Societal Value in Research Evaluation."

(and have arguably existed in the minds of many historical actors).[64] With the 'triple' and 'quadruple' helices of university-industry-government-society relations scholars have tried to describe a non-linear dynamics of innovation, which would have emerged as a consequence of the displacement of a Cold War (military) elite.[65] Again, this points to the networked structure between actors from universities, industry and government that both enables the alignment of research with practical interests and supports the many intermediate processes back and forth between research and use. I agree that, to understand utility, we need to be aware of the networked character of scientific research and its circulation. What is more, I argue that it points us to the spatial character of the processes that enable and sustain utility. In the next few sections, I will explore the study of this spatiality of research.

1.4 The Study of the Spatiality of Scientific Research

The places, sites and geographies of scientific research have received widespread attention in science studies since the 'spatial turn' in the 1990s.[66] Geographical approaches to the history of science are another way in which the 'modern' view of science has been challenged, replacing the universality and 'placelessness' of formalised knowledge with the contextuality, locality and situatedness of research practices. In this body of literature, a distinction is commonly made between *fixed sites of knowledge production* and *dynamic processes of knowledge circulation*. However, they can be perceived to be two sides of the same epistemological problem: 'How is it, if knowledge is indeed local, that certain forms of it appear global in domain of application?'[67] Or, as Thomas Gieryn reformulated it, this concerns 'the paradox of place and truth': claims originate *somewhere*, but once accepted as true they become *placeless* and apply *anywhere*.[68] Epistemological answers could be formulated in terms of the post-modern concepts of useful research described above. But in this section, I will focus on literature that approaches this question as a spatial issue.

In the following, I therefore discuss several approaches to this 'issue of travel': how can knowledge circulate (globally) if its production is fundamentally local?[69] First, I discuss approaches that stress the 'locality' of research and, second, those approaches that emphasize (global) circulation instead. Circulation is the key towards the development of a spatial understanding of the practice, policy and rhetoric of utility, and related concepts like knowledge transfer and valorisation. But, thirdly, I will argue that the exchange of knowledge, skills and values between scientific and 'non-scientific' actors

64 David Edgerton, "'The Linear Model' Did Not Exist: Reflections on the History and Historiography of Science and Research in Industry in the Twentieth Century," in *The Science-Industry Nexus: History, Policy, Implications.*, ed. Karl Grandin, Nina Wormbs, and Sven Widmalm (USA: Science History Publications, 2004), 31–57; Benoît Godin, "The Linear Model of Innovation: The Historical Construction of an Analytical Framework," *Science, Technology, & Human Values* 31, no. 6 (2006): 639–67.

65 Henry Etzkowitz and Loet Leydesdorff, "The Dynamics of Innovation: From National Systems and 'Mode 2' to a Triple Helix of University–Industry–Government Relations," *Research Policy* 29, no. 2 (2000): 109–123; Elias G. Carayannis and David F. J. Campbell, "Mode 3 Knowledge Production in Quadruple Helix Innovation Systems," in *Mode 3 Knowledge Production in Quadruple Helix Innovation Systems: 21st-Century Democracy, Innovation, and Entrepreneurship for Development*, ed. Elias G. Carayannis and David F.J. Campbell (New York, NY: Springer, 2012), 1–63.

66 Diarmid A. Finnegan, "The Spatial Turn: Geographical Approaches in the History of Science," *Journal of the History of Biology* 41, no. 2 (2008): 369–88.

67 Adi Ophir and Steven Shapin, "The Place of Knowledge: A Methodological Survey," *Science in Context* 4, no. 1 (1991): 15.

68 Thomas F. Gieryn, "Three Truth-Spots," *Journal of the History of the Behavioral Sciences* 38, no. 2 (2002): 113.

69 Steven Shapin, "Placing the View from Nowhere: Historical and Sociological Problems in the Location of Science," *Transactions of the Institute of British Geographers* 23, no. 1 (1998): 5–12.

receives less attention in this historical geographic literature. In the concluding section of this methodological introduction, I therefore elaborate the hybrid, heuristic concept of *utility spot* to highlight the local embedding of places that stimulate knowledge exchange between various contexts, communities and cultures. This adds another dimension to the problem of travel, namely, to what extent the circulation of knowledge can be considered part of its production. That, consequently, raises again the epistemological issue of the relations between the utility and truth of scientific research.

Before I begin the discussion of the historical geographical literature on science, some clarity is required about the conceptual distinction between space and place. It is quite common to perceive this as an epistemological distinction between two types of *understanding* place.[70] On the one hand, geometric representations of reality produce an abstract understanding of 'space', within which places are nodes, or mere 'locations'. On the other hand, the phenomenological approach values 'place' as concrete, meaningful milieus that mediate human activity and experience. Or, to rephrase this difference, space is merely a surface or canvas on which human life occurs, whereas place is a holistic context that makes it possible. Epistemologically, space is associated with a nomothetic approach—describing the general laws that structure spatial reality—and place with an idiographic approach—describing the particulars of lived experience and practice. This difference manifests itself in the extent to which these two approaches consider place to be incidental to, or actively shape, non-spatial processes. Although the mediating role of place in social relations and meaning has experienced a revival in geography, the passive place as location in space is still dominant in some social sciences.

However, alternative approaches have emerged that challenge the space/place dichotomy more generally.[71] Shared by these post-structuralist approaches, from neo-Marxists like Henri Lefèbvre to feminist geographers like Doreen Massey, is the emphasis on the construction of place through social practices. Place is then no more a sediment of the past and its apparent permanence is not fundamental, but an accomplishment of a temporally stable set of relations and interactions from local to global scales. Post-structuralist scholars therefore collapse the place/space dichotomy by speaking of 'relational space': physical, biological, social and cultural processes 'make' space.[72] Any place is always in the 'process of becoming', as its constituent parts are not rigid structures, but the flow of consensual and contested relations between various entities. Space becomes a 'meeting place' where relations come together and mix. This also entails that a 'power geometry' emerges: as any place is a unique intersection of social, cultural, and physical processes, some social groups

70 John Agnew, "Space and Place," in *Handbook of Geographical Knowledge*, ed. John Agnew and David N. Livingstone (London: SAGE Publications Ltd, 2011), 316–330.

71 Agnew.

72 Doreen Massey, *For Space* (London: Sage Publications Ltd, 2005); Jonathan Murdoch, *Post-Structuralist Geography : A Guide to Relational Space* (London: Sage Publications Ltd, 2006).

will be dominant or privileged, others excluded, suppressed or marginalised. The relations that constitute space can be both facilitating movement and access, as well as producing exclusion and confinement.[73]

In the historical, sociological and anthropological study of science the spatiality of scientific research has been generally studied in three ways. In some older approaches, both place and space are disregarded altogether: knowledge is universally true, it is placeless and fluently moves between locations. Second, places of knowledge production are studied in their particularity as *place*, often characterised by rigidity, permanence and partitions. Third, this localisation of research has incited the study of the global circulation of scientific results and technologies, characterised by stability-in-mobility, through *space*. These three options, which I will expand upon below, mostly fit within the space/place dichotomy. The criticisms raised of the 'circulation' concept offers the potential to study science too in relational space.

1.5 The Place of Scientific Research

It is much more difficult to imagine a practice of science outside space, than one outside society. Spatial, architectural and geographic factors are not external to research in the way some view societal and cultural factors to be. The latter might be contingent, historical facts of the production of knowledge, which shape (to a debatable degree, see section 1.2) the form and content of knowledge. But in theory-dominant views of science also space is incidental to intellectual work. No spatiotemporal context has epistemological privilege; any local site of investigation just functions as environment for the instantiation of universal claims.[74] Science studies in general disagree with this view because the study of research as practice has brought to light the importance of space and materiality. In this view, space is not a contingent canvas for scientific activities, but rather a condition of possibility. In an attempt to uncover the fundamental importance of space to research, historians, sociologists and anthropologists have analysed the historical variety of particular places geared at knowledge production.[75]

In science studies, and broader culture, the laboratory has functioned as an archetypical place for scientific research. Laboratories have achieved mythical status as temples of objectivity and truth. Since the 1980s, however, anthropologists have entered the lab to see for themselves what is really going on. Science studies scholars like Karin Knorr-Cetina, Sharon Traweek, Steve Woolgar and Bruno Latour have mapped the mundane activities, social interactions and material flows involved in the production of new reliable knowledge, and have

73 Murdoch, *Post-Structuralist Geography*, 22–24.

74 Joseph Rouse, *Knowledge and Power: Toward a Political Philosophy of Science* (Cornell University Press, 1987), 69–72.

75 David N. Livingstone, *Putting Science in Its Place. Geographies of Scientific Knowledge* (Chicago: Chicago University Press, 2003); Simon Naylor, "Introduction: Historical Geographies of Science–Places, Contexts, Cartographies," *The British Journal for the History of Science* 38, no. 1 (2005): 1–12; Finnegan, "The Spatial Turn"; Christopher R. Henke and Thomas F. Gieryn, "Sites of Scientific Practice: The Enduring Importance of Place," in *The Handbook of Science and Technology Studies,* ed. Edward J. Hackett, Olga Amsterdamska, Michael Lynch and Judy Wajcman (Cambridge, MA: MIT Press, 2008), 353–76.

described the variety of values and interests that shape the practice of research.[76] Ultimately, their studies have contributed significantly to the demystification of a value-free, pure image of scientific research. In these studies, space and place figured mostly abstract and schematically as part of the social-material context of knowledge production. More insight into the role of space in knowledge production can be found in microhistories of the laboratory, but also of the field, the museum or the botanical garden. Often such studies described how the (architectural) organisation of a certain space controlled *who* and *what* could be involved in research, both socially in- and excluding reliable actors, and materially in- and excluding disturbing environmental factors.

One of the most important ways to shape social interactions around science is the boundary between insiders and outsiders: between those who have access to the private backstage of knowledge production and those who are allowed to experience only the front stage of research, its results and successful public demonstration. The laboratory is situated ambiguously between the private and the public realm. The first laboratories in the seventeenth century were defined according to the presence of a furnace and mirrored the secrecy and seclusion of alchemist workplaces, often being situated in basements. The early modern experimenters that dwelled in the laboratories had to balance the privacy and exclusion of external factors required for inquiry, with the public demonstration and dissemination of their results. By physically rearranging features of gentlemen's houses, college rooms, artisan workshops and monasteries, the laboratories came to represent cultural credibility, and shaped social interaction in such a way that experimenters' claims to natural knowledge were accepted.[77] Exclusion is, both conceptually and historically, perhaps the most obvious strategy in this respect: women, for example, were excluded from official scientific spaces for a long time, and to the experimental space of the Royal Society only 'credible' witnesses of social standing were welcomed.[78]

In both cases, the exclusion or inclusion also had broader cultural significance, as the space of knowledge production became connected to powerful symbolic associations.[79] An extreme case of exclusion is represented in the image of the ivory tower, which isolates the (academic) pursuit of knowledge from all external factors.[80] This paradigm of seclusion has been reason for some philosophers to argue that societal detachment of science is a prerequisite, while many commentators have also used it as straw man to plead for a more socially engaged science. But, as Jan Golinski pointed out, even *anti*-social behaviour is not *a*-social, that is, even solitude follows social conventions and is a public pose: by seeking isolation one assumed 'the role of a dedicated searcher after truth' and was perceived to move closer to the abstract realm of truth.[81]

76 Karin Knorr-Cetina, *The Manufacture of Knowledge: An Essay on the Constructivist and Contextual Nature of Science.* (Oxford New York: Pergamon Press, 1981); Steve Woolgar and Bruno Latour, *Laboratory Life: The Construction of Scientific Facts* (Princeton, NJ: Princeton University Press, 1986); Sharon Traweek, *Beamtimes and Lifetimes. The World of High-Energy Physics.* (Cambridge, MA: Harvard University Press, 1992).

77 Jan Golinski, *Making Natural Knowledge: Constructivism and the History of Science* (University of Chicago Press, 2005), 84–86.

78 Peter Galison, "Buildings and the Subject of Science," in The Architecture of Science, ed. Peter Galison and Emily Thompson (Cambridge, MA: MIT Press, 1999), 4.

79 The foundational study in this respect is Steven Shapin and Simon Schaffer, *Leviathan and the Air Pump. Hobbes, Boyle and the Experimental Life* (Princeton, N.J.: Princeton University Press, 1985).

80 Shapin, "The Ivory Tower."

81 Golinski, *Making Natural Knowledge*, 81–83.

Still, it is only when a claim is transferred from private to public that it can become stabilised as a reliable assertion, as 'true' knowledge.[82] Where the laboratory is an enclosed space that facilitates a transfer from private to public, fieldwork represents a very different spatial modality of knowledge production—one in which scientific work begins 'outside', where regions of space have to be translated in such a way that they can travel inside, and be manipulated to become knowledge. Fieldwork sciences do not alter space (physically and socially) by seclusion, but rather by creating networks of spatial relations, of transfer and translation, between the field and the centres of knowledge production. Knowledge production in laboratories and the field actually share the characteristic that acceptance depends on the successful extension of private claims to the world outside.[83]

Places of knowledge production also situate scientists 'in cultural space' and enable particular types of work. Laboratories, universities and museums are imbued with, and imbue their users with, cultural values and identity. The architecture and symbolical arrangements of scientific practice represent and transform scientific identity with respect to other specialities as well as society at large.[84] In addition, spatial divisions and structures stimulate particular modalities of cooperation. For example, in the twentieth century, institutions were established that facilitated research based on the interactions between theorists, experimenters and engineers, or among researchers from various disciplines. More generally, the secluded, private and highly individual ideal of a monk's cell has been replaced by the factory-like mass production of scientific knowledge in the 'big science' facilities centred on million-dollar instruments.[85]

Ultimately, space thus functions epistemologically. Not only do certain geographical locations, spatial divisions and material networks enable diverse research practices, but particular places of knowledge production also determine its perceived veracity. This aspect of spatial arrangements is what Thomas Gieryn was after when he coined *truth spots*: 'delimited geographical locations that lend credibility to claims' and consist of the 'material stuff' and the 'cultural interpretations and narrations' that give it meaning.[86] The 'geographic, architectural and rhetorical construction' of truth spots achieves 'the passage from place-saturated contingent claims to place-less transcendent truths'.[87] Highly standardised laboratories in the life sciences are primary examples of contemporary truth spots. The 'presumption of equivalence' between geographically dispersed laboratories makes the spaces *as particular places* invisible: scientists have put work in excluding all irrelevant factors from the research process, so that spatial aspects, for example, do not have to be highlighted in publications or procedures. Clearly, space has a political-epistemic function in this

82 Steven Shapin, "The House of Experiment in Seventeenth-Century England," *Isis* 79, no. 3 (1988): 373–404.

83 Golinski, *Making Natural Knowledge*, 100–102; Robert E. Kohler, *Landscapes and Labscapes: Exploring the Lab-Field Border in Biology* (Chicago: Chicago University Press, 2002).

84 Sophie Forgan, "The Architecture of Science and the Idea of a University," *Studies in History and Philosophy of Science Part A* 20, no. 4 (1989): 405–434; Galison, "Buildings and the Subject of Science," 1–3.

85 Galison, "Buildings and the Subject of Science," 15–19.

86 Thomas F. Gieryn, "City as Truth-Spot: Laboratories and Field-Sites in Urban Studies," *Social Studies of Science* 36, no. 1 (2006): 5; Thomas F. Gieryn, *Truth-Spots: How Places Make People Believe* (University of Chicago Press, 2018).

87 Gieryn, "Three Truth-Spots," 113.

approach, as it contributes to the legitimation of certain claims as reliable scientific knowledge.[88] The lack of particularity of a place makes this epistemic function possible. The assumption is that knowledge can travel when social behaviour is identical at the sending and receiving end. Although it seems that this is achieved by the standardised spatial organisation of research, which transforms unique places into generic spaces, historical and sociological studies of scientific practice demonstrate that we need to situate truth spots in specific local and cultural contexts as well as with respect to unique and reproducible social relations.

As researchers are obviously situated in concrete places to conduct their investigative work, their laboratories, libraries, observatories, archives and museums are themselves situated in geographical and societal space. They are part of universities, government departments or firms; they are located in the midst, on the fringes or outside of cities; they participate in a regional and global economy and are subject to (inter)national policies and laws; and they are involved in the construction of cultural identities of larger scientific and societal wholes, from cities to nations, from disciplines to geopolitics.[89] And, some would add, spaces for knowledge production develop in relation to environmental conditions, from the soil and climate to an area's hydrology and latitude.[90]

1.6 The Circulation of Scientific Research

As we zoom out, it becomes clear that scientific places of production are not distributed evenly over the globe.[91] And if we likewise zoom out culturally, it turns out that also the appreciation of the different places is uneven. Historically, various commentators have presented science as a purely Western-European creation that spread from there to the rest of the world.[92] Infamous is George Basalla's 'three stage model' for the globalisation of scientific research: first, peripheral, non-European, territories served as reservoirs of information, from which scientific knowledge was produced in the European centres; subsequently colonial science, of lower standing, was transported to and performed in these same peripheral regions; and from those practices grew independent national scientific traditions in colonised countries. However, this concept of a unidirectional diffusion of science—its results, its methods, its values—from the West to the Rest has, after waves of criticism, been rejected.[93]

This diffusion debate is one of the origins of the widespread attention for 'circulation' in postcolonial studies, anthropology and history of science. For science studies more generally, the localisation and contextualisation of what was once regarded as universal knowledge is another important origin. The travel

88 Henke and Gieryn, "Sites of Scientific Practice: The Enduring Importance of Place," 353–55.

89 Naylor, "Introduction," 7–8.

90 Harold Dorn, *The Geography of Science* (Johns Hopkins University Press, 1991).

91 Henke and Gieryn, "Sites of Scientific Practice: The Enduring Importance of Place."

92 Kapil Raj, *Relocating Modern Science: Circulation and the Construction of Knowledge in South Asia and Europe, 1650–1900* (Palgrave Macmillan UK, 2007), 1–3.

93 Daniel R. Headrick, *The Tentacles of Progress: Technology Transfer in the Age of Imperialism, 1850–1940* (New York: Oxford University Press, 1988); Kapil Raj, "Beyond Postcolonialism… and Postpositivism: Circulation and the Global History of Science," *Isis* 104, no. 2 (2013): 337–347.

of knowledge requires explanation if its production is unveiled to be intensely local. Studying the 'circulation' of knowledge has been proposed as a response. A necessary move because, as James Secord has argued, in science studies 'the further we move away from sites of the production of new knowledge, the vaguer our descriptive categories tend to become'.[94] Concepts like 'trading zones' and 'boundary objects' have been used to capture knowledge 'in transit'. Peter Galison introduced the trading zone concept to tackle the rather inflexible Kuhnian notion of paradigms that resulted in the problem of incommensurability. Instead he identified the possibility of communication between different disciplines or specialties, as these communities created 'inter-languages', which functioned the way pidgins and creoles do in the sphere of trade between cultures.[95] The trading zone is usually limited however to interactions between (sub-) disciplines, technicians and engineers, implicitly excluding heterogeneous societal actors. And although it can be expressed materially, the trading zone concept is primarily linguistic. The same goes for Secord's 'circulation', which is understood in terms of *communication* between individuals within *specialised* communities.

To many ears, circulation rings too smooth as metaphor for the mobility of knowledge. Its emergence in scholarship concurred with the socio-cultural phenomenon of 'globalisation'. The risk of a focus on global interconnections and the flow of ideas, people and things, would be that it erases inequality, difference and power. To use Anna Tsing's metaphor, through the lens of circulation we stare at the creek, and only notice the water running. Rather, we should also pay attention to the channel that embeds this flow. Translated to the circulation of knowledge: 'political and economic channels' as well as 'material and institutional infrastructures' enable and stimulate the flow of knowledge.[96] In addition, circulation has been criticised because it seems to endorse an implicit model of knowledge production, consisting of three subsequent stages: data collection 'outside', which is processed into knowledge in a controlled and segregated laboratory, and then finally the spread (and acceptance) of this knowledge in the larger world. The materials, ideas and skills going in and out of the lab might move through space, but as scientific knowledge they remain stable. But, according to Kapil Raj, circulation should instead bring to the fore the 'mutable nature of the materials' (including actors, their embodied knowledge and skills) and the 'transformations and reconfigurations in the course of their geographical and/or social displacement'.[97] Or, to put that differently, the study of circulation should take account also of the obstacles, hindrances, detours and alterations of knowledge in transit.[98]

The mutability and infrastructural embedding of knowledge flows relate to 'immutable mobiles'. In *Science in Action*, Bruno Latour introduced this concept to explain the travel of scientific

94 James A. Secord, "Knowledge in Transit," *Isis* 95, no. 4 (2004): 662.

95 Peter Galison, "Trading with the Enemy," in *Trading Zones and Interactional Expertise. Creating New Kinds of Collaboration*, ed. Michael Gorman (Cambridge, MA: MIT Press, 2010), 25–52.

96 Anna Tsing, "The Global Situation," *Cultural Anthropology* 15, no. 3 (2000): 336–38.

97 Raj, *Relocating Modern Science*, 20–21.

98 Wiebke Keim, "Conceptualizing Circulation of Knowledge in the Social Sciences," in *Global Knowledge Production in the Social Sciences*, ed. Wiebke Keim, Ercüment Çelik, and Veronika Wöhrer (London: Routledge, 2014), 107–134.

knowledge: first, raw data travel as immutable mobiles to 'centres of calculation', where they are combined with others to produce scientific facts, which subsequently can travel as new immutable mobile from these local situations of production to laboratories elsewhere.[99] Or, in Simon Schaffer's words: 'We should then distinguish between the process of 'localisation', through which local techniques get to work at sites like labs via the concentration of widely distributed resources, and 'spatialisation', through which techniques which are efficacious within the lab, manage to travel beyond it.'[100] Characteristic of scientific knowledge, then, is that it can move in geographic space, while retaining its meaning, characteristics and effects by institutionalisation and standardisation. Preventing 'slippage within the network' is precisely the point of scientific practices but seems at odds with the origins of the circulation metaphor. In economic models of wealth creation through trade the circulation of money and commodities requires that 'not everywhere [is] the same as everywhere else', the opposite is required for the 'circulation' of scientific knowledge.[101]

Although Raj retains the circulation metaphor, he launches a fundamental criticism of the immutability of scientific knowledge. Instead, he proposes to consider the material of science as 'mutable mobiles', as they also change shape in the process of circulation. John Law and Annemarie Mol explicated these concepts by distinguishing between the different kinds of 'space' in which change takes place. Both Raj and Latour agree that technological and scientific things displace geographically, i.e. they are mobile in the geometric sense of space. But where Latour claims that the mobiles maintain stability in the 'network space', Raj argues that also this space mutates: that is, their position in the network—the relations to a whole configuration (or: channel) of other things, people and ideas (or: actants)—that defines their functioning and meaning *also* changes as they change places.

Law and Mol rather understand both mutable and immutable mobiles to be modalities of the circulation and spatiality of knowledge. What they dub 'fluid' spatiality allows the geographical *and* gradual network displacement of a thing, similar to Raj's concerns.[102] In their interpretation, we can distinguish this as one of four 'topological systems': with 'regions' they capture the attention for the 'local' sites of knowledge production (the 'somewhere' of research, as an immutable immobile); with 'network' the possibility of stability during travel (immutable mobile); with 'fluid', as mentioned, the possibility of configurational variance during geographical displacement (mutable mobile); and lastly, they add a 'fire' topology to exhaust the possibilities of Latour's original concept, namely to represent a 'mutable immobile'. The fire spatiality returns to the local, but now finds the global as always already a part of it. Things that remain in place, but in flickering patterns show the

99 Latour, *Science in Action*.

100 S. Schaffer, "The Eighteenth Brumaire of Bruno Latour," *Studies in History and Philosophy of Science* 22, no. 1 (1991): 190; Richard C. Powell, "Geographies of Science: Histories, Localities, Practices, Futures," *Progress in Human Geography* 31, no. 3 (2007): 313.

101 Dear, "Science Is Dead; Long Live Science," 49.

102 John Law and Annemarie Mol, "Situating Technoscience: An Inquiry into Spatialities," *Environment and Planning D: Society and Space* 19, no. 5 (2001): 609–21.

presence and absence of distant but conjoined alterities.[103] In a similar fashion, Tsing stresses that the local is *not* a stopping point for global circulations; rather, flow does not transcend or obliterate place, but is continuously 'making terrain' and 'making place'.[104] Also Raj's proposal to study circulation as 'site of knowledge production' takes the enduring significance of localities into account, while simultaneously calling out the historicity of the 'nature and geography of the spaces of circulation'.[105] As such, the historical and anthropological exploration of modalities of circulation concurs with the post-structuralist relational space, as it integrates 'space' and 'place', dynamism and stasis, the past, present and future.

Still, much literature in history and philosophy of science is focused on the transfer of knowledge between spatially dispersed specialised communities, (sub)disciplines and heterogeneous actors within a disciplinary practice. Although this literature often takes social, cultural and political factors into account, the focus is on movement of knowledge within 'scientific' boundaries. By delimiting the study of circulation, epistemic transfer, or 'flow of cognitive goods' to intra-scientific displacements between different disciplines (e.g. at the intersection of history and physics), these approaches participate in, or reproduce, boundary work; that is, it is implicated that knowledge exchange with society is not of similar epistemic interest.[106] However, constructivist studies of knowledge production support the idea that these different processes of knowledge exchange are epistemologically on a par (see section 1.3 above).[107] What is required therefore is the productive synthesis of two bodies of literature: one focusing on the political epistemology of *useful* research and one taking the *circulation* of scientific research as its site of analysis. Crosbie Smith and Jon Agar have pointed in this direction, when they ended their introduction to *Making Space for Science* with a section 'Of Knowledge Transfer'.[108] But an overarching analytical perspective on the circulation of useful knowledge is still lacking. In the following section of this introduction I therefore propose the heuristic concept *utility spot* to highlight, study and interpret the intersection of spatiality and usefulness in (the history of) scientific practice. This is the basis for a historical-geographic approach to the epistemology of useful research.

1.7 A Spatial Approach to the Utility of Scientific Research

The argument of this dissertation is that a spatio-historical approach is a fruitful way to study epistemological questions about science policy concepts. This concerns questions about the relation between knowledge production and value creation, and whether interactions with non-academic actors are

103 Law and Mol, 610–16.

104 Tsing, "The Global Situation," 338.

105 Raj, *Relocating Modern Science*, 234; Keim, "Conceptualizing Circulation of Knowledge in the Social Sciences."

106 Rens Bod et al., "The Flow of Cognitive Goods: A Historiographical Framework for the Study of Epistemic Transfer," *Isis* 110, no. 3 (2019): 483–496; Catherine Herfeld and Chiara Lisciandra, "Knowledge Transfer and Its Contexts," *Studies in History and Philosophy of Science Part A* 77 (2019): 1–10.

107 Smit and Hessels, "The Production of Scientific and Societal Value in Research Evaluation."

108 Crosbie W. Smith and Jon Agar, "Introduction: Making Space for Science," in *Making Space for Science: Territorial Themes in the Shaping of Knowledge*, ed. Crosbie W. Smith and Jon Agar, Science Technology and Medicine in Modern History (Basingstoke: Macmillan Press, 1998), 21–23.

conceptually, practically, temporally and spatially part of the research process. The concrete geographic, architectural and spatial arrangements for useful scientific research on which these concepts build, or that have been built because of these concepts, expose answers and entail political epistemologies. In this dissertation I will therefore study the *places* that stimulate and shape the interactions between 'scientific' and 'societal' actors, to be able to map useful knowledge production in circulation. Or what I call *utility spots*. As a heuristic concept, 'utility spot' is proposed as conjectural hypothesis that will inform, and be informed by, empirical studies. Its plausibility, in conclusion, will depend on its usefulness for the organisation and interpretation of historical reconstructions of scientific practice.[109] In this section, I combine the epistemology of useful research and the spatiality of scientific research into a historical-geographical approach to the meta-scientific concept of utility and its concrete instantiations in science policy concepts such as knowledge transfer, societal relevance and valorisation.

As might be obvious from the above, my methodological focus is informed by the broad field of science studies, especially historical and anthropological approaches to the geography, architecture and spatiality of research. There exists, however, also an extensive body of research on the economic geography of innovation. Much of this literature focuses more on firms and industries than on university knowledge production.[110] One important strand of research that is concerned with university-industry knowledge exchange focuses on the relation between (tacit) knowledge spill-overs and geographical location. Similar to the economic studies of utility, these studies are mainly interested in relating inputs (like the number of prominent researchers or publications) to outputs (like the number of new biotech firms or citations in patents).[111] In this particular case, their local and regional focus adds a spatial dimension to the understanding of the relations between science and society. However, these economic approaches tend to overemphasize the concrete (quantifiable) products of research in terms of new firms, patents, and profits, whereby they also adopt a limited (ahistorical and apolitical) understanding of usefulness and knowledge exchange.

The utility spot concept, and my historical geographical approach more in general, is instead informed by concepts that have been used to understand (post-) colonial knowledge circulation as well as knowledge exchange between science and society. This is not just a coincidental combination; Latour, for example, uses imperialistic discourse to discuss the circulation of knowledge through society because it have been 'patterns of military domination, colonialism and worldwide trade' that created the channels for the spread of knowledge.[112] And post-colonial critiques challenge linear models of knowledge transfer from centre to periphery (or North to South),

109 Compare the 'conjectural hypothesis' of instrumentality in: Dear, "Science Is Dead; Long Live Science." (pp.40, 55)

110 Augusto Cusinato and Andreas Philippopoulos-Mihalopoulos, *Knowledge-Creating Milieus in Europe* (Springer, 2016).

111 Ajay K. Agrawal, "University-to-Industry Knowledge Transfer: Literature Review and Unanswered Questions," *International Journal of Management Reviews* 3, no. 4 (2001): 294–96; Jeremy R. L. Howells, "Tacit Knowledge, Innovation and Economic Geography," *Urban Studies* 39, no. 5–6 (2002): 871–84.

112 Shapin, "Placing the View from Nowhere."

while science studies attack linear models of knowledge transfer from science to society. In the former, the emphasis is on the geographical displacement of knowledge within specialised communities. In the latter, the emphasis is instead on the movement of knowledge from a specialised community to a practical realm, and this is assumed to take place within a relatively homogeneous geographical space (like a nation). In both cases, 'linearity' of these relationships is the straw man to criticise. Instead, these scholars stress interaction, transformation and negotiation patterns between actors spread in either social or geographical space. When we consider both processes as interactions between different cultures or communities (without reifying them into homogeneous units) they are both processes of knowledge-production-in-circulation. These processes are themselves sites of knowledge production, and are not ephemeral but can be, and often are, situated in specific locales. The concept of utility spot is a lens to identify, magnify and examine such places.

Conceptually, I define utility spot dialectically with respect to three concepts from science studies and postcolonial studies that pay due to the locality of circulation. First, utility spot is an epistemological mirror-image of *truth spot*. I endorse Thomas Gieryn's attention for the geographic, architectural and rhetoric arrangements as well as cultural meanings that embed the practice of scientific research.[113] But where his concern ultimately is for *credibility* of knowledge, for example in relation to an international specialised scientific community, mine is for the *utility* of knowledge, precisely realised outside this 'internal' community. Second, I therefore adopt aspects of *spaces of circulation*, which direct our attention to the requirements for the exchange of knowledge to society. The movement of immutable mobiles, or the process of spatialisation, requires nodes in the network that function as landing strips, where practices also work outside their original site of production. Interpreting Pasteur's vaccination work, for example, Latour argues that knowledge was able to move—as an immutable mobile—from his laboratory into society by creating new local spaces where they could land, on which the required network space was transposed.[114] Building on the work of Latour, and Schaffer's interpretation of it, I aim to further concretise the spatialisation process in specific spots.

Utility spots thus are not only extensions of sites of knowledge production, but also testing grounds for societal use. This is, thirdly, stressed also by *contact zones*: the configuration for circulation of knowledge is determined by all involved actors. Mary Louis Pratt describes these zones, especially with respect to colonial situations and their aftermath, as 'social spaces where cultures meet, clash and grapple with each other, often in contexts of highly asymmetrical relations of power'.[115]

113 Gieryn, *Truth-Spots*.

114 Bruno Latour, "Give Me a Laboratory and I Will Raise the World," in *Science Observed. Perspectives on The Social Study of Science.*, ed. Karin Knorr-Cetina and Michael Mulkay (London: SAGE Publications Ltd, 1983), 141–70; Schaffer, "The Eighteenth Brumaire of Bruno Latour."

115 Mary Louise Pratt, "Arts of the Contact Zone," *Profession*, 1991, 34; Mary Louise Pratt, *Imperial Eyes: Travel Writing and Transculturation* (London and New York: Routledge, 1992).

‘Transculturation’ takes place: through strategies of critique, collaboration, translation, mediation, parody and denunciation also marginal groups selectively appropriate parts of the dominant actor into their traditions. Kapil Raj generalises the contact zone as a space for mutable mobiles, with a focus on ‘encounters … between different types of human activity—trade, statecraft, and knowledge-making—in the same or different geographical settings’. As different practices, knowledges and people come together in these contact zones, attempting to create a common world, the role of mediators emerges as crucial.[116]

Contact zones, spaces of circulation and truth spots respond to the question of travelling knowledge, without completely obliterating the importance of place. To understand places of knowledge transfer to society, *utility spot* combines the attention for the meeting place of heterogeneous cultures and its politics of the contact zone, with the emphasis on networks of spaces of circulation and the contextual meanings of a particular place of truth spots. I propose the following initial working definition:

> Utility spots consist of the spatial arrangements that facilitate and stimulate the political-epistemic interactions between heterogeneous actors, which actively shape the significance of research, with the public aim of creating and circulating useful scientific knowledge.

In this way, I view scientific sites of knowledge production and exchange not only as contexts of veracity, reliability and control, but especially as contexts of utility, extra-academic interactivity and power struggles. Analytically, I approach these spatial arrangements as modal conditions: they structure what useful research is considered possible. In the following chapters, I will use this framework to be able to identify such places in post-war Western societies. Reciprocally, the historical study of concrete meeting places will inform further refinements of the conceptual approach. The analysis of these places is informed by the concept of relational space, so that I will take seriously physical structures of various utility spots in relation to the social, cultural and power relations that form their fabric. Without reducing the spatial to the social, or vice versa, the utility spot concept serves as a lens that brings out the historically changing networks of useful research. Ultimately, my aim is to make past and current science policy (concepts) tangible by situating its problems, instruments and effects in concrete places and geographical dynamics. In the following section, I elaborate on recent Dutch valorisation policy to explicate what kind of epistemological questions will be investigated through the utility spot concept.

116 Raj, *Relocating Modern Science*, 225–33.

1.8 The Valorisation of Scientific Research

'I like to see science [*wetenschap*] as a city. A beautiful, strong fortified city [*vestingstad*],' spoke the Dutch secretary of state for science at the beginning of 2017, when he sent the 'valorisation letter' to parliament. Instead of an ivory tower, he continued, science as city sustained 'interactions with the world around it, [which] have, fortunately, increased in the last few years'.[117] Valorisation—'value creation from knowledge'—seemed to become the central concept of Dutch science policy after a decade of debate. In 2004, the Dutch minister responsible for science introduced valorisation in a strictly economic sense but it was hastily 'broadened' to include 'societal value' as well.[118] It had to encompass and stimulate a variety of activities, such as dissemination, application and co-production of scientific research. Notwithstanding plenty of opposition from the Dutch academic community, it materialised into specific 'valorisation paragraphs' in grant proposal assessments at funding organisations, valorisation support centres at universities, as well as rankings and indicators to evaluate 'valorisability' of research, researchers and universities. But the resistance persisted; the Royal Dutch Academy of Sciences (KNAW), representing the academic elite in the Netherlands, for example rejected valorisation because it still carried 'for many an economic connotation'.[119] A criticism that the new minister of Education, Culture and Science seemed to comply with when she restricted herself to the term 'societal impact' in a recent policy letter.[120]

Historically, the concept of valorisation first rings economically. Taking a conceptual historical approach, one could trace it to the English translation of Karl Marx's *Capital*. There, valorisation (*Verwertung*) denotes the creation of surplus value by labour power 'in the secret laboratory of production'. It is the process by which capitalist production escapes the paradigm of exchange. In French, valorisation is also used in a more abstract sense as an act that 'assigns greater value to something'. Philosopher of science Gaston Bachelard for example, in *L'air et les songes* (1943), described life as a poetic process of valorisation.[121] Etymologically, valorisation derives from the Latin *valor*, or value. The valorisation of scientific research thus has to do with the value of knowledge. More precisely, with a process of *valuing* knowledge. As valuation practice, we have to distinguish valorisation from evaluation.[122] In evaluating something—scientific research—we are merely estimating its value; when we valorise it, its value is actually modified. Where evaluation does not create value, but unveils a value already present in the good, valorisation adds value to the good. This distinction between evaluation and valorisation seems to parallel the difference between Bachelard's and Marx's use of the term.

117 All translations from Dutch are my own, including those used in quotations. 'Van publicatiedrift naar wetenschap met impact', *ScienceGuide*, 19 January 2017; State secretary of Education, Culture and Science, 'Wetenschap met impact', Parliamentary Papers 2016–2017, 31 288 (574), 19 January 2017.

118 Stefan P. L. de Jong, Jorrit Smit, and Leonie van Drooge, "Scientists' Response to Societal Impact Policies: A Policy Paradox," *Science & Public Policy (SPP)* 43, no. 1 (2016): 102–14.

119 KNAW, *Maatschappelijke impact in kaart* (Amsterdam: KNAW, 2018), 30.

120 Ministerie van Onderwijs, Cultuur en Wetenschap, *Nieuwsgierig en betrokken – de waarde van wetenschap.* (Den Haag: Ministerie van Onderwijs, Cultuur en Wetenschap (OCW), 2019).

121 Karl Marx, *Capital Volume 1*, trans. Ben Fowkes (London: Penguin Books, 1976), 293–306; Gaston Bachelard, *L'air et les songes* (Paris: José Corti, 1943).

122 François Vatin, "Valuation as Evaluating and Valorizing," *Valuation Studies* 1, no. 1 (2013): 31–50.

Even when we broaden our view from concepts to practices, valorisation still encompasses activities in the economic sphere of value increase and (re)creation: as a process to increase a product's exchange value on the market or as a process to create surplus value from products. For commodities like herring, dairy, coal, cacao, and coffee the issue of valorisation was raised whenever more monetary value had to be generated from existing production processes. Brazilian coffee producers and American cotton planters for example dominated the world market by conducting 'valorisation projects': they collected their coffee or cotton in a central depot, which required capital investments by the state, and then set prices by controlling distribution to the world market.[123] At other times, valorisation denoted specifically the exploration of new production processes to create more use value. Fisheries, for example, discussed in valorisation committees the conversion of pollack into animal flour.[124] In this sense, it connected to the use of the term in the context of valorising 'waste streams': the creation of 'useful applications' from residual goods through, for instance, chemical research.[125] Historically, then, valorisation refers both to practices that *increase* and practices that *create* value. The difference lies in the relation of valorisation to its object: value increase merely updates the value of the good through extrinsic measures (like control of distribution, cf. evaluation); value creation modifies the good itself, through new or improved production processes. It is the latter that takes place in the 'secret laboratory of production'.

Nowadays, one can speak not only of the valorisation of cotton and coffee, but also of the valorisation of scientific research. What does valorisation then entail epistemologically? In Dutch policy circles, including the ministry for Education and Science and intermediary bodies like the national research council and the association of universities, some consensus developed between 2005 and 2015 about the definition of valorisation. Namely, that it is a process that appears in diverse modalities and that leads not only to economic but also to societal use.[126] The Rathenau Institute, a publicly funded Dutch think tank for science policy and technology assessment, in 2011 articulated the definition that is currently in use at universities and the ministry:

> Valorisation is the process of creating value from knowledge by making it suitable and/or available for economic and/or societal use and translating it into [competitive] products, services, processes and entrepreneurial activity.[127]

This definition prompts epistemological questions such as: how do knowledge production and value creation exactly relate to each other? Are the same actors involved in both? Is valorisation part of the research process, or are they

123 Mercator, "Handelskroniek," *De Economist* 56, no. 1 (1907): 254–259; Th Luytelaer and J. Tinbergen, "De Koffievalorisaties: Geschiedenis en Resultaten," *De Economist* 81, no. 1 (1932): 517–538.

124 Nationaal Archief Den Haag (NA), Stichting Nederlandse Visserij, 2.19.031.02 inv.nr. 100, 'Valorisatie-cie, 1969–1970'.

125 NA, Ministerie van Landbouw; Directie Landbouwkundig Onderzoek, 2.11.73 inv.nr. 1148, 'Valorisatie van afvalstoffen 1986–1988.'.

126 de Jong, Smit, and van Drooge, "Scientists' Response to Societal Impact Policies," 108.

127 Leonie van Drooge et al., *Waardevol – Indicatoren voor Valorisatie* (Den Haag: Rathenau Instituut, 2011).

conceptually, practically, temporally and spatially distinct? Or, more generally put, is the utility of knowledge intrinsic or extrinsic to scientific research? Notwithstanding its apparently broad concept of value, an obdurate aura of commercial exploitation has persisted in policy contexts. The conceptual histories of valorisation can only partly explain this. The main thrust of this dissertation is instead that utility spots structure the epistemological questions and policy debates about the relation between research and value creation, and vice versa. In the conclusion of this dissertation, I will situate valorisation therefore with respect to real and imaginative spatial arrangements, *the science park* in particular. The historical part of this dissertation can thus also be viewed as an analysis of the emergence and circulation of this type of utility spot—and its impact on policy.

1.9 Overview

In the remainder of this dissertation, I develop the *utility spot* concept to test its fruitfulness as historical-geographical approach to the epistemology of useful research. My method will be historical in nature, with a main focus on the post-war period, 1950–1990, and on the United States, Western Europe and the Netherlands. A special interest lies with the transformation of universities and academic space more generally; this follows from the fact that a large share of publicly funded research takes place at universities and that science policy concepts like valorisation apply to this realm specifically. First, I will survey literature on utility spots in the US to refine the concept. Secondly, I will employ the spatial lens to revise history of science policy and universities in three chapters on utility spots in the Netherlands and Europe. These reconstructions will make manifest the spatiality and geopolitics of science policy, as well as the particularities of the circulation of utility spot models. I will cover this historical ground to develop further the methodological approach that I have introduced conceptually above. In the conclusion, I reflect in more abstract terms on the relations between the various excursions and what they have afforded us conceptually. As a consequence, I propose a fully developed definition of the utility spot concept that can incite further research.

Chapter 2, 'Utility Spots in the United States: Architecture, Location and Circulation', surveys the historiography of the organisation of scientific research in the US in the twentieth century through a spatial lens. This survey touches upon epistemological issues of knowledge production and transfer: the impact of external funders on the form and content of research as well as the debated existence of a linear model of innovation. But these themes will consistently be interpreted spatially by describing the scholarship on specific places of knowledge production that have functioned as paradigms of useful research, from Bell laboratories to RadLabs and Silicon Valley. Special attention goes to the origins of this last place, and the Stanford science park model more specifically, and its relation to larger political-economic shifts in the 1980s. From this I draw architectural, location and circulation aspects of the utility spot concept.

The employment of the spatio-historical approach in chapters 3 and 4 leads to a revision in the Dutch history of science (policy): concrete spatial tensions in, and virtual spatial solutions for, the organisation of useful research preceded (more abstract) science policy discussions in the 1960s. Chapter 3, 'The Spatiality of Science Policy. Para-University Institutes for Sponsored Research, 1954–1963', looks at a bottom-up, interuniversity debate about the appropriate place for independent and contract research in technical and general universities in the Netherlands. Policymakers, university governors, professors and industrialists discussed, in spatial terms, the organisation of useful research on campus. The ideal distance between academic and extra-academic actors turned out to be a delicate issue. Chapter 4, 'The Geopolitics of European Universities and Advanced Institutes for Humanities, 1955–1975', discusses that same issue on a larger scale, namely in terms of an international academic institution that would contribute to European cultural, scientific and/or economic integration. These virtual utility spots—plans for places of useful knowledge production—shaped political debates about the organisation of research also within the Netherlands. In particular, I will make a connection to an advanced institute for the social sciences and humanities, to show how internationally circulating spatial models are implemented locally.

Chapter 5, 'The Spatial Politics of Knowledge Transfer. From Science Shop to Science Park, 1970–1985', ties together the preceding historical chapters. It acts at the intersection of the circulation of North American models of useful research, for which the political-economic origins of the research park are relevant, and the local European histories of organising research for societal purposes. I describe the shift from the democratisation to the commercialisation of academic research in terms of various utility spots that were imagined and built in the late twentieth century: science shops, transfer points, technological business centres and science parks. Besides explicating the political and epistemic origins of these places, I relate them to changes in science policy: they both reflected new concepts, such as innovation, and informed new legislations, in this case an article on knowledge transfer in the Scientific Education Act. The science park, still today a shining example of the promise of progress through scientific research, will emerge as both a continuation, displacement and spatial transformation of the political-epistemic coalitions surrounding university research.

Each chapter on concrete utility spots in Dutch university history (chapters 3, 4 and 5) commences with a public university event where the utility of research was explicitly or implicitly at stake. These chapter openings serve two functions in the historical narrative of this dissertation. First of all, the successive discussion of events in 1954, 1963, 1975 and 1985 allows me to describe changes in the ideology and identity of academic actors and institutions. Here I follow an anthropologically informed approach that views public events like rituals, as instances of 'the enactment of new institutional narratives' and 'the symbolical articulation of the shifting political relations within the universities as well as between the universities and external actors within the society at large'.[128] At typical academic rituals like a university's dies natalis or lustrum I probe changing dynamics within and around academic knowledge production. This connects to the second, historiographical function of these festive events: just as the historical actors used these events to pause for reflection, I will employ them to review historiographical claims about change and continuity in the organisation of (useful) research in the respective periods. By situating such temporal concerns at the start, I can concentrate on the spatiality of useful research in the main body of the chapters.

In the concluding chapter, I summarise the findings from the historical experiments with the conjectural utility spot concept and distinguish three relevant analytic dimensions: the *politics of proximity*, the *spatiality of science policy* and the *spatial imagination of useful research*. In terms of the *politics of proximity* I will draw epistemological consequences of the spatial organisation and circulation of useful research. The embedding of this conceptual aspect of utility spots in social studies of innovation and socio-technical transitions will prompt a call for further fine-grained studies of utility spots both in the past and the present. In terms of the *spatiality of science policy*, I claim that abstract concepts, strategies and regulations often originate in concrete spatial issues and typically have geographic effects. I will illustrate this briefly by applying the spatio-historical approach to the current valorisation concept. Viewed through the utility spot lens, the science park emerges as spatial model for valorisation which enables an alternative explanation of the controversy surrounding the concept. Lastly, I will explore potential futures for a societally relevant science by taking seriously the role of the *spatial imagination of useful research*. This methodological introduction started with Bacon as the father of a modern ideal of useful knowledge production; in the last chapter I also visit his science policy utopia: *New Atlantis*. Spatial imaginaries have (had) the potential to direct our

128 Wil G. Pansters and Henk J. van Rinsum, "Enacting Identity and Transition: Public Events and Rituals in the University (Mexico and South Africa)," *Minerva* 54 (2016): 22.

thinking about, and acting upon, the organisation of scientific research—and the tensions between the different goals and conditions for science, from autonomy to societal relevance. This dissertation therefore ends with a speculative outlook on the potential value of scientific research, in spatial terms.

2. Utility Spots in the United States.

Architecture, Location and Circulation

2.1 Introduction

The United States is the birthplace of the science park, the pre-eminent spatial model of useful knowledge, innovation and techno-optimism in the 21st century. Since many countries, cities and universities have tried to replicate the success of, for example, Silicon Valley, Mile 128 and Research Triangle Park, the globe is 'littered with the ruins of all too many such dreams that have failed'.[129] These attempts in themselves are not surprising. The US was, for most Western European nations at least, the culturally, economically and politically dominant nation in the post-war period, and this also applied to science.[130] The North American hegemonic position has mostly been described in terms of the asymmetrical travel of scientific results, reputation and people, but also applied to the circulation of spatial modalities of

129 Peter Geoffrey Hall and Manuel Castells, *Technopoles of the World: The Making of Twenty-First-Century Industrial Complexes* (New York: Routledge, 1994), 8.

130 John Krige, *American Hegemony and the Postwar Reconstruction of Europe* (Cambridge, MA: The MIT Press, 2006).

research organisation. The failure of this circulation can be explained, at least partly, by a lack of situated understanding of how these places came about. Historians of US science have however extensively studied the political-economic, social and cultural conditions that made possible the emergence of industrial parks around academic institutions. Based on this scholarship, I situate the rise of science parks in a longer lineage of utility spots in the post-war US. It is in this period, namely, that a great variety of utility spots proliferated at, or close to, American universities.

In the previous chapter, I introduced the concept of utility spot to carve out a historiographical niche for the study of knowledge transfer practices and the societal legitimation of academic research in the post-war Western world. With utility spots I focus on the spatial arrangements that mediate the travel and translation of knowledge between heterogeneous actors and practices. In this chapter, I employ this working definition of utility spot to survey the post-war history of organised scientific research in the US: what spatial modalities of knowledge production and exchange manifest themselves, how did their quantity and quality change over time, and what narrative of the political economy of useful scientific research does this provide? By confronting the conjectural concept with ongoing debates in, and concrete spatial examples from, North American historiography of science, it is possible to develop and refine the spatio-historical approach to useful research.

This chapter offers a broad outline of the historiography of the organisation of scientific research in the United States in the twentieth century. It consists of two kinds of sections. Even-numbered sections discuss overarching spatial themes in the political economy of science (2.2, 2.4, 2.6). I will touch upon, amongst others, the spatiality of the linear model of innovation, the militarisation of the academic campus and the geography of the military-industrial-academic complex. Odd-numbered sections describe specific places of useful knowledge production and exchange (2.3, 2.5, 2.7). The examples highlighted have served as significant models for other post-war research facilities, and together span a wide range of possible relations between universities, industry, state (often: the military) and the public. The selection of modalities of organised research—corporate research laboratories (especially at Bell): radiation laboratories (at MIT and Berkeley)—work up towards the science park model. At Stanford University, these historical developments intersect in the emergence of Silicon Valley, the high-tech region that emerged around its research park. In the last section (2.8), I describe how this consecutively became a symbol of a more fundamental change in the political economy of scientific research taking place in the late 1970s, from a focus on national security to economic competitiveness.

In conclusion, I will reflect on the spatial and epistemological aspects of utility spots that have become manifest through the survey of US scholarship. To prepare the ground for subsequent historical excursions, I distinguish three main spatial aspects: architecture, location and circulation of utility spots. Here I introduce them only briefly; in the final section (2.9) I elaborate on them in relation to the historical developments in the US. *Architecture* concerns spatial separations between different types of research (e.g. in terms of funding, classification or goal) that typically also mediate a political-epistemic boundary between 'academic' and 'useful' research. This is closely related to the *location* of useful research, which symbolically says a lot about what relations are considered desirable at that spot. This can be interpreted at a small scale, in terms of *proximity*: many historical actors seem to assume a correlation between distance and interaction. It is also relevant at a larger scale, where a spot participates in a political-economic *geography*. Utility spots are established in certain regions because of their expected contribution to these areas and intersect with existing funding patterns and political-epistemic coalitions. These local complexities, of which the actors themselves are often readily aware, tend to get abstracted into clear-cut *geometries*, whenever they are put into *circulation*, with the promise of reproducing such highly situated success elsewhere. Architecture, location (including proximity and geography) and circulation (including geometry) will be highlighted throughout this, and later, chapters.

2.2 Linearity and Distortion in the Federal Political Economy of Science

The utility of scientific research in the post-war political economy of the United States has to be understood with respect to two historiographical themes: *linearity* (of the relation between science and society) and *distortion* (of the pursuit of science by society). Both themes follow from historical studies of the relations between academic, industrial and military actors, practices and places in the twentieth century. Scientific and political actors themselves observed how the Second World War changed for good the organisation of research in the US. The most significant aspect of this break was the emergence of a new primary patron of scientific research: the federal government and the Department of Defense in particular. Orchestrated by a scientific elite, two beliefs about the utility of (academic) research became commonplace: that *basic* science was the fountain of new technologies and profitable products, and that scientists *themselves*, not generals, engineers, politicians or industrialists, should call the shots on what new science to pursue. Later commentators dubbed the first belief the 'linear model of innovation', which arguably would have caused abundant funding of *basic* research, both on industrial and university campuses. The second belief conjoined the utility of basic science to its *autonomy* and corresponds to a debate between historians about distortion: whether the significant 'external' funding and interests of the government, military and industry have altered the course and usefulness of scientific development. The themes of linearity and distortion espouse general (constructivist) epistemological questions about how political economies and scientific research shape each other.[131]

David Edgerton has challenged the historical accuracy and agency of a linear model of innovation. If it ever existed, it was only as a self-indulgent argument of high-level academic scientists and policymakers. Edgerton concludes that later historians and analysts of science have inflated the importance and impact of this view on the utility of basic research. Instead, a revised historiography of twentieth-century science would view wartime R&D activity, for example, not just as the mobilisation of academic research but also, or more so, as the 'extension and strengthening of pre-existing military and industrial organizations'.[132] For the study of utility this means that academics' self-reporting has to be approached with healthy scepticism, and that attention should be paid to alternative sites and types of scientific activity besides academic research. As Edgerton notes, twentieth-century science is 'a great mass of non-research science, some "applied science," and a little bit of "basic" science'; and most of the scientific activity occurred not in academic spaces but in the laboratories of the government, military and industry.[133]
To study the usefulness of university knowledge production only in relation to the history of science policy would therefore produce a rather limited view. Instead, the addition of a spatial perspective, via hybrid spaces of knowledge exchange, does pay tribute to the historiographical insight that the very 'small space' for academic and fundamental research is overrepresented in academic studies of twentieth-century science. The identification and analysis of utility spots, in imagination, construction and action, can be used to problematize oversimplified models of innovation: they can precisely bring into focus the circulation of spatial models of organised research and the diverse political-epistemic coalitions that support them. Based on these historiographical insights, I begin the survey of US utility spots in the next section not at the university, but in industry.

The linear model cohered quite well, theoretically at least, with the autonomy of academic scientific research. But if the first did not exist, what about the latter? The historiographical debate about the distortion of science dealt with the issue of autonomy—or more specifically with the question whether

131 David Hounshell, "The Cold War, RAND, and the Generation of Knowledge, 1946–1962," *Historical Studies in the Physical and Biological Sciences* 27, no. 2 (1997): 238–39; Sismondo, *An Introduction to Science and Technology Studies*, 189–204; Mirowski, *Science-Mart*, 47–56.

132 Edgerton, "'The Linear Model' Did Not Exist," 46–47.

133 Edgerton, 46.

science develops in a certain direction because of, or despite, the relations with non-scientific actors. On one side of this debate are those who claim that the Cold War funding patterns significantly altered, or ‘distorted’, the development of scientific fields. Paul Forman has stated, for example, that alongside the quantitative change, effected by the increased budgets, a qualitative change took place in the purpose, character and practices of physics research.[134] Ultimately, this argument states that ‘all the triumph cost Stanford, MIT and the nation at large a great deal—the militarisation of engineering and much of physics’.[135] In the history of the human sciences the federal patrons have also been identified as shaping the research agenda and methods both constructively and repressively.[136] Critics of this ‘distortionist’ view, like Daniel Kevles and Roger Geiger, instead describe the relation between the military and science as one of ‘loose coupling’ or ‘symbiosis’: without challenging the fact that the military shaped some research fields, they find it unlikely that certain basic laws and knowledge have gone undiscovered or unexplored because of it.[137] In addition, they identify (and challenge) a counterfactual assumption of the distortionist position: that science and engineering would have progressed in more societally useful directions without the defence funds. Rather, these historians hold that science and the military reciprocally shaped each other, and that attempts to instrumentalise science for military purposes often failed or left more than enough room for science to develop freely.

The ‘militarisation’ of academic research is a contested and complex issue. It is especially sensitive because it deals not just with the *results* of research, but also, or even primarily, with the *possible* results, or form, of scientific fields.[138] Questions, concerns and contract research structure what questions and concerns, and thus results, are thinkable and rational. Over time, this shapes the possible content of a research area (cf. my remarks about the ‘significance’ of research in the introduction). This subsequently also limits what usefulness is possible, etcetera. The study of the changing utility of research can therefore be directed at the conditions that shape the form of research, rather than attempting to uncover ‘external’ distortions in the content of science. The spatial organisation of research is one tangible way in which the potential space for scientific fields and their usefulness takes shape. In the following, I will review these issues therefore via a variety of spatial modalities of organised research located between federal government, military, industry and universities. It matters *where* the money flowed: on a national, regional and local scale. Nationally, federal and military funding created a particular political-epistemic geography by dispersing research to particular academic and industrial institutes, affecting regional economies. Locally, it changed the spatial organisation of research on and beyond campus. Before discussing

134 Paul Forman, “Behind Quantum Electronics: National Security as Basis for Physical Research in the United States, 1940–1960,” *Historical Studies in the Physical and Biological Sciences* 18, no. 1 (1987): 150–59.

135 Daniel J. Kevles, “R&D Powerhouses,” *Science* 260, no. 5111 (1993): 1161.

136 Joel Isaac, “The Human Sciences in Cold War America,” *The Historical Journal* 50, no. 3 (2007): 735–36.

137 Kevles, “R&D Powerhouses”; Roger L. Geiger, “The Cold War and American Science: The Military-Industrial-Academic Complex at MIT and Stanford (Book Review),” *Technology and Culture* 35, no. 3 (1994): 629–631.

138 Ian Hacking, “Weapons Research,” in *The Social Construction of What?* (Cambridge, MA: Harvard University Press, 1999), 163–85.

the geography of useful research and the emergence of buffer organisations to deal with the new contractual relation to the government, I turn to the rise of in-house laboratories and R&D campuses in industry.

2.3 Industrial Research from In-House Lab to R&D Campus

Several historical studies identify the rise of the industrial research laboratory as a major development in the organisation of scientific research in the twentieth century.[139] It is also a modality of research whose utility has been obvious for most of that period. In the US, industrial labs preceded universities as dominant examples of useful knowledge production. Before 1940, universities were quite peripheral to the industrial political economy of the US and regarded themselves primarily as institutions of learning. The university campus, located on the fringes of urban areas or in rural towns, resembled this ideal. The spatial organisation of universities in the 'pastoral' campus form—consisting in separation from the chaotic city and plenty of open, green space—was typical to the US from the late nineteenth century onwards.[140] Thomas Jefferson's 'academical village' at the University of Virginia, founded in 1819, long served as the spatial archetype of the American campus: especially its central lawn, for recreation, gossip and scholarly exchange was iconic.[141] At the beginning of the twentieth century, research and service to society were still much less visible in this miniature city of the academic community. Organised academic research was funded mainly by external patrons (industrialists, philanthropists and wealthy alumni) and housed in distinctive spaces on campus. The relatively isolated observatories, museums and laboratories created, according to Roger Geiger, a culture of 'separateness' between organised research and university life.[142]

Between 1900 and 1940, research did become increasingly present on the grounds of various American chemical, telecommunications and electronics companies. It should be noted beforehand that *scientific activity* in industry encompassed more than just research; analytical, testing and development labs typically preceded laboratories for research, and scientists were historically first employed for roles close to production and only later upgraded to positions to perform more fundamental forms of research.[143] Several international and national developments as well as scientific and economic factors help explain the establishment of corporate research laboratories.

In the late nineteenth century, not the US but European nations dominated scientific education, research and organisation. Germany especially set the tone in the emerging science-based industries in electronics, telecommunications and chemistry.[144]

139 See e.g.: Pickstone, *Ways of Knowing*; Mirowski, *Science-Mart*; Agar, *Science in the 20th Century and Beyond*, 160–85.

140 Margaret Pugh O'Mara, *Cities of Knowledge: Cold War Science and the Search for the next Silicon Valley* (Princeton, N.J.: Princeton University Press, 2015), 60–63.

141 Jonathan Coulson, Paul Roberts, and Isabelle Taylor, *University Planning and Architecture: The Search for Perfection* (Routledge, 2015), 16–20.

142 Roger L. Geiger, *Research and Relevant Knowledge: American Research Universities since World War II* (New York: Oxford University Press, 1993), 47.

143 Edgerton, "'The Linear Model' Did Not Exist."

144 Ernst Homburg, "The Emergence of Research Laboratories in the Dyestuffs Industry, 1870–1900," *The British Journal for the History of Science* 25, no. 1 (1992): 91–111. Industry and science were culturally intertwined in late nineteenth century Germany, see: Ursula Klein, *Humboldts Preußen: Wissenschaft und Technik im Aufbruch* (Darmstadt: Wissenschaftliche Buchgesellschaft) & Norton Wise, *Aesthetics, Industry, and Science: Hermann von Helmholtz and the Berlin Physical Society* (Chicago: Chicago University Press, 2018).

Their success was ascribed to a German model of scientific industrial research and development (R&D) that consisted of both industrial sponsorship of university research and the build-up of an in-house research organisation. Most American scientists would spend parts of their education at German institutions, where they experienced first-hand these new models of organised research. In this way, the German model would travel over the Atlantic and inform the establishment of large-scale industrial research laboratories in the United States, which rose to prominence well before academic research labs would. These labs replaced an existing pool of dispersed (external) inventors, working in small machine shops on which US firms had been relying for innovations up to the late nineteenth century. Thomas Edison is often perceived as the personification of the ingenious and perspicacious inventor and as a precursor to the first organised industrial R&D laboratories. In his Menlo Park laboratory in New Jersey, Edison gathered machinists, glassblowers, instrument makers, chemists and physicists to work on innovations for the telegraph industry. Increasingly, US firms required the application of chemistry and physics for the practical production and innovation problems they encountered. As they started to hire scientists for that purpose directly the R&D strategy that had based itself on dispersed inventors in small workshops withered.[145]

At the same time, scientists were professionalising and profiling themselves as a community separate from inventors. Academically trained scientists were not very willing to respond to the manpower needs of industry. Instead, they hailed the ideal of purity, independent of the pressure of practical interests. The corporate research laboratory was a better fit to this ideal. Between 1900 and 1920 a research system emerged in the US industry that was comparable to the German model of R&D, catalysed by the mobilisation of science during World War One. Major corporations like General Electric (GE), American Telephone and Telegraphy (AT&T), DuPont and Eastman Kodak initiated fundamental research programmes. They were motivated by competitive threats, antitrust law and reliance on foreign (German) intermediate products to establish research laboratories for the long-term survival of the company.[146] The in-house lab for commercialised science was not simply a factory churning out gadgets. Rather, its prime purpose was market control, managing the uncertain future and stifling external competition in a context of changing antitrust and intellectual property (IP) law. Invention, for example, was changed in IP law from the achievement of an individual into the effort of a collective, so as to ensure corporate ownership of innovations.[147]

While these successful industrial research laboratories may have ended the myth of the individual inventor, they continued to face the myth of pure science. In fact, they reinforced it.

145 David Hounshell, "The Evolution of Industrial Research in the United States," in *Engines of Innovation U.S. Industrial Research at the End of an Era*, ed. Richard S. Rosenbloom and William J. Spencer (Boston, Mass.: Harvard Business School Press, 1996), 16–19.

146 Hounshell, 20–22; J.W. Spurlock, "The Bell Telephone Laboratories and The Military-Industrial Complex: The Jewett – Buckley Years, 1925–1951" (Washington, The George Washington University, 2007), 11–16.

147 Michael Aaron Dennis, "Accounting for Research: New Histories of Corporate Laboratories and the Social History of American Science," *Social Studies of Science* 17, no. 3 (1987): 479–518; Philip Mirowski and E.-M. Sent, "The Commercialization of Science and the Response of STS," in *The Handbook of Science and Technology Studies*, Third (Cambridge, MA: MIT Press, 2008), 643–48.

Many academic scientists looked down upon research in industry, for a large part because most industrial science in the first half of the twentieth century consisted of other activities, like testing and analysis. Therefore, David Hounshell and others have argued that corporate laboratories were fashioned in the image of the university primarily to attract more academic graduates to industry. This fashioning consisted in imitating academic practices normally at odds with company policy—from liberal publication policies to a great deal of freedom in research topics—and mirroring the spatial organisation and architecture of the university campus.[148] Industrial laboratories and the academic community thus shaped each other.

Bell Labs: private interdisciplinary research in a campus setting

This reciprocal shaping becomes manifest in concrete spots, like the Bell Laboratories of AT&T. The Bell Labs came to be regarded as the 'epitome of organised research' in interwar industrial and academic communities in the US.[149] Officially established in 1925, Bell Labs was the result of two decades of a growing research programme in the Bell System, the association of companies directed by AT&T that basically functioned as a monopoly in telephone services. In the first decade of the twentieth century, AT&T felt the threat of independent telephone companies, a new wireless technology (radio) and the impending expiry of the Bell patents. The company leapt forward and planned to beat its competition by building a coast-to-coast telephone network. Research manager Frank Jewett, himself a physicist, argued that AT&T should hire more skilled physicists to realise this goal. In response, the company launched a relatively large-scale research programme in electronics, communications and circuit theory, staffed with physicists (most of whom had received training in Germany) and theoretically inclined engineers. In 1911 a separate 'research branch' was established, which was staffed with talented scientists whom Jewett drew from his academic network.[150]

In these early years, the Bell System also developed links with military organisations: besides personal relations and involvement of scientists in military operations, they also used each other's facilities during the First World War.[151] Later, AT&T would use this as an argument in Congressional discussions about its heavily criticised near-monopoly status: Congress should not threaten the industrial organisation of R&D because 'their' scientists had helped win the war. In the entire interwar period, researchers at the Bell Labs sustained close relations with the Navy and the Army, for example with respect to long-distance communications. In this way, the industrial research programme, and later the Bell Labs, were

148 Hounshell, "The Evolution of Industrial Research in the United States," 27.

149 Hounshell, 57; Spurlock, "The Bell Telephone Laboratories and The Military-Industrial Complex: The Jewett – Buckley Years, 1925–1951," 3.

150 E.g. through his doctoral supervisor Robert Millikan at the University of Chicago. Spurlock, "The Bell Telephone Laboratories and The Military-Industrial Complex: The Jewett – Buckley Years, 1925–1951," 79–83.

151 Spurlock, 106–10.

places where industrial and military interests could be productively combined. This was instrumental in Jewett's strategy to secure the military as a long-term ally of AT&T, so as to overcome future outbreaks of fear of big business in Congress and society.[152]

As well as functioning as argument in political discussions, the laboratory was supposed to bring AT&T a competitive advantage as an incubator for new profitable products and as a source of patents to achieve market protection.[153] Increasingly, this gave R&D a central place in the AT&T organisation, and by 1925 the Bell Laboratories were formally established with Frank Jewett as its first director. By then, its budget and staff made it the largest industrial R&D programme in the country.[154] At first, it was housed in a former manufacturing plant in Manhattan. This had the advantage of being close to the entry point for European visitors to the US, which made it very convenient for many international scholars to visit or give presentations at Bell Labs colloquia.[155] By the 1930s, plans were made to move the research facilities out of the New York City hubbub because 'vibration, dust, noise and electrical interference' all complicated proper measurements, and the lab had become overcrowded. After the Depression, this plan turned into reality at the Murray Hill Laboratories, in a suburb some 30 kilometres away from downtown New York and the central AT&T office. This also happened to be very close to the homes of the lab's president and research directors (resp. Frank Jewett, Oliver Buckley and Mervin Kelly).[156]

The move out of the city did not mean the lab's position in the Bell System deteriorated. Rather, it was the occasion to raise its standing, especially towards the world of science. After touring industrial labs in the US and in Europe, Kelly and Buckley decided that the Murray Hill facility should breathe more an academic than an industrial atmosphere. This fitted with the lessons learned at Bell Laboratories in the 1930s, namely that it was much to the company's advantage to give excellent researchers freedom in a university-like atmosphere. A lot of their technological problems required deep theoretical understanding of physics; to attract the best scientists to Bell, they created an environment that they deemed conducive to intellectual creativity and, at least as important, competitive with academic appointments. As new staff members established research seminars, study groups and journal clubs, the atmosphere became even more like a university.[157] But in contrast to an ordinary university campus, where each discipline was physically separated from others in different departmental buildings, Bell designed one single building to assure more intimate contact and easy interchange among departments. It had to retain the advantages of separate buildings while also discouraging departmental 'ownership of space'.[158]

152 Spurlock, 168–71.

153 Spurlock, 148–51.

154 Hounshell, "The Evolution of Industrial Research in the United States," 23–24.

155 Lillian H. Hoddeson, "The Entry of the Quantum Theory of Solids into the Bell Telephone Laboratories, 1925–40: A Case-Study of the Industrial Application of Fundamental Science," *Minerva* 18, no. 3 (1980): 437.

156 Scott G. Knowles and Stuart W. Leslie, "'Industrial Versailles': Eero Saarinen's Corporate Campuses for GM, IBM, and AT&T," *Isis* 92, no. 1 (2001): 1–33; Jon Gertner, *The Idea Factory: Bell Labs and the Great Age of American Innovation* (Penguin, 2012).

157 Hoddeson, "The Entry of the Quantum Theory of Solids into the Bell Telephone Laboratories, 1925–40," 445–47.

158 Knowles and Leslie, "Industrial Versailles," 19–23.

The H-shaped building was officially opened in 1942. The architecture of the laboratory building contributed to interactions between experimentalists and theoreticians, and between scientists, engineers and technicians. The offices and laboratories of technicians were located on different corridors, so that it was often necessary to walk from the ones to the others. And although the seemingly endless hallways might have appeared architectural weaknesses, in practice they facilitated many chance encounters during the commute. By the end of the war, 8000 staff members would work at Murray Hill on radar systems, sonar, electronic fire control and communication technologies. Already by the mid–1940s, many representatives of industrial laboratories visited the facility, to pattern their own laboratories after its image. After the Second World War, the military projects of AT&T were moved to Whippany, and the Bell Laboratories at Murray Hill became a centre for basic research in electronics and materials. Under Kelly's leadership, the lab was reorganised explicitly into interdisciplinary groups to work on new electronic technologies.

The Bell Laboratories became a model for organised industrial research with high degrees of freedom akin to academic practice: in the 1930s the laboratory brought forth both technological innovations and Nobel Prizes. This produced an image of useful research as simultaneously secluded (in a suburban area and like a university campus) and open and interactive (internally by co-locating different specialists, and externally by inviting academic scientists to visit). Spatial aspects, from location to architecture, were essential elements that legitimised industrial, and by implication federal, investments in R&D. Industrial, governmental and academic organisations would later try to mimic the dynamics of this utility spot.

The post-war industrial research campus

The in-house corporate laboratory, as we got to know its ideal form at Bell Laboratories, was a product of the interwar period. In a way, the trend to build large-scale research facilities in campus-like settings continued amongst large corporations in the 1950s and 1960s. But, in distinction to Murray Hill, the external aesthetics became as important as the internal structures. This transformation of the pre-war in-house lab is considered a consequence of the new political-economic context of the Cold War. This was linked to the emergence of the multi-divisional bureaucratic managerial culture (the M-form) after the war, in which each division was its own profit centre. R&D divisions could survive as long as they were able to obtain their own income, which in the Cold War context consisted mainly of contracts from the Department of Defense. The corporate laboratories thus became more of an external research contractor. As a consequence, these R&D divisions had to deal with the protocols and accounting procedures of the military, which provided incentives towards a division of labour *within* companies, and *between* industry and universities, in line with the 'linear model'.[159] Partly motivated by military secrecy demands, corporate research labs were increasingly removed from production facilities, and placed in 'campus-style settings'. These spatial developments relied on the views of defence contractors and companies who heralded basic science and scientific freedom as the source of new products and profits. Historians argue that this view neglected the significance of manufacturing, engineering and construction capabilities for the wartime progress in (the application of) research and overlooked the importance of mass production capacities.[160]

However, the myth of the linear relation between fundamental research and technological progress survived the first two post-war decades. This was based on a handful of extremely successful examples like nylon (DuPont) and the transistor (AT&T). And, according to Philip Mirowski and Esther-Mirjam Sent, it was the federal, mainly military, patronage that transposed this linear relation between university and industry, actively inverting the pre-war relationship.[161] Indeed, many industrialists did not challenge these beliefs and accordingly implemented the university campus model of basic research for their R&D facilities. This isolated research spatially, organisationally and intellectually from the rest of the company, in particular its production and development departments.

One prominent architect, Eero Saarinen, designed the most architecturally distinguished corporate laboratories after the Second World War: the labs of GM, IBM and AT&T. Saarinen shared the conviction that the isolated campus was the ideal model for creative research and used it to create a new spatial and symbolic identity for basic research in industry. Contracting a famous architect for a landmark research campus was tenable only for very large, almost monopolistic companies (like General Motors, IBM and Bell) for whom a highly visible laboratory functioned as symbol of technological leadership and market control. Ultimately, Saarinen's designs focused on this corporate image and research ideal. Less attention was reserved for attuning architecture to stimulating environments for research. Still, the academic atmosphere of the industrial laboratories had to attract the greatest scientific talents and offer them independence and creativity. But the pre-war Murray Hill lab of AT&T had produced scientific excellence—both in terms of Nobel Prizes and in terms of products—notwithstanding its mundane architecture and defiant functionality (which turned out to be a secret strength). The trend-setting post-war corporate laboratories of GM, IBM and Bell defined the standards for the creative research environment, which university research parks would later reflect: isolation, low rises, and a visible contrast between steel and concrete building and surrounding greenery and landscaping.[162]

159 Mirowski and Sent, "The Commercialization of Science," 649–54.

160 Hounshell, "The Evolution of Industrial Research in the United States," 41; Knowles and Leslie, "Industrial Versailles"; Hoddeson, "The Entry of the Quantum Theory of Solids into the Bell Telephone Laboratories, 1925–40," 447.

161 Mirowski and Sent, "The Commercialization of Science," 649–54.

162 Knowles and Leslie, "Industrial Versailles."

2.4 The Spatial Model of *The Endless Frontier*

The establishment of fundamental R&D spaces in industry was informed, at least on the face of it, by a linear model. At the same time, the use of such legitimations can also be interpreted as window-dressing to conceal more practical concerns for manpower and market control. The linear model has figured in a similar way in the history of *public* funding of scientific research in the post-war US. Typically, historians and analysts of science present the famous 1945 report *Science: The Endless Frontier* as evidence of the existence of this model in federal science policy.[163] As part of his broader criticism of the linear model, David Edgerton has attacked these arguments: they exaggerate the importance of the context of origin of the report (the OSRD), as well as its institutional consequences (the NSF), and, most importantly, it is based on a misinterpretation of what Bush's report was about.[164] It was not a *linear* but a *spatial* model that the author of the report, Vannevar Bush, advocated. I will elaborate on these three points of criticism to come to an understanding of the spatiality of science policy more generally.

As director of the Office for Scientific Research and Development (OSRD), Bush was requested by President Franklin D. Roosevelt to draft the report. In this function, the 'staunch conservative' Bush coordinated scientific research for military purposes during the Second World War. In the First World War the research effort had been organised in separate government labs, clearly separating research for military purposes from academic research. In the 1940s, a new relation between the government and universities was established in the form of *contracts*, through which research activity in university laboratories was supported, without demanding specific results. This worked out especially well during the war, as long as goals and priorities were shared by all actors. Ample resources and little accountability allowed flexible relations between OSRD and the universities, and decentralised scientific choice to the scientific researchers themselves.[165] In this way, there was state intervention in science with minimal distortion of academic freedom. But, as Edgerton points out, the OSRD was only one amongst many wartime military organisations that funded research; and its budget was only a fraction of those of the Army, the Navy and the Manhattan Project.

The attention in scholarship for *The Endless Frontier* also does not match its limited impact on federal science policy. The primary outcome was the National Science Foundation (NSF). The NSF was officially established in 1950, after years of Congressional stalling, and came to play some role of significance only after the launch of the Sputnik satellite by the Soviet Union in 1957. The Russian achievement had a

163 Vannevar Bush, "Science: The Endless Frontier," *Transactions of the Kansas Academy of Science* 48, no. 3 (1945): 231–64.

164 Edgerton, "'The Linear Model' Did Not Exist," 40–42.

165 Geiger, *Research and Relevant Knowledge*, 3–12.

great impact on scientific research funding in the United States, especially causing rapid increases in funding for the NSF (and the establishment of NASA). It might seem that, more than ever, political leaders saw basic science, scientific excellence and education as key in winning the Cold War. But even then, the NSF subsidies for academic research in elite universities were only a fraction of total federal spending on research: the funds related to the military support of scientific research by far outweighed medical and basic research.[166]

The concrete origins and the limited practical effects of Bush's report revise the relative importance of the linear model, if this was indeed defended in *The Endless Frontier*. And that, argues Edgerton, is not the case. Rather, Bush advocated a spatial model for the organisation of publicly funded research. According to Edgerton, the model consisted of two parts: 'different kinds of scientific activity take place in different spaces, and secondly, the extension of scientific knowledge creates a new enlarged arena for the actions of others'.[167] Instead of a linear, chronological understanding of the utility of basic science, Bush embraced a 'reservoir' model with respect to the utility of basic science.[168] Similar to the historical exploitation of the 'fallow' land in the west of the US, science could create a resourceful space without frontier, to be developed by any entrepreneurial US citizen. Ultimately, post-war federal science policy was not just occupied with causal models of science and societal progress but can also be described in spatial and geographical terms.

The location of different types of scientific research was indeed a central concern in the political debate about the NSF, which dealt with the appropriate boundaries between academic research, the federal government, the military and industry.[169] The progressive liberal Senator Harley Kilgore, who took the first initiative in 1944, wanted to put an end to the 'laissez-faire' attitude to science of the federal government by supporting socially and economically useful science in federal laboratories. Kilgore also hoped to transform the hierarchical political geography of science by making the NSF a central federal agency, responding to the president, governed by a 'lay' coalition (including for example business leaders) and executed by (less biased) policy officials. This had to break the institutional favouritism that had developed during the war, where a political, military and scientific elite distributed most defence contracts to a handful of institutions like MIT and Harvard. Kilgore's proposal frustrated the military and scientific elite and also the research-based industries, as he argued for a non-exclusive licensing policy for the funds, so that inventions could circulate freely.[170]

Bush, in his final report *The Endless Frontier*, disagreed with Kilgore's proposal for the organisation of useful research on almost every aspect. Instead, the conservative

166 Geiger, 13–18.

167 Edgerton, "'The Linear Model' Did Not Exist," 40–42.

168 As observed by Arie Rip, cited in: Edgerton, 41.

169 Michael Aaron Dennis, "Reconstructing Sociotechnical Order: Vannevar Bush and US Science Policy," in *States of Knowledge. The Co-Production of Science and Social Order*, ed. Sheila Jasanoff (London; New York: Routledge, 2004), 236–264.

170 Daniel J. Kevles, "The National Science Foundation and the Debate over Postwar Research Policy, 1942–1945: A Political Interpretation of Science – The Endless Frontier," *Isis* 68, no. 1 (1977): 16–24.

Bush defended a conception of utility that did not interfere with the interests of the scientific, industrial and military elite. This was part of a broader meritocratic elitism that he had introduced in the report: the scientist and the engineer stood at the top of society and had the responsibility to guide policymaking. As part of this worldview, he advocated the support of basic research in non-profit institutes of higher education, and privileged universities above federal labs. Independence of research from any federal involvement was to be secured by making the NSF an elite body run by professional scientists. In addition, Bush's pre-war experience and close collaboration with industry, as dean at MIT and director at the Carnegie Institution, aligned him with business interests of large, vertically integrated companies with in-house R&D labs.[171] His focus on basic, not applied, research and his opposition to Kilgore's patent policy were not so much convictions about the linearity of innovation as they were an attempt to preserve the pre-war arrangement in which firms could use patents and R&D to control markets. Above all, Bush was a representative of an elite coalition of politicians, scientists, industrialists and military officers so he would never disturb existing geographies of power, between universities and corporate labs.

Bush thus strove to maintain different types of research in different types of spaces. In particular, he strove to keep relations with external parties outside academic spaces. Like many scientists, university administrators and politicians, Bush had thought that wartime organisations like the OSRD were of a temporary nature and hoped that it would be possible to return to the arrangements for organised research of the 1930s.[172] The failure of Bush and his industrial, military and scientific allies to realise how the military and researchers had transformed each other during the war—and to imagine its irreversible effects in the post-war world—informed the initial failure of his proposal for a national research foundation that based itself on an insulated image of science.[173] Instead, all kinds of research had already been supported extensively at universities before the NSF started to play a role. Several wartime practices of organising research for national security were continued almost silently into post-war patterns of federal funding. Often this funding flowed not directly to traditional, or 'pre-war', disciplinary departments, but instead to newly created 'interdepartmental labs' or 'organised research units'.[174]

Interdepartmental labs were on the one hand institutional innovations within the American university, buffer organisations to deal with the new contractual relation to the government. On the other hand, they set in motion the spatial transformation of campuses. In between the traditional on-campus department and the off-campus mission-oriented

171 Daniel Lee Kleinman, "Layers of Interests, Layers of Influence: Business and the Genesis of the National Science Foundation," *Science, Technology, & Human Values* 19, no. 3 (1994): 275–78.

172 Dennis, "Reconstructing Sociotechnical Order," 230–33.

173 Dennis, 247–48.

174 Stuart W. Leslie, *The Cold War and American Science: The Military-Industrial-Academic Complex at MIT and Stanford* (Columbia University Press, 1993), 15.

federal institute, Roger Geiger has discerned two intermediate ideal types of such buffer organisations—centres and institutes.[175] *Centres* were externally funded, multidisciplinary and interdepartmental organisations directed at complex problems. Typically, these would be located on campus and they were still rooted in academic departments and cultures. In practice, it proved difficult to unite the conduct of academic research with the ulterior motive set by the external funder. Often, the goal of the centres drifted in time towards those of the academics involved. As space, these centres do seem to have stimulated exchange between various academic specialties. For example, many centres for area studies were established, like the Russian Research Centre at Harvard, ultimately to inform military intelligence. But in practice, it also brought together various social scientific disciplines. *Institutes,* on the other hand, were more independent of the university. They housed (non-academic) professional scientists alongside faculty researchers, with a full-time director in charge. The research at institutes was more closely linked to the interests of the external funder, while the university basically took care of practical and administrative issues. Housing the advanced facilities helped them to increase their institutional prestige and to keep more entrepreneurial faculty satisfied. As space these institutes seem to have fostered exchange between academic research and external parties: broader utility motivated and dominated the institute research, which was partly performed by faculty professors and graduate students. The Research Laboratory for Electronics at MIT, discussed below, is an example of this. Moreover, federally funded organisations for communications research, like the Bureau of Applied Social Research at Columbia, functioned as institutes.

In the following I will discuss different modalities of organised research, with special attention to spatial and geographic aspects of these utility spots. To understand the entanglement of the federal government, industry, and the universities in the development of organised research in the United States, it does not suffice to focus only on (hybrid) academic spaces. My discussion of the radiation laboratories located at MIT and UC Berkeley will end with a federal contract research laboratory and a private non-profit think tank. These kinds of institutions were, often more explicitly, continuations of wartime arrangements and had fewer academic linkages: the universities merely offered managerial services or occasional advice. Because of the classified nature of the work these were isolated on off-campus sites, because of which they resembled industrial spaces more than academic ones. Again, it becomes manifest that post-war developments in industrial research are pivotal to the understanding of the spatiality of useful academic research.

175 Geiger, *Research and Relevant Knowledge*, 48–57.

2.5 Hybrid Spaces on and Beyond Campus: Three RadLabs

The post-war contractual relation between government, industries and scientific institutions catalysed the establishment of hybrid spaces for useful research. Patterns of research funding and organisation that emerged during the war continued in peacetime but could not be housed in pre-war spaces. Utility spots emerged that embodied the altered relations between science and society. By way of three Radiation Laboratories, one on the east coast (at MIT) and two on the west coast (at UC Berkeley), I will discuss two different patterns in federally organised research. One pattern mirrored the experiences with nuclear physics in the Manhattan Project, for the construction of the atom bomb, and the other reproduced the mobilisation of other engineering and natural science fields for military applications, like radar and missiles.[176] The Atomic Energy Commission was installed after the war to coordinate and direct nuclear physics towards peacetime purposes. For the continuation of research for military applications, several offices of the Navy, the Air Force and the Army established or continued contractual relations with a variety of university laboratories. In the early 1950s, the Korean War led to another dramatic increase of military funding, further 'militarising' university research.

My choice of the three Radiation Laboratories as relevant utility spots follows from their paradigmatic status. They exemplified the 'best' the world war had to offer in terms of scientific mobilisation and technological warfare: the MIT RadLab was synonymous with radar and its applications, and the Berkeley RadLab had a crucial role in the development of the atom bomb in the Manhattan Project. After the war the Californian RadLab created a spin-off Radiation Laboratory at Livermore for all classified research in nuclear weapons. The immense societal impact of these applications created an aura of success around the RadLabs that also shone onto their innovative models of organised research.

RadLab, MIT, Massachussetts

Already before the war, the private Massachusetts Institute of Technology (MIT) actively nurtured relations with industry. Unlike most elite academic institutions in the US, MIT did not rely much on foundation grants and rather became very experienced in working with research contracts and providing services to industry.[177] During the 1930s, the new MIT president Karl Compton was urged (amongst others by Frank Jewett, who served on the advisory board of the electrical engineering department) to reform MIT towards a more fundamental science and research-based institute, rather than to continue the serviceable orientation to industry.

176 Geiger, 13–18.

177 Christophe Lécuyer, "The Making of a Science Based Technological University: Karl Compton, James Killian, and the Reform of MIT, 1930–1957," *Historical Studies in the Physical and Biological Sciences* 23, no. 1 (1992): 153–180; Hall and Castells, *Technopoles of the World*, 33–34.

Compton, who had previously been an administrator at Princeton and a consultant at General Electric (GE), introduced various changes that concurred with established practices at elite research universities. With these more academic aims in mind, foundations like Rockefeller were willing to support also MIT.[178] At the same time, Compton, with the support of Vannevar Bush (who managed research in electric engineering), reorganised the relations with industry so as to increase the institute's autonomy with respect to industry (especially Bell and GE). In order to raise sufficient funding, Compton was 'keen to show the usefulness of scientific pursuits…[fostering] approaches that privileged instrumentation and interdisciplinary cooperation and offered potential applications.'[179] As a result, MIT would soon become known precisely for its stimulation of fruitful interactions in research between scientists and engineers with useful result for industry.

During the Second World War, Bush and Compton played central roles in the wartime scientific organisations. This, as well as MIT's renewed reputation and industrial experience, definitely must have informed the Department of Defense's decision to concentrate research activities in the field of radar, based on one concrete device (the magnetron), there in a dedicated laboratory.[180] Hiding its true function, this was named Radiation Laboratory. Although some older academics doubted the usefulness of concentration on campus, and it led to strained relations with industry (Jewett had advocated Bell Laboratories as probable site), RadLab quickly expanded from borrowed space into several new buildings. During and after the war it came to function as framework for relations between the government and universities. Similar labs were established at Johns Hopkins University, for the proximity fuse, and at Caltech, for missiles. The experiences at these kinds of university facilities that developed military applications resulted in a relation of negotiation through contracts between the universities and the military. After the war, this was institutionalised most importantly in the Office for Naval Research (ONR) of the Navy. The ONR also funded a lot of basic academic research at universities, even being its main patron in the first post-war decade as long as the NSF bill had not yet passed Congress.

MIT emerged as the largest defence contractor after the war, continuing the pattern of its dominant wartime involvement. The RadLab had been most prominent during the war, and parts of it were transformed by the new MIT president James Killian into the Research Laboratory of Electronics (RLE). This lab became exemplary for the post-war political economy of knowledge, at least at MIT. The staff consisted of MIT faculty, professional staff as well as new graduates who had worked at RadLab. RLE was a hybrid of the physics and the

178 Lécuyer, 157–159.

179 Lécuyer, 164–167.

180 Lécuyer, 172.

engineering department, emphasizing both basic research and process development, and was a way to sustain the relationships with both the military and the industrial contractors that had been built up in the war. Through summer schools and graduate studentships, it also attempted to connect to the teaching mission of MIT, although it would always remain reflecting the military character of the research. This meant both performing classified research as well as complying with 'unwritten rules' of self-censorship with respect to results that might endanger national security.[181] Graduates from RLE went on to work in established companies, but also created many new ones. These spin-offs from RLE often relied as much on federal contracts as the laboratory itself. The industrial region on the periphery of Boston that later became known as *Mile 128* thus had its origin in research and production organised by defence contracts. Similar dynamics played around other MIT laboratories, like Lincoln Laboratory for advanced electronics in air defence. It was modelled after RadLab and RLE, functioned as meeting place for academics, professional scientists and engineers, and was a place where students gained practical experience with real-world problems. Different from RadLab, Lincoln functioned as a federal contract organisation, as it was located off-campus, and closer to an airbase and Mile 128 than to university buildings.[182]

The Berkeley and Livermore Radiation Laboratories, UC Berkeley, California

The Radiation Laboratory at the public University of California at Berkeley (UC Berkeley) exemplified 'west coast pride' and served as standard for the entire university.[183] After the war, it would emerge as the leading centre in government-sponsored research in high-energy physics. This RadLab differed from the one at MIT in several ways: it was established long before the war, it was a component of the, first dispersed, Manhattan Project, and in the post-war period it would rely on funding from the Atomic Energy Commission (AEC) instead of the Department of Defense. Physicist Ernest Lawrence established the Radiation Lab in 1931 and first focused on the development of a cyclotron. His success in building and using this magnetic particle accelerator brought him the 1939 Nobel Prize. Apart from this academic prestige, the Radiation Lab had already become known for its industrial approach to organised research. As the cyclotrons grew bigger and bigger, the lab and staff expanded correspondingly. And the use of the cyclotron to produce isotopes for medical and biological purposes as well as the ongoing design of new machines created a far-reaching division of labour and hierarchy in the lab.[184] Later commentators would credit Lawrence's laboratory as the first 'big science' lab because capital-intensive research took place in large interdisciplinary

181 Lécuyer, 176–177.

182 Leslie, *The Cold War and American Science*, 26–37.

183 Robert W. Seidel, "Accelerating Science: The Postwar Transformation of the Lawrence Radiation Laboratory," *Historical Studies in the Physical Sciences* 13, no. 2 (1983): 375–400; Geiger, *Research and Relevant Knowledge*, 75–77.

184 Seidel, "Accelerating Science," 384.

teams of physicists and engineers, was concentrated around single, complex instruments and supported by external funders and long-term research management.[185] In awe of its impressive results, European visitors also noted with a bit of doubt the frenetic pace and peculiar camaraderie of the industrial organisation of research.

In the 1940s, the potential of the 184-inch cyclotron was redirected completely to the war effort. The laboratory became of central importance to the aim of the military to realise an atomic bomb based on the newest nuclear physics. Partly because of the required secrecy, any informal pre-war group work was replaced with corporate discipline and formal research and development groups.[186] Cyclotrons were used to enrich uranium and Glenn Seaborg, one of the research group leaders, isolated plutonium. This contributed significantly to the Manhattan Project, which was first dispersed over various universities (UC Berkeley, Columbia, Chicago and others) and was concentrated into a 'huge multinational physics faculty' at the Los Alamos Special Weapons Lab only in 1943. Just like Berkeley RadLab this spot has been credited as the paradigm of big science, because it housed large multidisciplinary teams dealing with complex problems and sophisticated, expensive instruments.[187] Social relations between the two labs enabled the spread of this model of useful knowledge production: Robert Oppenheimer left the Berkeley lab to become director at the Los Alamos facility, after Ernest Lawrence had recommended him to General Leslie Groves, the director of the Manhattan Project. Sometimes the circulation of utility spots as model was even more direct, for example when Lawrence designed the Oak Ridge facility where uranium was to be enriched on a large scale.[188]

After the war, most RadLab researchers, who had been dispersed over the country during mobilisation, flocked back to the Berkeley hillside. In the meantime, the laboratory had expanded further, and consisted by 1944 of some thirty buildings and a staff of 1200. Lawrence, still lab director, first expected things to normalise as soon as the urgency of the war passed and proposed to scale down the activities. They also needed to reorganise research activity once more, to recapture the group spirit and scientific freedom that had characterised the pre-war work. But the useful aspects of the wartime corporation, like finance, design and engineering, also had to be maintained. These opposite demands were met by centralising administration and engineering, and decentralising scientific work into relatively autonomous research groups, which each worked on their own machines.[189] 'Outsiders' would visit these groups to acquire the specific know-how for each machine. Each group was supported by the developmental groups in mechanical and electrical engineering, medical physics and chemistry as well as the

185 Andy Pickering, "The Rad Lab and the World," *British Journal for the History of Science* 25, no. 2 (1992): 247–251; Michael Hiltzik, "The Origins of Big Science: And What Comes Next," *Boom: A Journal of California* 5, no. 3 (2015): 98–108.

186 Seidel, "Accelerating Science," 385.

187 Geiger, *Research and Relevant Knowledge*, 30.

188 Hiltzik, "The Origins of Big Science," 102–3.

189 Seidel, "Accelerating Science," 385.

centralised workshops and administration departments. Rival laboratories, like Brookhaven National Laboratory, tried to mimic the Berkeley model of centralised support for decentralised, interdisciplinary team research.[190]

By 1945 Lawrence came to realise that normalisation would not occur and tried to capitalise on the opportunities that federal patrons offered for peacetime research. The close ties to the military leadership that Lawrence had built, especially with General Groves, proved crucial in this respect. During the war Groves had led the Manhattan Engineering District (MED) that allocated funds for the research in the Manhattan Project. As the war drew to a close, Lawrence kept close taps on his intentions, and was able to persuade the MED to fund several projects at the Berkeley lab. The Atomic Energy Commission (AEC) took over most of the MED projects and became the main patron of the Radiation Laboratory at Berkeley. Allies of the lab had strategic positions in the AEC: Oppenheimer chaired the commission that decided its research policy and Seaborg had a seat in this committee of nine. Lawrence tinkered with his proposals so as to meet the demands and possibilities of the AEC, just like he had reached compromises with private foundations (Rockefeller) before, and, with the military, during the war. Lawrence's cultivation of the relationship with Groves and the AEC led to the building of a fourth major machine (the Bevatron) at Berkeley in 1948, which assured the continuation of its dominance in high-energy physics. Even though the official policy of the AEC had been to avoid concentration of resources in large institutions, it would pay due heed to Berkeley's 'special history'.[191]

The Berkeley Radiation Laboratory—later renamed Berkeley Lawrence Laboratory—successfully transformed itself back into an organisation for fundamental research in peacetime. The secrecy limitations during the war were discontinued, mainly by establishing an offshoot laboratory dedicated to classified research into nuclear weapon design. This Radiation Laboratory at Livermore, later baptised as the Lawrence Livermore Laboratory, had to compete with the development and innovations at the Los Alamos Laboratory. Similar to the Lincoln Laboratory at MIT, this institute was further removed from UC Berkeley, at a former air force base, providing more space for large experiments and, above all, making it possible to maintain higher levels of secrecy.

To conclude, the organisation of nuclear physics in the Manhattan Project led to a pattern in federal science policies on topics with high costs and high stakes. This was institutionalised in the Atomic Energy Commission that funded self-contained, but university administered, laboratories on campuses like the two Lawrence laboratories associated with UC Berkeley. The various 'big science' spaces stimulated interdisciplinarity and relied strongly on relations with the

190 Seidel, 387–88.

191 Seidel, 392–99.

military and industry. The relation between secrecy and utility in the highly controlled transfer of knowledge could translate into specific locations and architecture. While utility concerns could dictate a location close to academic expertise or industrial production, secrecy measures were easiest at separate buildings located off-campus.

2.6 The Geography of the Military-Industrial-Academic Complex

The post-war organisation of research in the United States, described in the pages above, was famously baptised by Dwight Eisenhower as the 'military-industrial complex'. In his farewell speech as president in 1961, he introduced the term to warn the American people of its unwarranted influence on politics. This military-industrial complex consisted of a close alliance between the Department of Defense and the armed forces on the one hand, and very large industrial contractors on the other. In between, there were government laboratories as well as university centres and institutes, in which academic and professional scientists worked on lavishly funded research projects with a, sometimes distant, military interest. This 'golden triangle' of military, science and industry made some also call it the 'military-industrial-academic complex'. Although universities played a 'minor but indispensable' role, the golden triangle very visibly materialised around elite institutions like MIT and Stanford.[192] In some locations, the military-industrial-academic complex took actual physical shape. It is in concrete places of knowledge production and exchange at and around universities that the structural effects of this Cold War political economy of research, and continuities with subsequent neoliberal developments, can become clearly visible.

There is quite some agreement among historians and other scholars on the organisational impact of the military-academic-industrial complex on science: its scale increased, security restrictions were sometimes enforced, and interactions between different disciplines, engineers and societal actors were stimulated. As reconstructed above, the complex was supported by a political-epistemic alliance that had its roots in the Second World War. The mobilisation and dispersion of academic researchers and the redirection of industrial research to national purposes defined the post-war political economy of research. Funds, people, technologies and knowledge circulated in the triangle between the federal government, industry and university, sectors that had previously been more separated.

The opposite positions in the *distortion* debate about the militarisation of the content and form of science (see section 2.2), in the end come down to a political dismissal of the military as a warranted patron for science or an economic

192 Leslie, *The Cold War and American Science*.

appraisal of military necessity as the mother of invention. Increasingly, the consensus amongst historians has become that historical reality for scientific actors in the Cold War was often ambiguous and that each relation between research and its patrons needs to be understood in context.[193]

It was in such ambiguity that universities and their administrators could play an active role by mediating between professors and patrons.[194] In the post-war political economy, each university would imagine its role in society also spatially. Stuart Leslie and Robert Kargon have argued that a 'mental and physical geography' of the university defined the boundaries of their societal community. Where, for example, Princeton University situated itself on a national scale, Stanford University aspired to be connected to regional businesses and government labs in physical proximity of the university.[195] Stanford was therefore not just oriented to a community of scholars, but also to a broader group of scientists, engineers and entrepreneurs. In these territorial imaginations the universities functioned as regional engines of economic development, urban planners and political actors. These aspired and actual roles of academic institutions are the product of broader political-economic developments in the Cold War period. The regionally biased political geography of science funding and the suburbanisation of science should therefore also be taken into account.

The flow of defence contracts not only steered research and education programmes in particular directions, it also reshaped university campuses and transformed the surrounding regions. Margaret Pugh O'Mara has demonstrated how the military-industrial-academic complex created a very specific political-economic geography. Where the universities had been a historically independent and elite sector, their research became increasingly organised as big science and through governmental intervention. This intervention, in terms of research contracts for defence purposes, had geographical consequences. The flow of funds followed existing hierarchies of scientific excellence (institutional favouritism) and existing spending patterns of military production (regional favouritism). This made scientists and university administrators (sometimes unwillingly) political actors in a skewed economic geography.[196] To increase their political standing, universities more remote from Washington opened offices in the capital. Stanford University was one of the first to open an office, in 1945. Ultimately, such efforts could not prevent a skewed geography of the military-industrial-academic complex emerged that concentrated scientists and engineers in a few regions (Illinois, California, New Jersey, New York, Ohio and Pennsylvania) and around a handful of elite academic institutions.

This geographical hierarchy coincided with the spatial spread of military production and led, in O'Mara's terms, to 'cities of knowledge': 'consciously planned communities' as

193 Mark Solovey, "Science and the State During the Cold War: Blurred Boundaries and a Contested Legacy," *Social Studies of Science* 31, no. 2 (2001): 165–70; Isaac, "The Human Sciences in Cold War America," 739.

194 Rebecca S. Lowen, *Creating the Cold War University: The Transformation of Stanford* (Berkeley: University of California Press, 1997), 6–11.

195 Robert Kargon and Stuart Leslie, "Imagined Geographies: Princeton, Stanford and the Boundaries of Useful Knowledge in Postwar America," *Minerva* 32, no. 2 (1994): 121–143.

196 O'Mara, *Cities of Knowledge*, 5–9.

‘physical manifestations’ of a political ideal, with research universities at their heart.[197] Research facilities and defence manufacturers privileged the same regions, which were characterised by high rates of suburban growth.[198] The preference for locating defence facilities in suburban areas was the outcome of several policy incentives for decentralisation. To decrease the vulnerability of central business districts to a potential nuclear attack, firms were stimulated (with cost and tax reductions) to locate in dispersed areas outside the cities. In addition, a dispersal policy also structured the spread of defence contractors who became ideally located in the suburbs. Implicitly, this approved the suburban space as the logical home for scientific work.[199] When in the 1960s economic development policies centred more on the university, campus expansion was stimulated in *research parks* to strengthen partnerships with government and industry. This was the kind of industrial development that was well suited to a suburban setting, as these parks aesthetically mimicked both the university campus and the white-collar suburb. Ultimately, O’Mara stated that even *without* the ideologically loaded Cold War spending pattern, science would probably still have ‘suburbanised’. But, she continues, the high degree of it, and the clustering in specific regions, was highly dependent on the geography of the military-industrial-academic complex. Federal suburbanisation policy reorganised urban space in such a way that new networks of innovation and production between university and industry could emerge, ‘away from the distractions and disorder of the changing industrial city’.[200]

So far, I have described the post-war development (and demise) of campus-like industrial research laboratories and more generally the places and geography of the ‘military-industrial-academic complex’. These histories of the public and private organisation of scientific research intersect in the next section at Stanford University. After 1945, this private elite institute of higher education in Palo Alto, California, came to serve as prototype for federal science policymakers. It has been regarded, both by contemporary commentators and historians, as archetype of the ‘Cold War University’. Globally Stanford has in addition become known as the nucleus of a model of science-based economic development: Silicon Valley.[201] Compared to preceding discussions of particular places, the treatment of the Stanford case will be relatively elaborate because it ties together the previously discussed twentieth-century developments in the spatial organisation of research. By zooming in on the pastoral Palo Alto foothills where Stanford is situated, it is possible to expose the architecture, geography and circulation of that exemplary late-modern utility spot—the research park.

197 O’Mara, 1–2.

198 O’Mara, 27–36.

199 O’Mara, 44.

200 O’Mara, 1–2.

201 Lowen, *Creating the Cold War University*, 6–11; O’Mara, *Cities of Knowledge*, 97–98.

2.7 Stanford University: From Research Park to Silicon Valley

From its inception, Stanford University has been oriented on research and its practical application.[202] Already before the war, close ties with the local business community in the Palo Alto region existed. Especially for electronics, it has been argued that cooperative structures between university and industry existed since the beginning of the twentieth century.[203] During the war, however, Stanford was not very active and acquired almost no defence contracts. Instead, most Stanford scientists dispersed over the nation, to work at laboratories geared to the war effort, like those mentioned before at MIT, Harvard and Los Alamos. Frederick Terman was one of those scientists. He had gained his PhD at MIT under Vannevar Bush, and during the war worked at the Radio Research Laboratory (RRL) at Harvard University. This lab was itself a spin-off from the MIT RadLab.[204] When Terman returned to the west coast in 1945, as dean of the School of Engineering, he concluded that Stanford had been 'underprivileged' during the war.[205] As dean he hoped to undo this harm by remaking his faculty in MIT's image. To this end, he initiated cooperative programmes with industry, strengthened ties to electronic firms and turned Stanford into a centre of radio research with a focus on real-world problems of industry.[206]

Initially, Stanford University did not aspire to rely on federal funding for its remaking. Like many private institutions, Stanford cherished its independence from government involvement, and it pursued a position like Harvard: focused more on basic science than relying on military funds. However, to acquire such a privileged position, it had to be 'hungrier' than its east coast competitors: this drove dean Terman, for example, to accept ONR funds for two electronics research laboratories. Eventually, Stanford secured a well-defined niche and would fully participate in the huge future of electronics. However, electrical engineering was the outlier. For most other university departments academic advancement was a more 'grudging process'. Funds from private sources played a significant role in other departments, like the support of the Ford Foundation for Institute for Advanced Behavorial Studies and the Business School, for example, were stimulated by the Ford Foundation. When Terman became provost of Stanford in 1955, he hoped to apply the lessons from electrical engineering, MIT and Harvard to the entire university.[207] Even in the federal political economy of research, individual university administrators could play motivational and catalysing roles. For Terman, Stanford was a space to realise his technocratic model of society, with an essential role for the university as efficient

202 Leslie, *The Cold War and American Science*; Hall and Castells, *Technopoles of the World*; AnnaLee Saxenian, *Regional Advantage: Culture and Competition in Silicon Valley and Route 128* (Cambridge, MA: Harvard University Press, 1996); Lowen, *Creating the Cold War University*; Martin Kenney, ed., *Understanding Silicon Valley: The Anatomy of an Entrepreneurial Region* (Stanford, CA: Stanford University Press, 2000); O'Mara, *Cities of Knowledge*, 99.

203 Timothy J. Sturgeon, "How Silicon Valley Came to Be," in *Understanding Silicon Valley: Anatomy of an Entrepreneurial Region*, ed. Martin Kenney (Stanford, CA: Stanford University Press, 2000), 15–47.

204 Stuart W. Leslie and Robert H. Kargon, "Selling Silicon Valley: Frederick Terman's Model for Regional Advantage," *Business History Review* 70, no. 4 (1996): 439–40.

205 O'Mara, *Cities of Knowledge*, 106.

206 Stuart W. Leslie, "The Biggest 'Angel' of Them All: The Military and the Making of Silicon Valley.," in *Understanding Silicon Valley: Anatomy of an Entrepreneurial Region*, ed. Martin Kenney (Stanford, CA: Stanford University Press, 2000), 51–53.

207 Geiger, *Research and Relevant Knowledge*, 120–25.

and rational production centre of scientific and technical knowledge and expertise.[208] I will explore how this played out practically and spatially for the exceptional case of research in electronics at Stanford University.

Electronics research: ERL, SRI & SIP

In the post-war period, a 'triangular nexus' emerged around electronics, tying together electrical engineering at Stanford, the Department of Defense and the young electronics industry. Booming electronics firms cultivated continuing relationships with the academic laboratories. Varian and Hewlett Packard are especially interesting in this respect: both were founded by Stanford alumni who were actively stimulated by Terman to start companies. The ties were so close that Varian, for example, had access to faculty laboratories in exchange for a university stake in any resulting patents. More practices existed in which industrial and academic scientists came into contact, could exchange skills, ideas and instruments, and through which they visited each other's site of work: honorary cooperative programmes, faculty consulting and advanced courses for industrial scientists.[209] To grasp the relations between Stanford and industry, and the emergence of a 'city of knowledge', I will highlight the histories of three places of exchange, buffer organisations, or utility spots for electronics research: the Electronics Research Laboratory (ERL), Stanford Research Institute (SRI) and the Stanford Industrial Park (SIP)—arguably the first research park.

At the Electronics Research Laboratory (ERL) Terman, then Dean of Engineering, actively used the triangle between university, industry and the military to secure academic control over the research agenda. Partly, he was trying to reproduce the dynamics that he had observed at Harvard's RRL during the war, where scientists were giving directions to, rather than taking them from industry, while being paid by the military. At the ERL at Stanford, Terman reproduced similar systematic liaisons, based for a large part on (often free) consulting services. In his reading, the university scientists did not need industrial patronage, since they could be well funded through federal channels. Industry, however, did need academic expertise and graduates. Terman used this situation to the university's advantage, by declining industrial subcontracts and instead proposing a system of informal consultancy. In this way, the Stanford scientists and engineers controlled the interaction with industry and as such established the in their eyes 'appropriate' linear relationship between the university expertise and technological development. In the early 1950s, Terman carved out a powerful niche for the ERL, which functioned as mediator between the military and private industry, acting both as consultant and contractor.[210]

208 Lowen, *Creating the Cold War University*, 14–15.

209 Leslie, "The Biggest 'Angel' of Them All," 52–56.

210 Lowen, *Creating the Cold War University*, 123–28.

At the Stanford Research Institute (SRI), established upon instigation of the same Terman, similar dynamics of exchange, funding and control emerged. Stanford President Donald Tressider had envisioned SRI as an embodiment of an opposite ideal of the relationship between university and industry: contract research on particular problems, defined by industry patrons. This mirrored pre-war practices between Stanford and the Sperry Gyroscope Company. Many academics, including Terman, disliked them however. Terman instead took the relationship with Varian as exemplary arrangement of the university-industry interaction: long-standing friendships, geographical proximity, as well as financial and legal bonds. A conflict ensued between Tressider and Terman over the organisation of useful research at the SRI, and this boiled down to different epistemological distinctions, which ultimately were expressed spatially. Tressider characterised different types of research in terms of their funding—either government or industry sponsored—and he wanted to emphasize industrial research to avoid political conflict. Terman, on the other hand, had adopted an epistemic model from Bush's *Endless Frontier*: based on the distinction between basic and applied research, academic staff should work on fundamental issues at the beginning of the whole R&D process, while the SRI should focus on the intermediate process of applied science. Similar to the RLE, this would avoid corporate control over research priorities. Terman, ultimately, used SRI to his benefit by allocating all federal contracts for *applied* research to the institute: this separated applied research spatially from regular academic research in departmental laboratories, while also sustaining close relations to the military patrons.[211]

By 1947, the Navy, through the ONR, accounted for 70% of SRI's external funding. Tressider became increasingly concerned about the very small contributions of private industry to SRI, and higher education in general. After the Korean War, which further boosted federal funds, ONR desired more control over the research projects they funded. Most importantly, this led to the classification of *all* research under defence contracts. Both 'basic' and 'applied' projects, the former taking place in ERL and the latter in SRI, were now subjected to secrecy restrictions. Terman's dislike of 'applied' research in academic laboratories had been decreasing—even using contracts for applied research to cover part of professors' salaries—but he could not accept the ERL research's becoming classified. Thus, Stanford established a new laboratory, the Applied Electronics Laboratory (AEL). Administratively, Terman reorganised the ERL and AEL into 'one' lab, the Stanford Electronics Research Laboratory (SERL), but in practice—and in space—classified and unclassified research were now separated physically in different buildings.[212] By 1967, the success of SRI in acquiring defence contracts would

211 Lowen, 113–17.

212 Lowen, 138–42.

even lead to its outgrowing the university in terms of size and reputation.[213] Partly for this reason, but also because students and faculty protested at its entanglement with the Department of Defense, SRI was spun off as an independent institute in 1970. The defence contracts had to be put at 'a distance' from the university.[214]

If not at the SRI, contact with industry was warmly welcomed at the Stanford Industrial Park (SIP), established in 1951. Terman, who initiated the SIP, also formalised the relations between industry and the university through the Honors Cooperative Program and the Industrial Affiliates Program, both of which responded to the need of companies for access to information, advanced training and potential employees. The Affiliates programme was introduced to Stanford from MIT by John Linvill in 1954. Linvill first set up a microelectronics affiliates programme that mimicked the support system for the establishment of the Laboratory for Nuclear Science and Engineering at MIT, which received large endowments from industries in exchange for access to research results.[215] Although the scope of the Stanford Affiliates programme in solid-state microelectronics was national in scope, there was also the idea that proximity of these companies would enhance the likelihood of such ties.[216] HP and Varian not only served as primary examples and customers for these programmes but also were the first tenants of the Stanford Industrial Park. Also for Lockheed Corporation, the giant aeronautics manufacturer from southern California, the close relations to the Stanford faculty and laboratories were a good reason to lease a facility at the Industrial Park. The SIP became the centrepiece of the university-centred economic development taking place in Palo Alto.

It was not the first industrial park, but its spatial proximity to and close association with the university were distinctive. However, there were ulterior motives for the university to develop their land into a business park. Stanford was extremely privileged in terms of the size of the land endowment they had at their disposal. But up to the 1950s, they had been making only small profits on it. After the war, tax regulations were changed in such a way that it became highly unfavourable *not* to develop land. Municipalities could even requisition private land for public purposes if that was regarded necessary for the economic development of the region. Thus, in the late 1940s, university administrators commissioned several advisory reports to decide on the use of the undeveloped land. An industrial purpose fitted better with the university's interests than, as one report advised, a residential area. The Stanford Industrial Park came to occupy about half of the available land in the proximity of the university and was established with the purpose to 'strengthen Stanford's position as a top national research university'. Institutionally Stanford would benefit,

213 Leslie, *The Cold War and American Science*, 243–44.

214 Leslie, "The Biggest 'Angel' of Them All," 66.

215 Elizabeth Popp Berman, *Creating the Market University: How Academic Science Became an Economic Engine* (Princeton, NJ: Princeton University Press, 2011), 26.

216 Lowen, *Creating the Cold War University*, 130–31; Berman, *Creating the Market University*, 34; O'Mara, *Cities of Knowledge*, 124–25.

its administrators thought, from profitable connections to local business and the reputation of a net contributor to regional economic development.[217]

As space, the Industrial Park was a combination of various planning traditions, cultural currents and economic developments. According to Terman the SIP would serve as example of the peaceful coexistence between high-tech industrial development and affluent suburban life. This was achieved through high standards for the types of companies that were welcome and the aesthetics of the buildings and the surrounding space. Low-rise, cleanly modernist architecture, lush greenery and spatially distant facilities made this new type of industrial development mirror both suburban space and university campus. This recreated a pastoral environment in which, arguably, scientific creativity would flourish and which would attract and please a scientific and technological workforce. Again, the demands of the elite workers were dominant in shaping the spatial model of useful research.[218] The pastoral aesthetics of the research park related to cultural currents (amongst the white middleclass) about the rejection of the cities and the 'old' heavy industries, in favour of the healthy outdoors.[219] The mirroring of the campus planning tradition, seen above also in corporate settings, could be observed at Stanford Industrial Park where the combination of pastoral isolation, separation of functions and comprehensive design were applied to an industrial area.

This peaceful coexistence was as much hope as reality. In the late 1950s, several community organisations from Palo Alto, as well as Stanford alumni, opposed the expansion plans of the Industrial Park into the foothills that had been so characteristic of the Stanford campus. Although the image of high-tech industries was always 'clean', residents around Stanford worried and complained about several forms of pollution. Also, they successfully challenged the zoning buffers between industrial buildings and surrounding residential areas. Ultimately, Stanford University was able to forge a strong alliance with willing local government and the local chamber of commerce, so that expansion of the park could proceed. But, as they catered to the needs of industry, and chased additional leasing income, they were generally disdainful of community concerns. The eventual rebranding of the Industrial Park into 'Stanford Research Park', in 1961, was an attempt to defuse future community suspicion.[220]

Around Stanford University and its Research Park high-tech industrial activity in advanced electronics, especially semiconductors based on silicon, grew to such an extent that, from 1970 onwards, it would be referred to as 'Silicon Valley'. Stanford provost Terman is often remembered as the 'father' of this region. His various initiatives in strengthening the ties between academic science, industry and federal patrons

217 O'Mara, *Cities of Knowledge*, 111–20.

218 O'Mara, 67–68.

219 O'Mara, 101.

220 O'Mara, 132–39.

definitely were catalysts. It is also an example of the ingenuous ways in which individual university administrators, like Terman, used the relation to federal government not as an alternative to industrial patronage, but as means to achieve their own aims of industrial support, consulting opportunities and employment.[221] But all this came at a cost and could take place only because of a specific political and geographic context. Ultimately, it did lead to the accommodation of research programmes to the interests of patrons, for example in electronics but also in behavioural sciences. Also the eventual success of the Stanford Research Park was due to 'extraordinary circumstances' and favourable historical conditions: the location amidst a booming wartime economy, desirable residential areas, an ecosystem of electronics innovation that dated back to pre-war times, the emergence of unobtrusive, white-collar technological spin-offs, the rising political status of science, a wealthy, entrepreneurial, politically savvy university with a large endowment of undeveloped land and close ties to local civic leaders.[222] Many of these factors were often lost on imitators who hoped to replicate this type of university-based economic development.

Circulation of the Stanford Model

Since the name Silicon Valley was introduced, in the early 1970s, it came to stand for a myth of entrepreneurial individuals and instantaneous development.[223] This made, and still makes, Silicon Valley appealing to politicians, businessmen and scientists across the world. However, Stanford and the Palo Alto region had some, partly coincidental, advantages. The booming area of high-tech entrepreneurship did not arise 'in spite of' government involvement: rather, the 'entrepreneurial drive', also amongst academics, stemmed largely from the competitive dynamics set up by the federal government.[224] Thus, it might be clear now that a much broader context and longer history of academic-industrial development in the region, in electronics especially, has to be taken into account to understand its emergence as high-tech ideal of economic development. Silicon Valley was the result of a historical co-evolution of high-tech industry and a high-tech academic institution between which horizontal relations of interdependence and collective learning existed. Its famed firms, like Varian, Hewlett-Packard, Shockley and Fairchild, were not the first movers of this model, but rather an outcome of these historical conditions.[225] Place and historical context set the limits for path-dependency of a regional economy.

Already in the 1950s, many admired the Stanford Industrial Park as a model for regional economic development. For example, at the 1958 World Fair in Brussels it featured in a colour film of 'Industrial Parks USA'.[226] Following this exhibition, many international visitors passed by the actual

221 Lowen, *Creating the Cold War University*, 236.

222 O'Mara, *Cities of Knowledge*, 107; Leslie, "The Biggest 'Angel' of Them All."

223 Saxenian, *Regional Advantage*; Gwendolyn Wright, "The Virtual Architecture of Silicon Valley," *Journal of Architectural Education* 54, no. 2 (2000): 88–94; Christophe Lécuyer, *Making Silicon Valley: Innovation and the Growth of High Tech, 1930–1970* (Cambridge, MA: MIT Press, 2006).

224 O'Mara, *Cities of Knowledge*, 10–13.

225 Sturgeon, "How Silicon Valley Came to Be," 16.

226 O'Mara, *Cities of Knowledge*, 127–28.

Stanford site to see for themselves 'this wonder of modern industrial development'. Also within the United States, various cities and localities tried to recreate the same kind of dynamics around 'clean' industries, notwithstanding major contextual differences. And many universities, eager to enter into real estate and economic development, looked at Stanford as instructive example. Berkeley city officials, for example, toured the Stanford Industrial Park in 1961 to assess whether they could engage in similar economic activities. They returned north 'painfully aware' of the spatial, demographic and political differences between Berkeley and Palo Alto that made it impossible to copy the Stanford model (even though it is only a one-hour drive, if traffic runs smoothly). Berkeley lacked available space and a similar pro-business attitude within its university administration. Also, they noted a difference in the socio-economic make-up of the two towns: the racial and economic homogeneity of Palo Alto, or its affluent whiteness, made it especially appropriate for science-based economic development. Minorities were underrepresented in science and technology while the whiteness of the Palo Alto area made it appealing to professionals during a 'time of racial change and social upheaval'.[227]

From the mid–1960s onwards Terman, by then retired, played a pivotal role as consultant in attempts at circulation of the Stanford model of regional economic development, in other American states and in Korea.[228] In these cases, both imitators and consultants usually overestimated the importance of the educational institute as catalyst and underestimated the importance of a cooperative business culture and generous government subsidies. Post-war defence subsidies had fuelled the economic development of the region, in which the Stanford Research Park flourished. It was also not always sufficiently realised how different large vertically integrated firms and small high-tech start-ups fitted in the science park model. The start-ups that spread in Silicon Valley had actively sustained open and informal relations with external parties—both academics and other companies—which benefitted from proximity. More traditional companies, however, moved close to excellent institutions of higher education not for direct knowledge transfer, but because they hoped to stay competitive on the scientific and technological job market. Research parks were a way to demonstrate ties to a university and convince a highly educated (and in demand) workforce to move to, e.g., Texas or New Jersey.[229]

Most studies that deal with the imitation and circulation of the Stanford Research Park and Silicon Valley model come to similar conclusions: a successful outcome relies heavily on local implementation, social context and historical conditions.[230] O'Mara, for example, has compared developments of research parks at University of Pennsylvania, in Philadelphia, and at

227 O'Mara, 127–30.

228 Leslie and Kargon, "Selling Silicon Valley."

229 Leslie and Kargon, 445–47; Leslie, "The Biggest 'Angel' of Them All," 59–61.

230 Sturgeon, "How Silicon Valley Came to Be," 47.

Georgia Tech, in Atlanta. In Philadelphia, the racial and class politics of an urban neighbourhood—instead of a homogeneous and affluent suburban area—proved incompatible with the university model of high-tech development. Georgia Tech, on the other hand, could not play the same role as Stanford, as it lacked the political and economic engagement with the local community.[231] Internationally, the replicability of Silicon Valley in localities from East Asia to Europe appears even more problematic. The export of the silicon dreams were based mostly on glossy but weakly studied consultancy reports that distilled all too simple formulas of the economic success.[232] For the United Kingdom, Doreen Massey, David Wield and Paul Quintas likewise have observed a widespread, superficial assumption that a combination of a prominent academic community and a growing high-tech industry was the causal, and therefore reproducible, factor behind Silicon Valley.[233] Hans Weiler has identified physical proximity and cultural affinity as the pillars under the Palo Alto success story. As Weiler notes, these depend on a historically developed 'knowledge ecology', which makes international travel of the model unlikely.[234]

The attempts to circulate and replicate the Stanford model of science-based economic development can be situated in a broader history of transnational circulation of knowledge in the post-war period. The *hegemonic* position of the US in science existed in a tense competition, and sometimes conflict, with the Soviet Union in the first three to four decades after the Second World War. American hegemony thus existed mainly in the 'Western' or capitalist part of the world, as well as in decolonising low-income countries. In these regions of the world, the examples of MIT, Stanford Research Park and Silicon Valley were, at different times, admired and functioned as models. This was also actively stimulated by the 'missionary fever' to export American models of research organisation. Visiting Europeans were often both fascinated, by the energy, efficiency and organisation, and contemptuous, of the emptiness and uniformity of mass production and consumption.[235] However, models are abstractions of reality, and need to be accommodated in each instance of application. This makes imitation and circulation of utility spots, especially transnationally, a great challenge, if not improbable.

Ultimately, many attempts at imitating the 'putative advantages of the US regime' for useful scientific research stranded on social and cultural barriers. This does not, however, warrant O'Mara's conclusion that *only* in the US 'cities of knowledge' are the 'organic outcome' of policy structures, while abroad they are *just* imitations of the American model.[236] Also Weiler's claim that 'Europe' lacked proximity between academic and industrial communities in spatial, epistemic and cultural terms, is too simplistic.[237] Such assertions recreate the lack of attention for local context that missionaries and imitators of Silicon

231 O'Mara, *Cities of Knowledge*, 7–9.

232 Hall and Castells, *Technopoles of the World*, 8.

233 Doreen Massey, David Wield, and Paul Quintas, *High-Tech Fantasies: Science Parks in Society, Science and Space* (Routledge, 1992), 5–6.

234 Hans N. Weiler. "Proximity and Affinity: Regional and Cultural Linkages between Higher Education and ICT in Silicon Valley and Elsewhere." In *The Use of ICT in Higher Education: A Mirror of Europe*, edited by Marijk van Der Wende & Maarten van de Ven, 277–297. Utrecht: Lemma, 2003.

235 Krige, *American Hegemony*, 261–66.

236 O'Mara, *Cities of Knowledge*, 9–10.

237 Weiler, "Proximity and Affinity."

Valley embodied; instead, I will demonstrate in subsequent historical reconstructions of European developments that hegemonic spatial models of useful knowledge production were actively used and appropriated in political-epistemic localities there.[238]

2.8 Increasing Space for Industry and Commercialisation on Campus

The story so far has focused on the most intense period of the Cold War, between 1945 and 1968, in which a huge bubble of federal funding for scientific research was inflated. In US historiography less attention has been paid to the subsequent 'comprehensive deflation of that bubble', even though this created the dynamics that still structure scientific practice today.[239] Some argue that although the amounts of federal patronage fluctuated between 1960 and 1980, the basic triangular relationship between government, industry and science persisted.[240] But the focus of federal science policy, and the political notion of the usefulness of publicly funded scientific research, shifted from national security to economic competitiveness.[241] We can capture this political-epistemic shift, and the concurring cultural and scientific developments, by focusing on four hybrid spaces on the fringes of campus in the period 1960–1980: contract research institutes embody the removal of military research *from* campus, whereas research parks, University-Industry Research Centers and Technology Transfer Offices typify the attraction of industrial actors *to* campus.

First of all, new buffer organisations, like SRI at Stanford, dealt with contract research for the federal government, in particular the military, and emerged in response to financial success of the interdepartmental labs *and* anti-war activism. From the late 1960s onwards student protests against the war in Vietnam and Cambodia fuelled controversies over military research *on* campus.[242] This explicit moral revaluation of military patronage put pressure on the all-pervasive and tacitly accepted alliance between science and national security. These protests participated in a broader culture of challenges to the public image of science and its self-proclaimed freedom, following issues like environmental pollution (Silent Spring), weapons research (Agent Orange) and general responsibility for social effects (thalidomide). Discontent with military support might have been brewing longer though, also amongst faculty: as the federal research economy drove one segment of academics towards military sponsors, it drove the remaining segment further away from any applications.[243] The friction that this produced was reinforced by the ideological representation of the nationalised system of science as an autonomous invisible college of creative individuals, which allowed academics to

238 Jeroen van Dongen and Friso Hoeneveld, *Cold War Science and the Transatlantic Circulation of Knowledge* (Leiden: Brill, 2015).

239 Cyrus Mody, "How I Learned to Stop Worrying and Love the Bomb, the Nuclear Reactor, the Computer, Ham Radio, and Recombinant DNA," *Historical Studies in the Natural Sciences* 38, no. 3 (2008): 457.

240 Lowen, *Creating the Cold War University*, 235.

241 Ann Johnson, "The End of Pure Science: Science Policy from Bayh-Dole to the NNI," in *Discovering the Nanoscale*, ed. D. Baird, A. Nordmann, and J. Schummer (Amsterdam: IOS Press, 2004), 217–30.

242 Leslie, *The Cold War and American Science*, 243–44.

243 Mody, "How I Learned to Stop Worrying," 456–61.

believe in ivory tower isolation of basic science.[244] To deal with the friction and disparity between interdepartmental labs lavishly funded from military sources and other faculty and activist students, these labs either divested or remoulded their purpose. Organisations like SRI at Stanford and MITRE at MIT (founded already in 1958) were established at a greater administrative and physical distance from academic departments to shake off the military image. When academic linkages were broken, these contract research institutes did not necessarily suffer, partly because informal relations often remained in place. But in the campus imagination, the military was banned at least to the periphery.

The first research parks, or 'cities of knowledge', in which companies could locate proximate to academic institutes, emerged at the intersection of Cold War science policy, industrial dispersion and mass suburbanisation.[245] The history of these utility spot can be traced back to the 1950s, as described in the previous section. Subsequently, the research park development 'mushroomed' moderately in the 1960s and dipped again in the 1970s, so that only a handful of parks can be considered a success (amongst which Stanford). Universities underestimated the difficulty of convincing companies of the comparative advantage of proximity and no additional public funds were available to develop the parks further.[246] It was only in the 1980s that the model of the research park spread more widely and successfully with the support of local and state governments, which hoped for technology-based economic development.[247]

Only with public support could the research park model become more viable for universities, which in addition hoped to gain income from industrial tenants. From the side of industry, interest in locating R&D close to universities grew. This is because in the late 1970s firms increasingly outsourced their research activities on the global marketplace, to new private R&D corporations, but also often to 'academic and hybrid settings, like research parks and quasi-academic start-ups'.[248] In response to a globalising economy and consecutive oil crises, vertically integrated companies had to reform. Especially the semi-autonomous corporate research laboratories became a liability for these companies. The belief in basic science had already received some blows, as new blockbuster products failed to materialise and global competition threatened market positions. At the same time, previous inventions like the transistor became the battleground for scholarly and policy debates about the relationship between science and technology. Increasingly, funds for research and development would be reallocated to shorter-term projects.[249] Eventually, it became all together unprofitable to sustain a division with a campus ambiance and an external orientation. As an effect of these developments, research was outsourced to new hybrid spaces close to campus.

244 Mirowski and Sent, "The Commercialization of Science."

245 O'Mara, *Cities of Knowledge*, 1–9.

246 Berman, *Creating the Market University*, 26–34.

247 Berman, 150–51.

248 Mirowski and Sent, "The Commercialization of Science," 655–61.

249 Hounshell, "The Evolution of Industrial Research in the United States," 45–51.

University-Industry Research Centers are one example of the hybrid academic-industrial spaces that, for various reasons, started to spread to and flourish on university campuses in the US after 1978. Of course, multiple initiatives directed at the interaction between actors from university and business existed before. Above, I have touched upon the establishment in the 1950s of a research park and an industrial affiliates program at Stanford. Both these practices, as well as 'industry extension offices' that helped local small businesses with technical problems, emerged at several institutes of higher education but, according to Elizabeth Popp Berman, never became widespread. This lack of success would be due to a culture gap between the two worlds (different goals, values and reward systems) and, especially, an unconducive policy environment. By way of contrast, Berman discusses the success of University-Industry Research Centers (UIRC) in the 1980s. Similar to the research parks, some (engineering-oriented) universities, like MIT, Caltech and Rensselaer Polytechnic Institute, experimented with such spaces already in the 1960s and 1970s. But only after 1980 the UIRC spread widely with the help of lavish public funding and were regarded as acceptable spaces on campus.[250] By the end of the decade, NSF had supported about 40 centres in such fields as ceramics, robotics, material sciences, and microelectronics, often located at state universities. In an UIRC, faculty could periodically discuss research agendas with industrial sponsors, actively collaborate and publish with visiting industrial researchers, or facilitate annual meetings with industrial affiliates to share important results and meet potential employees.[251]

The UIRC was first modelled after the existing phenomenon of organised research institutes (or interdepartmental labs), in which many universities housed interdisciplinary research not fit for disciplinary departments; the only difference was the explicit goal of the UIRC to collaborate with industry.[252] The UIRC combined a well-known organisational form with the functionality of previous attempts, like the affiliates programme and extension office. After some early bottom-up instances of this type of space struggled, it was an experiment started by the NSF in 1973 that made the first of these centres viable. The NSF's break with its commitment to basic science by turning to fund cooperation with industry was actually a strategy to circumvent the political pressure to fund industrial research directly. The MIT-Industry Polymer Processing Program (PPP) was the biggest success and came to function as a model for all later UIRC funded by the NSF: it had a strong director in a powerful role—'a champion'—and worked for an industry with a pre-existing orientation to R&D and common, relatively fundamental technical concerns. The spread of this model took off after 1978 for two reasons: considerable funding by federal and state governments, based on the belief that the interaction

250 Berman, *Creating the Market University*, 11–34.

251 Berman, 119.

252 For the following discussion of UIRC I rely completely on Berman, 119–45.

between universities and industry was key for innovation and economic growth, and active promotion by the NSF of a replicable model for this interaction. Through programme evaluations, practice manuals and historical profiles of all centres, the NSF funded UIRC's had a 'disproportionate impact' on the spread of this utility spot that, according to later commentators, became 'the most prevalent means of providing technological development services for industry' in this period.[253]

A last novel place of exchange, to characterise the changes taking place in the 1970s and 1980s, is the Technology Transfer Office (TTO). Most universities nowadays house such a research support organisation, staffed by small teams of transfer officers, to make scientific advances available to the public via patenting and licensing of research results. The spread of TTOs is intimately tied to the 'watershed' in the history of organised university research brought about by the rise of biotechnology and commercialisation of research.[254] That many situate this break in 1980 is due to three legal innovations which all took place in that year and stimulated the practice of patenting at universities. The Bayh-Dole Act rationalised patenting rules, explicitly allowing universities to patent publicly funded inventions and to grant exclusive licenses to commercial parties. The Stevenson-Wydler Act became known for making technology transfer to the private sector a mission for federally funded research. Federal laboratories were subsequently required to establish Offices of Research and Technology Applications (ORTA). Lastly, the *Diamond v. Chakrabarty* Supreme Court decision made genetically modified microorganisms, and more complex life forms, patentable. Together, these developments did not so much make legal what was previously illegal, nor can it be proved that they led to all-round radical changes in practice. Ultimately these policy decisions had differential effects but did legitimise hybrid academic practices that in a previous decade had seemed dubious and made industrial-university collaborations more attractive. This was further improved by the 1986 Federal Technology Transfer Act (FTTA), which allowed government laboratories to engage in cooperative research and development agreements (CRADA) with other (private) parties and made it possible for employees to receive a part of the royalties.[255]

In this context, David Guston has described the model of the TTO as a boundary organisation that 'promotes collaboration between non-scientists and scientists over the assurance' of the productivity or, I would say, utility of research.[256] The boundary between science, politics and industry became permeable in this space, especially for the technology transfer specialists who mediated the commercialisation process. In addition, CRADAs introduced a formalised and interactive version of scientific discovery, collaboration and dissemination.[257] These types of developments have been reason for Philip Mirowski

253 Berman, 134–39.

254 Geiger, *Research and Relevant Knowledge*, 297–305.

255 David H. Guston, *Between Politics and Science: Assuring the Integrity and Productivity of Reseach* (Cambridge, MA: Cambridge University Press, 2000), 119–25; Johnson, "The End of Pure Science: Science Policy from Bayh-Dole to the NNI," 220–21; Berman, *Creating the Market University*, 94–114.

256 Guston, p. 115.

257 Guston, "Stabilizing the Boundary between US Politics and Science."

to argue that in these decades the 'meaning of knowledge' changed radically: by the end of the 1980s, neoliberal doctrines had transformed research and development, and the knowledge resulting from it, from a public good in need of state support into a fungible commodity in a sufficiently competitive market.[258] Bio- and information technology functioned as paradigms for this commercial knowledge production and so did places like research parks, TTOs and UIRCs.

Often, 1980 is thus identified as a hinge point for a fundamental change in the research system: the emergence of the 'market university', 'privatised' science, and commodified knowledge. Traditional explanations point to two factors: first, corporate outsourcing of R&D due to globalisation and, second, cash-strapped universities that, following the money, embrace contract research.[259] The relative defunding of scientific research by the military in the 1970s was an underlying cause for both developments. Firms had relied on defence contracts for basic research, and universities reinvented themselves as key contributors to economic competitiveness. More specifically, universities transitioned from a passive 'resource' model of their economic function—in which universities relied on their basic knowledge to help industries with their problems—to an active 'engine' model, in which the university became the source of innovations, companies and economic growth.[260] The quick growth of commercial biotechnology start-ups was the exemplary model of this; they attracted both manpower and resources by offering, once again, an 'academic' environment for creativity and innovation. This also forced universities and existing industries into new forms of cooperation.[261] As discussed above, many of these practices geared at the private sector pre-date 1980. But they were boosted significantly after 1980 by changes in policy, state funding of research and political-economic context.

The historiographical themes of distortion and linearity identified for the post-war political economy did not disappear but transformed with respect to the context and spaces of the 1980s. If the concern over the autonomy of university research was previously directed at the militarisation of research, commercialisation became the new concern. It was again a question whether the most societally useful science and technology were being produced, this time questioning the profit-driven interests of libertarian high-tech entrepreneurs on suburban science parks. The linear model of innovation was carried to its grave by many scholarly and (neoliberal) political commentators. By retrospectively projecting linearity, previous interventionist science policies were criticised by the figureheads of neoliberalism, from Reagan to Thatcher.[262] The necessity of (public funding for) basic research for technological development was explicitly questioned, which we have seen reflected in increasingly collaborative practices and hybrid spaces between the university and industry.

258 Mirowski, *Science-Mart*, 6–7.

259 Mirowski, 16–20.

260 Berman, *Creating the Market University*, 30–33.

261 Martin Kenney, *Biotechnology: The University-Industrial Complex* (New Haven; London: Yale University Press, 1986).

262 Mirowski, *Science-Mart*, 54–56.

2.9 Conclusion: Utility Spots and the US Historiography of Science

The societal legitimation of university research in the post-war United States has typically been described in terms of funding streams, policy measures and related discourses. In such narratives, an organisation like NSF receives a lot of attention. When we turn our attention instead to the spatiality of useful university research and the transfer of knowledge, other kinds of places and organisations become manifest and abstract concepts appear in architectural or physical terms. The survey of spatial themes in the US historiography of organised science in the twentieth century helps construct a historical-geographical methodological approach. Using the utility spot as a heuristic concept, the subsequent chapters examine the history, political economy and epistemology of utility in other geographical contexts.

To grasp the historical, political and epistemic aspects of the utility spot, two observations on American historiography are specifically relevant. First the historical observation that a large number of epistemic spaces can be identified where interactions between academic and extra-academic actors took place, were allowed or stimulated. What is more, it seems that the number of purposely built hybrid spaces increased after the Second World War. More informally, networks and exchange between university, government and industry actors already existed, sometimes even sharing (academic) space. The surge in hybrid utility spots does not necessarily entail a greater intensity of this cooperation, although it seems likely. What it definitely implies is a stronger public image of, and political-epistemic coalition behind, these particular modalities of useful knowledge production. The visibility of specific types of utility spots therefore indicates changing ideas and values in the socio-political context of universities. The removal of military-related research from campus in the 1970s, by housing them in new extra-academic institutes, and the subsequent establishment of industry-oriented spaces is a case in point.

Second, a historiographical reflection. Historians and sociologists of US science have posited a variety of concepts to describe some of the places discussed above. Geiger, for example, described various ‘buffer organisations’ or inter-departmental labs, distinguishing between centres and institutes. Leslie baptised similar places of exchange as ‘organised research units’. Galison used ‘trading zones’ in his analysis of increasing cooperation between different types of specialists in big science environments. Berman identified the rise of an ideal type of University-Industry Research Centers in the 1980s. Guston dubbed the offices that mediated between science, politics and commerce ‘boundary organisations’. O’Mara, lastly, spoke of ‘cities of knowledge’, in her study of university-based economic development of the research park type. The utility spot is not introduced as a challenge to these concepts; it is meant to encompass the complete scope of places that are considered necessary and desirable to streamline and improve relations between science and society. *Utility spot* functions therefore on a different analytical level: it does not so much provide a description of one concrete historical phenomenon, but rather is meant as a methodological approach to study the history of science, universities and their societal meaning in space.

From the survey of the US historiography it is possible to derive a set of spatial, geographic and architectural aspects of the utility spot concept. The actual *architecture* of these places can have intended and coincidental effects on the conduct of research. Organisational innovations aimed at solution of practical problems, like interdisciplinary collaboration as well as trading between different specialists (e.g. engineers, scientists and instrument makers), can be both enabled and obstructed by the physical constraints of a building. The strategy of architectural separation is applied to install a difference: between basic and applied research, between different funding streams, or between classified and unclassified activities. Often, issues of public legitimation and institutional responsibility of different types of research at universities inform such spatial choices. These boundaries are political-epistemic separations: they respond to a broader political economy of research and have epistemic consequences for the kinds of research that are considered acceptable on campus.

That brings us to location, because, as we have seen, it matters a great deal *where* a spot is located with respect to the university and societal space in general. Many proponents of new hybrid interactive spaces advocate a rather simple distance function of cooperation: proximity increases (the likelihood of) interaction between university researchers and non-academic actors. On-campus location then usually implies stronger ties to academic departments, whereas these decrease in strength the further away a utility spot moves from campus. Inversely, the relation to the external patron—industry, the military or the government—intensifies. My main concern is not the reality of these proximity effects, but rather their complex intertwinement with other social, cultural and political aspects. The case of Stanford University for example demonstrated that there were ulterior, financial motives to attract industry to campus. There is thus a politics to proximity, especially because the power of the argument is seldom challenged. Another example of the politics of proximity is the tendency of both traditional large-scale companies and smaller high-tech spin-offs to locate close to university campuses. Where the latter might have their reasons—because the entrepreneurs studied at that university or nourish active relations with a department there—the former often have one main rationale: to attract workforce.

Throughout the twentieth century, the relative scarcity of highly skilled scientific and technological manpower had far-reaching spatial consequences. From industrial research labs creating an 'academic atmosphere' on their grounds, multinationals relocating to the vicinity of famous universities or establishing entire R&D campuses with a futurist aesthetics, all the way to universities creating in-between places for entrepreneurial academic staff: they were all informed by a concern for sufficient scientific workers in their own institution. The relation between proximity and interaction can therefore also be more publicity than practice.

At various sites, we have also seen how utility spots fitted in larger political-economic *geographies*. Where patrons spend their dollars structures the development of scientific research and endorses what counts as useful. Institutional and regional favouritism, by the federal government and the military, created a nationally skewed geography of science in the US. Connected is the concern whether centralisation, decentralisation or even state-regulated regional spread is the best model for epistemic progress—both for science and for society. And it is not only about *what* works best; the image of useful science depends on such geographical patterns. The suburbanisation described above was a result of the geography of funding and created a very tangible, white and affluent, model of high-tech economic development. This model, known so well today as Silicon Valley, points us to the local and regional conditions for a particular place of exchange to function: the contingent co-location of production facilities and the importance of relations with local city councils, business community and societal groups.[263]

This, lastly, also significantly limits the likelihood of successful *circulation* of spatial models of useful knowledge production elsewhere. The desire to copy examples from abroad seems inexhaustible, but this is not often matched by a similar willingness to investigate these histories. The Stanford model and the case of UIRCs hint that a lot of work goes into the replication of utility spots. Instead, many have accepted simplified geometries of the relations established in a certain spatial example of knowledge exchange. In the period described above, especially linear and triangular models, between science and production, or universities, the military and industry, circulated to describe in highly simplified form the organisation and epistemology of the interactions between university knowledge production and societal use.

Architecture, location, proximity, geography, geometry and circulation: these six spatial themes intersect in utility spots. Combining these different aspects can provide tangible histories of utility spots as the products of local conditions, regional environment, national political economy and international geopolitics. The spatiality of useful research is

263 Others have called this the 'Corporate-Government-Education' environment of scientific research. Mirowski and Sent, "The Commercialization of Science," 665.

thus very specific to the context in which it emerges, and the political-epistemic alliances on which it relies. In the next few chapters, this tension will come to the fore when I reconstruct how spatial models of useful knowledge production circulated in debates about the Dutch and Western European organisation of research. The three main themes of architecture, location (including proximity and geography) and circulation (including geometry) inform, both explicitly and implicitly, these historical reconstructions.

3. The Spatiality of Science Policy.

Para-University Institutes for Sponsored Research, 1954–1963

3.1 Introduction

The paradigmatic utility spot of the science park is ubiquitous today. Yet, its circulation has never been unproblematic. Ill-understood or not, as model and ideal, US utility spots travelled across the globe. However, such models never arrived in a vacuum. The previous chapter concluded with the observation that the historical and geographical origins of a supporting political-epistemic alliance have to be taken into account to explain, for example, Californian success stories. In addition, we need to understand also the historical and geographical origins of political-epistemic alliances and appropriation processes at the 'receiving end' of the circulation of spatial models of useful research.

In the following three chapters, I will work towards the arrival of the science park on the other side of the Atlantic. Where at the beginning of the twentieth century a *German* model travelled to the US, towards the end of the century *American* models moved in the reverse direction. More specifically, my geographical interest will be the Netherlands. This affluent, scientifically advanced but small Western European nation was in this period relatively open towards international developments. In contrast to much larger countries like Germany, France and the UK, the Netherlands had less independent academic institutional tradition. If we could pinpoint a Dutch tradition, it would probably consist in the mirroring and appropriation of foreign examples. This small country on the North Sea is therefore an appealing context to study the creation, transnational circulation and transformation of utility spots.

My first historical reconstruction focuses on the 1950s and the appropriate places for free and sponsored research, which became known to historical actors as the 'TNO issue'. Policymakers, university professors and industrialists discussed the acceptability of and criteria for the funding of research in universities by 'extra-academic' bodies, like the Nederlandse Organisatie voor Toegepast-Natuurwetenschappelijk Onderzoek (Dutch organisation for applied natural science research, TNO) and industry, especially Philips N.V. My discussion of the TNO issue and the ensuing Kronig report, neither of which have been covered in Dutch history of science, will make clear that the relation between the utility and independence of university research expressed itself, and can be understood, spatially.

In the first section (3.2) I situate the concept of utility in post-war Dutch culture and the Cold War context. Subsequently, I introduce the Dutch research landscape as it developed between 1900 and 1950 (3.3), to understand the place of TNO in the political, institutional and societal contexts of organised research in the Netherlands. Second, I will discuss two concrete places of knowledge production and exchange—the virtual Medical Physical Institute (3.4) and the Technical-Physical Service (3.5)—to uncover spatial frictions at the root of a broader debate about the coordination of useful research. The friction in these hybrid places, mixtures of TNO, industries and universities, led to a national enquiry into the 'character' of university research (3.6). I will explore the consequences of this practical science policy debate *avant la lettre* in terms of architectural (3.7) and geographical (3.8) solutions to the strained relations between independent and sponsored, academic and extra-academic, free and useful research. In conclusion (3.9), I collect the implications of the spatial approach for Dutch historiography of science policy in relation to the utility spot concept.

3.2 Freedom and Utility of Scientific Research in the Netherlands

Hendrik Wagenvoort, a classics scholar and prominent figure in Dutch academic organisations, identified in 1954 an 'urgent problem' that had been imported from the US: 'the gradual, but quickly accelerating concentration of scholarly work [*wetenschapsbeoefening*] ("teamwork", institutes outside the university, international cooperation and division of labour)'.[264] He raised this concern as chair of a committee that organised a conference on the freedom and restraints of science, following an invitation from Columbia University. This east-coast university celebrated its 200th birthday by stimulating academic conferences worldwide on 'man's right to knowledge and the free use thereof'.[265] Unavoidably, this was occasion for Cold War propaganda and the manifestation of the military-industrial-academic-complex. At a celebratory dinner US president Dwight D. Eisenhower, a former president of Columbia, called the use of knowledge 'the key to peace':

> Today, of course, we must have infantry—and planes and ships and artillery. Only so can we be sure of a tomorrow and the opportunity to continue the mobilisation of moral and spiritual energies. But there is no time to waste if truth is to win the war for the minds of men! Here is the unending mission of the university—indeed of every educational institution of the free world—to find and spread the truth![266]

In the Netherlands, it was the occasion for the Dutch universities to present themselves, for the first time as a united front, at an 'inter-academic conference' in the Zoological Gardens of The Hague. But, in the Cold War context, the rectors of the Dutch universities explicitly did not intend it as an embrace of American values: they feared that it would obscure the 'Dutch character' of these issues.[267]

Honoured by the attendance of Queen Juliana, quite some academics ended up in rather abstract reflections about 'freedom and restriction in science'. Later commentators have even presented this conference as evidence of a stronger 'emphasis on ethical reflection than on proposals for change' in the Dutch 1950s and a general 'contemplative attitude' to questions of organisation and utility of research.[268] But in almost every presentation, policy draft or discussion in the Zoological Gardens the practical realities of scientific research came to the forefront: science was 'no cool and sober business', concluded one newspaper.[269] The questions of planning and frustration, or utility and freedom, translated into the question of organisation as such: who was allowed to steer or direct research, and with whom should the results be shared? In this chapter I will argue that this boiled down to: *where* should (useful) research take place?

264 A professor of animal physiology, E. Brouwer, from the agricultural polytechnic in Wageningen, had brought this to the attention of Wagenvoort. Nationaal Archief Den Haag (NA), College van Rectores Magnifici (CRM), 2.14.16 inv.nr. 222, Prof. Wagenvoort to Secretary of the Rector College, 2 June 1954.

265 Jean L. Preer, "Man's Right to Knowledge: Libraries and Columbia University's 1954 Cold War Bicentennial," *Library Trends* 55, no. 3 (2007): 623–37.

266 'The Text Of President Eisenhower's Address At Columbia's Bicentennial Dinner,' *The New York Times,* 1 June 1954.

267 'Universiteiten en hogescholen organiseren samen congres,' *Parool*, 6 September 1954; H Wagenvoort et al., eds., *Freedom and Restriction in Science and Its Aspects in Society: Congress Promoted by the Netherlands University [Sic] for the Discussion of the Subject (...), The Hague, 17 and 18 September 1954* (The Hague: Martinus Nijhoff, 1955), 1–4.

268 Arie Rip and Egbert Boeker, "Scientists and Social Responsibility in the Netherlands," *Social Studies of Science* 5, no. 4 (1975): 464–66.

269 'Wetenschap geen koel en nuchter bedrijf,' *De Telegraaf*, 21 September 1954.

In the previous chapter, I have argued that *utility spots* provide a fruitful perspective on the organisations and political-epistemic alliances that support university research. The increased role of federal patrons in the post-war US produced new spaces and imaginaries for the organisation and exchange of useful scientific research. Also in the Netherlands after 1945, the direction and coordination of research by extra-academic bodies, industry and the state were important issues that can be explicated at concrete spots. Utility was primarily defined in relation to the large-scale concerns of post-war reconstruction and industrialisation of the Dutch economy. For universities and professors this entailed concerns about their autonomy and freedom: whether they preserved the power to establish institutes and research fields. Still, the first two post-war decades are commonly described as one of exponential growth of support for undirected, fundamental research in universities—even though a surplus of freedom could produce a mismatch with industrial demand for scientific and technical manpower. By 1955, a high-level policymaker could remark that finance was no bottleneck for the development of institutes of higher education, in this case the polytechnic in Delft. Instead, he continued, 'manpower and space are currently the prohibiting factors' [*'manpower en ruimte zijn op het ogenblik de remmende factoren'*].[270]

Dutch historians of science and of universities have paid ample attention to the *finance* available for post-war science, as well as the organisations, ideas, and people that supported, and were supported by, the expanding system of public funding for research in universities, industry and government laboratories.[271] Recently, the *manpower* issue has also been discussed, in the context of the organisation of the natural sciences, physics specifically.[272] But *space*, the other limiting factor identified by the policymaker in 1955, has not received considerate treatment in historiography. Only very recently, the post-war spatial transformation of the university campus—both its educational and research facilities—has received coherent attention.[273] I will advance this new focus by using the utility spot concept as a lens. That will uncover the spatial origins, relations and effects of the practice, politics and (over)organisation of scientific research in the Netherlands.

3.3 The TNO Issue and Dutch Organisation of Research

In May 1955, the Ministry for Education, Arts and Sciences (OKW) sent letters to the main six Dutch institutes for higher education requesting more information about their relationships with TNO, the Dutch organisation for applied natural scientific research.[274] TNO had been established in 1932 with two official tasks: to coordinate applied research in a fragmented

270 NA, TH Delft (THD), 3.12.08.01, inv.nr. 301, Report of the study group TH-Derden, 12 January 1955.

271 Frits Henry Brookman, *The Making of a Science Policy: A Historical Study of the Institutional and Conceptual Background to Dutch Science Policy in a West-European Perspective* (Amsterdam: Academische Pers, 1979); Leo Molenaar, *"Wij kunnen het niet langer aan de politici overlaten … ": de geschiedenis van het Verbond van Wetenschappelijke Onderzoekers (VWO) 1946–1980* (Delft: Elmar, 1994); Albert Kersten, *Een organisatie van en voor onderzoekers: de Nederlandse Organisatie voor Zuiver-Wetenschappelijk Onderzoek (ZWO), 1947–1988* (Assen: Van Gorcum, 1996); Jan C. C. Rupp, *Van oude en nieuwe universiteiten. De verdringing van Duitse door Amerikaanse invloeden op de wetenschapsbeoefening en het hoger onderwijs in Nederland, 1945–1995* (Den Haag: Sdu, 1997); Gerard Alberts, *Jaren van berekening. Toepassingsgerichte initiatieven in de Nederlandse wiskundebeoefening 1945–1960* (Amsterdam: Amsterdam University Press, 1998); Jasper Faber, *Kennisverwerving in de Nederlandse industrie 1870–1970*, Neha-Series III (Amsterdam: Aksant, 2001); Peter Baggen, Jasper Faber, and Ernst Homburg, "The Rise of a Knowledge Society," in *Technology and the Making of the Netherlands* (Cambridge, MA: MIT Press, 2010), 253–323; Klaas van Berkel, *De stem van de wetenschap: Geschiedenis van de Koninklijke Nederlandse Akademie van Wetenschappen. Deel II: 1914–2008* (Amsterdam: Bert Bakker, 2011); H.W. Lintsen et al., *Tachtig jaar TNO* (Delft: TNO, 2012).

272 David Baneke, "De vette jaren: de Commissie-Casimir en het Nederlandse wetenschapsbeleid 1957–1970," *Studium: tijdschrift voor wetenschaps- en universiteitsgeschiedenis* 5, no. 2 (2012): 110–27; Friso Hoeneveld, *Een vinger in de Amerikaanse pap: fundamenteel fysisch en defensie-onderzoek in Nederland tijdens de vroege Koude Oorlog.* (Utrecht: Utrecht University, 2018).

system of (semi)public laboratories and to initiate and support useful research at other institutions. By the 1950s, university scientists too were receiving research grants from TNO. This raised questions about the size and nature of these activities: how much time and space did they occupy in university laboratories, and did they constitute research of 'university character'? Various actors referred to freedom, independence or purity to characterise academic practice. Although this rhetoric was omnipresent, also in the 1950s, I will demonstrate that practical, material and *spatial* concerns and criteria were more forceful. Utility and freedom were ultimately understood spatially, in terms of physical and geographical relations.

The ministerial request also was an attempt at 'coordination of the cooperation and interactions' between universities and extra-academic institutes, or academic and societal actors more generally.[275] Historically, the relation between academic research and society has often been interpreted spatially, with metaphors like *gap* or *abyss*.[276] These metaphors entail *difference* and *distance* between, for example, university and industry. The positing of a gap allows the description of separate identities, in terms of practices, values and norms that exist in academic laboratories but not in industrial research facilities. Simultaneously, the spatial metaphor of the gap is used to demand a *bridge*: ideas, values and people should go from one part to the other. The bridge metaphor structured the debates about TNO, from its earliest roots in the 1920s, to the issue in the 1950s and its reorganisation towards the end of the century. What was TNO supposed to be a bridge between? To answer this question, I briefly review the history of Dutch organised research in the first half of the twentieth century to formulate an answer to the question where what kind of research was (or ought to be) conducted and how results travelled through society.

As we have seen in the US case, the world wars structured to a significant extent the ideas about, and practices of, the appropriate organisation of societally relevant academic research. Also in the Netherlands, scientists, industrialists and politicians agreed both after 1918 and after 1945 that better use could, and should, be made of scientific research for societal and economic progress. At the same time, these were moments that the Netherlands were confronted with geopolitical gaps: after both wars the Dutch felt they were lagging behind the quick developments in the organisation of scientific research in Germany, the UK and France (after WWI) and the US (after WWII). Two research organisations were established by the Dutch government in response: one for 'applied research' in 1932 (TNO) and one for 'pure research' in 1949 (ZWO). But before I discuss the utility and spatial concerns that informed those policy decisions, I discuss where, by 1950, most of the organised research was taking place: in industry.

273 In particular, the newest edition of the Universiteit & Samenleving (University & Society) series: A. C. Flipse and Abel Streefland, *De universitaire campus. Ruimtelijke transformaties van de Nederlandse universiteiten sedert 1945*, Universiteit & Samenleving 15 (Hilversum: Verloren, 2020).

274 NA, Ministerie van Onderwijs, Kunsten en Wetenschappen, Afdeling Hoger Onderwijs en Wetenschappen (OKW-HOW), 2.14.58 inv.nr. 155, Minister of OKW to the boards of trustees of the national universities of Leiden, Utrecht and Groningen, the municipal university of Amsterdam, the free university of Amsterdam and the polytechnic college in Delft, 26 May 1955.

275 Ibid.

276 Arjan van Rooij, "Gaps and Plugs: TNO, and the Problems of Getting Knowledge out of Laboratories," *Minerva* 51, no. 1 (2013): 25–48.

The emergence of industrial research labs in the Netherlands was comparable to the developments in the US: both adapted German examples in the beginning of the twentieth century and it only really took off in response to market changes.[277] A big difference is the fact that between 1860 and 1910, there was no active patent law in the Netherlands. This stimulated 'import' of knowledge and imitation of foreign products in Dutch industry, rather than the creation of new technologies and products. If companies did innovate, they usually relied on individual efforts. Only when the number of engineers on the job market rose and a patent law came into effect in 1910, it became feasible and rational to pursue market protection via industrial research.[278] The first companies who indeed invested early on in research facilities often scaled up from small-scale testing and experimentation, like the Batavia Petroleum Maatschappij (BPM, the Dutch East Indies subsidiary of Royal Dutch Shell) in Schiedam and the Koninklijke Nederlandsche Gist- en Spiritusfabriek (Royal Dutch Yeast and Spirit Factory) in Delft. Lightbulb manufacturer Philips, on the other hand, implemented a chemical lab 'from above'. Like General Electric in the US, Philips had to cope with new German technologies (such as the wire filament) for which it hired external experts. By 1910 Philips decided to establish its own chemical laboratory to conduct fundamental research in the electronic processes taking place in the incandescent lamp. In 1914 it established in addition the Natuurkundig Laboratorium, later known as NatLab.[279]

The First World War had a catalysing effect on research in Dutch industry: the number of engineers increased to develop *Ersatz* products, as the regular supply of raw materials was cut off. A mentality change occurred: industrialists realised that research could be useful to their purposes, and academics understood that it could be worthwhile to consider industrial interests.[280] However, only the larger companies, like Philips, were able to expand their activities onto the terrain of fundamental research after the war: Natlab moved to a new laboratory complex that included several pilot plants, with workspace for some 400 employees. In 1927 BPM also expanded on their Amsterdam site, for their 500 employees. By 1940, Philips had 500 employees in its research labs, and BPM 1350.[281] These exceptionally large research labs were largely disconnected from production facilities, although before the war links existed between scientific and company management. Corporate research labs carried out projects of direct and indirect relevance for the technical problems of electronics and oil manufacturing. Much like American industrial labs, research directors created an academic atmosphere to lure graduates to positions in industry. At NatLab, for example, research director Gilles Holst, who had gained his PhD at Leiden University, instituted a liberal publication policy, focused research on fundamental scientific problems and organised regular colloquia. In the

277 E. Homburg, *Speuren op de tast: een historische kijk op industriële en universitaire research* (Maastricht: Universiteit Maastricht, 2003), 13–23.

278 Faber, *Kennisverwerving in de Nederlandse industrie*, 16–39.

279 Kees Boersma, *Inventing Structures for Industrial Research: A History of the Philips Nat. Lab., 1914–1946* (Amsterdam: Aksant, 2002).

280 Faber, *Kennisverwerving in de Nederlandse industrie*, 37–38.

281 Homburg, *Speuren op de tast*, 13–23.

1920s, he invited Paul Ehrenfest, also from Leiden University, to update his employees on the latest developments in statistical physics, relativity theory and quantum mechanics. Later, stars like Albert Einstein and Lise Meitner followed.[282] Eventually, the laboratories of Philips and Shell also accumulated scientific prestige and functioned as paradigms for useful knowledge production in the Netherlands. A tightly knit network, partly based on special professorships, developed between the Dutch academic world and the elite industrial research labs with the aim of recruiting the best students and access to university experts.[283] A strict distinction between fundamental and applied research thus cannot be mapped onto the institutional boundary and spatial distinction between industrial and academic labs.

But, rhetorically, universities liked to present themselves as places for 'pure research' in the first half of the twentieth century. This put them in contrast with industrial labs, but also drew a line between universities and the polytechnic in Delft, which educated engineers. In 1905 the polytechnic received the same institutional status as universities, and by 1906 also the *ius promovendi* or prerogative to award PhD degrees, but according to university scientists it remained different, of a lower order: a place for 'applied research'.[284] This boundary work was widespread and according to Jasper Faber even led to the dissociation of ties to societal actors, who used to visit laboratories more often in the nineteenth century.[285] There are, however, many examples of twentieth-century academics who hailed the ideal of purity in public, but in practice actively cooperated with extra-academic actors and organisations. To name a few examples: physical chemist Ernst Cohen interacted with electrical engineers and worked for the shipping industry; Hugo Kruyt, Cohen's direct colleague and co-occupant of the Van 't Hoff laboratory, carried out colloid research of interest to industrial parties; the research of hormone producer Organon basically took place in Professor Ernst Laqueur's laboratory at the University of Amsterdam; and an industrial research association had a structural presence in L. S. Ornstein's lab to study heat isolation.[286] In general, it was not uncommon by 1930 to find application-oriented research and extra-academic actors in Dutch university laboratories (and vice versa in industry).

Apart from coordinated efforts in industry, one could hardly speak of organised research in the Netherlands before the 1930s. State-funded labs for agriculture, trade and industry focused mostly on testing and information services, and the academic undertakings for applied research relied on individual initiative.[287] What gap was TNO supposed to fill then, when it was established in 1932? The prehistory of TNO—through various advisory committees starting in 1917—has been extensively described in the literature.[288] I will highlight here only

282 Boersma, *Inventing Structures for Industrial Research*; Marijn J. Hollestelle, *Paul Ehrenfest: Worstelingen met de moderne wetenschap, 1912–1933*, (Leiden, 2011), 180–203.

283 Brookman, *The Making of a Science Policy*, 312–16.

284 David Baneke, *Synthetisch denken: natuurwetenschappers over hun rol in een moderne maatschappij, 1900–1940* (Hilversum: Verloren, 2008), 76–97.

285 Faber, *Kennisverwerving in de Nederlandse industrie*, 18–21.

286 H. G. Heijmans, *Wetenschap tussen universiteit en industrie: de experimentele natuurkunde in Utrecht onder W.H. Julius en L.S. Ornstein 1896–1940*, Nieuwe Nederlandse bijdragen tot de geschiedenis der geneeskunde en der natuurwetenschappen 48 (Rotterdam: Erasmus Publishing, 1994); G.J. Somsen, *'Wetenschappelijk onderzoek en algemeen belang' : de chemie van H.R. Kuyt (1882–1959)* (Delft University Press, 1998); Pim Huijnen, *De belofte van vitamines: voedingsonderzoek tussen universiteit, industrie en overheid 1918–1945*, Universiteit & Samenleving 7 (Hilversum: Verloren, 2011); Knegtmans, P.J., *Geld, ijdelheid en hormonen: Ernst Laqueur (1880–1947), hoogleraar en ondernemer* (Amsterdam: Boom, 2014); Smit, "Purity in an Impure World."

287 Faber, *Kennisverwerving in de Nederlandse industrie*, 38–39.

288 Brookman, *The Making of a Science Policy*, 113–47; Baggen, Faber, and Homburg, "The Rise of a Knowledge Society," 300–304; Lintsen et al., *Tachtig jaar TNO*; van Rooij, "Gaps and Plugs."

spatial aspects of the proposals for this new organisation—whether it was to concentrate research in one place, or function as a decentralised coordinating body. Already after WWI, the idea had arisen to copy institutional developments from abroad, where research organisations had been founded to serve the purposes of the state, like Fritz Haber's Kaiser-Wilhelm-Institut für Physikalische Chemie und Elektrochemie in Berlin, infamous for its role in chemical warfare, or the Department for Scientific and Industrial Research (DSIR) in the UK.[289] These two options represent two different spatial models of useful knowledge production: one a physical institute, supported by public and private funding, that concentrates in one place research of relevance to society, the other a coordinating body that supports scientific research 'with a practical aim', with public funding, in both academic and industrial spaces. Throughout the history of Dutch organisation of useful research, the spatial issue of local concentration versus regional dispersion would reappear.

In 1917, for example, the Wetenschappelijke Commissie voor Advies en Onderzoek in het Belang van Volkswelvaart en Weerbaarheid (Scientific Committee for Advice and Research for Well-being and Resilience, or Lorentz Committee) was inspired by these foreign examples and mainly followed the UK model: it distributed subsidies to universities for small applied projects and largely failed to interest industry's need for Ersatz products. According to one influential critic, industrial chemist C. J. Nieuwenburg, this was due to the predominantly academic composition of the committee. Instead of the overrepresentation of 'pure science' in the committees, he argued there should have been more representatives of 'practice', such as engineers and industrialists. His lecture raised the awareness of the Minister of Education and Sciences, J. Th. de Visser, who then requested another report about the issue from engineer I. P. de Vooys. He was a professor at Delft polytechnic, had close ties to industry and had a seat in the Lorentz Committee. He advised the establishment of a physical research institute to bridge the gap between pure research and practice. This in-between body would focus on 'technical scientific work', taking its problems from practice, but approaching them in close contact with fundamental research. De Vooys stressed that an ideal location for this institute, which was to resemble the German model, was in the vicinity of the Technische Hogeschool Delft (polytechnic college, TH Delft).[290] The minister agreed and installed another committee to elaborate the precise structure and organisation of this bridging institution. The committee convened in 1923 and was chaired by botanist and KNAW president F. W. Went. Although it followed De Vooys' line of thought, the committee clearly preferred a national distribution of the research organisation over concentration in Delft. This allowed them to subsume existing publicly funded research

289 Jeffrey A. Johnson, *The Kaiser's Chemists: Science and Modernization in Imperial Germany* (Chapel Hill/London: University of North Carolina Press, 1990); Carolina Sachse and Mark Walker, eds., "Politics and Science in Wartime: Comparative International Perspectives on the Kaiser Wilhelm Institute," *Osiris* 20 (2005); Clarke, "Pure Science with a Practical Aim."

290 Jasper Faber, "C.J. van Nieuwenburg over organisatie van wetenschappelijk-technisch werk. Stemmen uit de industrie over toegepast natuurwetenschappelijk onderzoek 1900–1919," *GEWINA / TGGNWT* 21 (1998): 15–29; Somsen, *"Wetenschappelijk onderzoek en algemeen belang,"* 197–206; Baneke, *Synthetisch denken*, 115–18.

establishments, like agricultural test stations, government labs and inspection institutes, under the new umbrella organisation.

The act that finally installed TNO in the Dutch research landscape presented it as a logical step: to bring unity in diversity, it would coordinate disparate research activities in private and public organisations. Besides this coordination task, TNO could also set out research contracts with other organisations. The result was an intermediary or hybrid body, in multiple ways. TNO activities were situated between scientific knowledge production, industrial application and state planning. Also, it had an atypical organisational form as a national public body outside the government bureaucracy and without a profit orientation. It consisted of a coordinating 'central organisation' and several independent 'special organisations', which were devoted to specific societal and economic sectors, such as agriculture, health and industry. The Central Organisation distributed funds, decided on the establishment of new institutes and kept a general overview of Dutch research activities. The special organisations were largely free to decide their research programmes in discussion with the sector for which they worked. There were big differences between special organisations in their approach to and practice of these tasks. Representatives of sciences, industrial sectors and the state sat on the boards of the central and special organisations. These boards would meet a few times per year to discuss the research agenda. This 'mixed' organisation was later hailed as (another) 'golden triangle': it created and sustained tightly knit formal and informal networks between state, science and society.[291]

Although TNO's task might seem logical, and some regarded its establishment as urgent, it was initially off to a slow start. In the economically strained 1930s, there was little funding available and existing government labs and test stations refused to be incorporated in TNO. Several historians point, perhaps counterintuitively, to the German occupation of the Netherlands from 1940 to 1945 as a defining period for the functioning of TNO.[292] First, its unusual organisational character, at a distance from the government, kept it out of German control. For that reason, various existing institutes that had refused transfer to TNO before the war, now relocated (for example the fibre institute in 1941, the leather institute in 1942 and agricultural test stations in 1945). In this situation, other organisations and also companies decided to temporally station their instruments or employees at TNO locations, to avoid *Arbeitseinsatz* and keep their staff at work. Because useful work they did: the scarcity of raw materials in the war created an increase in requests for advice and research on substitute materials. This research, as well as the direct contact between TNO researchers and industrialists, boosted the credibility of TNO and created a post-war network from which more assignments followed.[293]

291 Lintsen et al., *Tachtig jaar TNO*, 27–29; Harry Lintsen and Evert-Jan Velzing, *Onderzoekscoördinatie in de gouden driehoek: een geschiedenis* (Den Haag: Rathenau Instituut, 2012).

292 Faber, *Kennisverwerving in de Nederlandse industrie*, 40–49; Baggen, Faber, and Homburg, "The Rise of a Knowledge Society," 300–304.

293 This can be illustrated by the fact that industrial contributions to the TNO budget rose from 35% in 1946 to 50% in 1956. Faber, *Kennisverwerving in de Nederlandse industrie*, 40–42; Jonathan Scheeres, "Het ideaal van wetenschap voor de samenleving: toegepast natuurwetenschappelijk onderzoek in Nederland, een historische case-study" (Enschede: University of Twente, 2007), 55–60.

The period between 1945 and 1960 is typically characterised not only in terms of increasing state support for pure, or fundamental, research but also in terms of intensifying relations between industrial and the academic worlds. Although these might seem opposite developments, they were motivated by the same issues of post-war reconstruction and industrialisation of the Dutch economy. The perception was widespread that Dutch science had suffered deprivation due to the war, and that Dutch industry had to secure sufficient scientific and technical manpower to maintain and expand their market position. The deprivation issue fuelled expansion of public research funds, while the manpower issue led to several industries investing in corporate and university research. Shared by industry, government and universities was a strong belief in the societal value of fundamental, or 'pure', research in post-war reconstruction.[294] Again, both foreign and industrial models for organised research circulated in response. Some Dutch scientists, exiled abroad, came into contact with wartime research organisations, like the physicists Goudsmit and Bartelink who worked at the MIT RadLab. Returning to the Netherlands after the war, they saw with their own eyes the great difference in development and advised the Dutch government to send Dutch professors and PhD candidates to the US.[295] This time, especially American examples carried rhetorical force and many referred to Vannevar Bush and his report *The Endless Frontier*, even though similar ideas already circulated in Europe. In the Netherlands, Dutch companies and universities wanted to follow the examples set at Philips and BPM to create fundamental research labs. Chemists, like Bert Staverman and Jan Boldingh, stated quite explicitly that they took NatLab as an example for the organisation of research in their subsequent jobs at TNO and Unilever.[296]

The first Dutch post-war government, headed by Willem Schermerhorn, had a reformist outlook and allotted a central role to science in the reconstruction process. The importance ascribed to fundamental research would, eventually, lead to a new funding organisation for pure research alongside TNO: the Nederlandse Organisatie voor Zuiver Wetenschappelijk Onderzoek (Dutch Organisation for Pure Scientific Research, ZWO).[297] Initial plans for this national organisation again compared concentrated and decentralised international models. Professor of geophysics F. A. Vening Meinesz (Utrecht and Delft) visited the US in 1946 to study American 'organisational forms'.[298] Of most interest were the private Carnegie and Rockefeller foundations, and to a lesser extent the plans for the National Science Foundation. The main difference between the two private philanthropies was the kind of institutions they funded, which implied different spatial organisation of research. Carnegie supported only research concentrated in its own institutes, whereas Rockefeller distributed funds to a

294 Kersten, *Een organisatie van en voor onderzoekers*, 6; Rupp, *Van oude en nieuwe universiteiten*, 109; Hoeneveld, *Een vinger in de Amerikaanse pap*, 30.

295 Hoeneveld, *Een vinger in de Amerikaanse pap*, 97–99.

296 Homburg, *Speuren op de tast*, 28–38; Kersten, *Een organisatie van en voor onderzoekers*, 9.

297 Kersten, *Een organisatie van en voor onderzoekers*, 7–8; Wim Hutter, "Chemie, chemici en wetenschapsbeleid," in *De geschiedenis van de scheikunde in Nederland 3*, ed. Lodewijk Palm and Ernst Homburg (Delft: Delft University Press, 2004), 20.

298 Kersten, *Een organisatie van en voor onderzoekers*, 11–13; Hoeneveld, *Een vinger in de Amerikaanse pap*, 135–42.

dispersed set of individuals and existing institutions. Vening Meinesz, and others in the committee that prepared the ZWO plans, preferred the Rockefeller model, mainly because it preserved the universities as the appropriate place for pure research. The fear was that subsidies to extra-academic, specialised research institutes would degrade the university to a mere teaching body.[299] This concern was not completely unfounded: although ZWO was established on a decentralised 'Rockefeller' model, most of its funds ended up at two previously established extra-academic foundations, for applied mathematics (Mathematisch Centrum, MC) and fundamental research into peaceful applications of nuclear physics (Fundamenteel Onderzoek der Materie, FOM).[300]

In 1954, Wagenaar again aired this concern, in the context of the Columbia congress on freedom and restraints. Indeed, the concern about centralisation of pure research in institutes outside the university—and thus the concentration of human and material resources—survived well into the 1950s. The KNAW, representing the Dutch academic elite, viewed itself as the main scientific advisory board for the government and had tried to prevent the establishment of ZWO before.[301] When they learned in May 1952 that ZWO was lobbying to obtain the right to establish institutes—to centralise research and prevent duplication— the Academy considered all this intervention 'crippling ... [to the] appetite for starting scientific enterprises'.[302] The universities, in the meantime, considered the right to establish institutes a 'matter of vital importance', and feared that a result of this power struggle might be the 'erosion' of the university.[303] The Senate of Leiden University, for example, sent a letter to the ZWO board to state that 'ordering scholarly work is always a precarious enterprise', and that 'a surplus of dirigisme' could hamper 'spontaneous scientific research'.[304] Above all, the universities wanted to safeguard their status as place of pure, fundamental research.

The organisation of research in the Netherlands in the first half of the century makes clear that the location of research mattered to questions about the independence, orientation and usefulness of research. But it also shows that, regardless of various purification attempts, many hybrid modalities of useful knowledge production existed. Industrial research labs merged a 'pure' atmosphere with commercial interests; academic laboratories housed teaching and independent research as well as contract research; and each TNO institute created its own unique combination of different actors and research types. The distinction between types of research could sometimes be made *between* places, but often a line had to be drawn *within*. In the following I discuss debates about two hybrid spaces under the TNO umbrella—the Institute for Medical Physics and the Technical Physical Service. These spaces were the occasion for the 1955 ministerial request about the 'university character' of

299 Kersten, *Een organisatie van en voor onderzoekers*, 16–26.

300 Alberts, *Jaren van berekening*; Hoeneveld, *Een vinger in de Amerikaanse pap*.

301 Van Berkel, *De stem van de wetenschap*, 222–34.

302 Archief Universiteit Leiden (AUL), Archief van de Rector Magnificus en de Senaat 1875–1992 (ASE), inv.nr. 82, ZWO board, 'Concept ten behoeve van de raad voor het zuiver-wetenschappelijk onderzoek inzake een aan de regering uit te brengen advies betreffende het te voeren beleid aangaande de wetenschapsbevordering in Nederland,' 1954; Letter from KNAW to Universities, February 1955.

303 AUL, ASE, inv.nr. 82, Meeting of Senate, Leiden University, 4 February 1955.

304 AUL, ASE, inv.nr. 82, Senate Leiden University to ZWO board, March 1955.

sponsored research. The discussion of these *utility spots* should make clear that the organisation of research, including its societal usefulness and its independence, was tied to, and was understood in, spatial terms.

3.4 Spatiality of Sponsored Research: The Institute for Medical Physics

Although concentration of TNO activities around the TH Delft appeared in the first plans for TNO, it did not become the official model. Still, in the first post-war decade, this desire for geographical concentration materialised around the polytechnic in buildings, facilities and research groups of the national applied research organisation. Cooperation and exchange between academic scientists, polytechnic engineers and TNO researchers appeared to rely on physical proximity. In several cases, TNO working groups were physically integrated in university laboratories. This occurred for example at Utrecht University, where TNO had been able to house their 'Organic Chemistry Institute' in the laboratory of Prof. Fritz Kögl. The Health Organisation subsidised, amongst others, a biocide research group in the pharmacology department and a laboratory animals service in the Zootechnical Institute. But in Delft, there were by far the most TNO labs, departments and institutes housed in the polytechnic's buildings. The Nijverheidsorganisatie (Industry Organisation) of TNO located its central laboratory on the Delft premises, as well as its institutes for the washing, packaging and shipping sector and laboratories for the study of rubber, fibres, and plastics.[305]

Delft, the city that housed the first, and until the 1950s only, polytechnic of the Netherlands is therefore central to the sections on the spatial origins of the 'TNO issue'. The town housed the large yeast producer, Koninklijke Nederlandsche Gist- en Spiritusfabriek (which established one of the first industrial research labs, see above) and was located in the proximity of the government in The Hague, the port in Rotterdam and the oldest general university in Leiden. In 1953 a beginning was made with the expansion of the TH Delft. The architect S. J. van Embden led the building plans and would later oversee the completely new design of a 'second' polytechnic in Eindhoven in 1956. Van Embden previously designed his first university buildings in Indonesia (then the Dutch Indies) in the late 1940s, at the second polytechnic school in the Dutch Empire, Bandung.[306] In Bandung, the original university design by the Dutch architect Henri Maclaine Pont was a hybrid between vernacular architectural styles and American campus models. But Van Embden did not just implement this campus model in the Wippolder area on the outskirts of Delft. Here the plans for the TH expansion took their place as part of urban planning. Taking their physical

305 NA, OKW-HOW, 2.14.58 inv.nr. 155, 'Andere contacten met instellingen voor het hoger onderwijs,' overview tables attached to letter from TNO to Minister OKW, 12 September 1955.

306 Esther Gramsbergen, "Integrating the Campus and the City," *OverHolland*, June 15, 2018, 07–28.

proximity and even integration into account, it is no surprise that the polytechnic and the buildings of the applied research organisation TNO were grouped together functionally into one area, outside the city centre but still tied to the city. However, the presence of TNO also changed the geographical focus of the TH Delft: its 'mental geography' shifted from local links with the city to one of national importance to industrialisation.[307] How TNO, institutes of higher education and industry related in practice, will be illustrated in discussions about a proposed Instituted for Medical Physics and, in the next section, about the Technical-Physical Service.

The TNO Gezondheidsorganisatie (health organisation) was established in 1949 to stimulate and coordinate public health research. In the 1930s, a first initiative in this direction had come not from medical practitioners or professors, but from engineers who considered improvement of 'hygienic' conditions in work environments of importance.[308] In 1941, the initiative to develop cooperation between engineers and medical experts was ranged under the umbrella of TNO as an 'organisation committee for Health Technology'. This was the root for, and later part of, the Gezondheidsorganisatie. As a special organisation of TNO, the ties with the medical profession became stronger from 1949 onwards. Up to that point the focus had been that of an engineer: on the relation between health and the built environment. Most of that research was conducted in The Hague and in Delft, close to the polytechnic, and organised in close contact with labour and health inspectors as well as the building sector.

A sign of the turn to the medical world was the appointment of one former health inspector, Albert Polman (1902–1959), as the first chair of the Gezondheidsorganisatie. Polman was, since 1951, a professor of anthropogenetics at Groningen University. Under his leadership, the organisation responded to the request from the Ministry of Social Affairs to initiate a medical-physical department for the study of physical instruments for medical uses. Polman hoped to stimulate cooperation between physical scientists and medical professionals:

> Not in the manner of the physician as principal figure who takes a physicist as his assistant, nor as the physicist supplying himself with a medical advisor; both methods would fall short eventually and the purpose of the new department is instead that the physician and the physicist concentrate, in solid collaboration, on a problem, and that, although from different vantage points, they try to solve it together.[309]

These goals mirrored practices in Anglo-American medicine, where work was organised in multidisciplinary teams and various physical technologies, like radiation, were applied to health issues.[310]

307 Pieter Caljé, "Proximity without propinquity? De verschuivende relatie tussen de stad Delft en het polytechnisch onderwijs in de negentiende en twintigste eeuw," *Gewina* 24 (2001): 60–73.

308 Eric Berkers and Harry Lintsen, "TNO en gezondheid (1949–1970)," in *Tachtig jaar TNO*, ed. H. W. Lintsen (Delft: TNO, 2012), 130–43.

309 Albert Polman, "De Gezondheidsorganisatie TNO en Medische Fysica," *Nederlands Tijdschrift voor Geneeskunde* 95, no. 32 (1951): 2355–57.

310 Pickstone, *Ways of Knowing*, 181–83; Berkers and Lintsen, "TNO en gezondheid (1949–1970)," 143.

The establishment of the medical-physical department was a response to many questions and requests from healthcare practice. Notwithstanding this societal demand, the hybrid field had remained 'underdeveloped' at the universities.[311] At first, this department existed only as a coordinating body, on paper, in meetings and in subsidies for research at different institutions. Between 1950 and 1956, the department was the most prolific of the whole Gezondheidsorganisatie by setting out 24 research projects at external research labs, often at universities. There was (almost) no medical-physical research taking place within TNO buildings and this part of the TNO Gezondheidsorganisatie thus functioned primarily as a 'network organisation'.[312] An important part of that network, in this case, consisted of universities and academic hospitals. The content and orientation of TNO and university research were intertwined and became defined in relation to each other: through TNO subsidies academically underdeveloped but societally relevant fields of research were stimulated at universities.

Most actors seemed to have accepted this entanglement between sponsored and academic research in medical physics, as long as the association existed as *virtual department*. The stakes were driven higher when, in 1955, Polman proposed to establish a *physical institute* for medical physics at TNO. The subsidised working groups lacked sufficient working space, which the universities refused to expand, and a desire grew to centralise all medical physics activities in one building. In addition, there were regulatory and testing tasks that had to commence as soon as possible but could not be conducted at a university. But the discussion of the plan at the Ministry for Education and Science focussed mainly on the right 'place' for societally relevant *research*. To begin, the policymakers issued a plea for caution.[313] The current 'equality' in Dutch medical physics, where TNO coordinated the research, would be disturbed by such an institute. Subsidies for research had flowed to various universities and academic hospitals, in Amsterdam and Groningen for instance, and also to the TNO group of engineer D. H. Bekkering, who temporarily occupied a space in one of the laboratories of the TNO Defence organisation in The Hague.[314] In that situation, there was no real distinction between internal and external researchers, as everybody primarily occupied the same virtual space. The concern was that the Ministry of Finance could object the support of sponsored medical physics research in university departments once a central lab existed. First, the material conditions and technical equipment at universities and the TNO institute would therefore have to be levelled, to make possible the coordination of, and task division in, research. But improving the material equipment at each participating university was a serious issue which could take years, while TNO had to begin the regulatory tasks immediately.

311 NA, OKW-HOW, 2.14.58 inv.nr. 155, Report of a meeting about the Medical-Physical Institute and the Department Health Technics of TNO, 4 October 1955.

312 Berkers and Lintsen, "TNO en gezondheid (1949–1970)," 132–33.

313 Polman met with OKW policymakers H. J. Woltjer, J. J. Brutel de la Rivière and E. A. C. Meijlink.

314 E. S. Houwaart, "Medische techniek," in *Techniek in Nederland in de twintigste eeuw. Deel 4. Huishoudtechnologie, medische techniek.*, ed. J. W. Schot et al. (Zutphen: Walburg Pers, 2001), 243–44.

Polman and the policymakers therefore reached a functional compromise. The institute could be founded but had to limit its tasks to responding to 'questions from society', healthcare in particular. This entailed that the associated university departments would *not* have to conduct demand-driven research. Polman and the ministry seemed to share a view of academic research as free and specialised. Although it was the goal of the department of medical physics to facilitate and even stimulate multidisciplinary collaboration and exchange between university science and medical practice, they still drew this principled difference between research in academic and extra-academic settings. Actually, Polman believed that the virtual existence of technical physics as coordinating body would support rather than threaten the academic freedom to choose research topics, by offering flexible personal and material subsidies for underdeveloped fields.[315]

The proposed physical institute for medical physics, however, ran the risk, even with a strict societal mission, of intruding onto university terrain: successful treatment of a question, about something as mundane as a measurement technique, might incite specialisation.[316] To preserve this privilege for the academic researcher, the institute would have to deal with many different kinds of research and make sure the workers remained generalists and focused on the quick solution of single problems. This called for a specific kind of 'personal attitude'. The policymakers illustrated this argument by way of a notable example: the industrial research laboratory of Philips. They reported that at NatLab researchers of different psychological profiles worked on fundamental research and development respectively—where the first could stimulate the second. Analogously, the Ministry argued, universities and TNO could exchange research workers, swapping specialists at TNO with the general problem solvers and product developers in academia. Ultimately, this was based on a concern that TNO would lure academically motivated researchers away from the university if it could not only offer better wages and facilities, but also housed scientifically advanced research.

Eventually, a Medisch Fysisch Instituut (MFI, Medical Physical Institute) was established physically in 1960 on the grounds of the Academic Hospital Utrecht, with Bekkering as director. Located proximate to the hospital, the institute had envisioned active cooperation with the Utrecht University department of medical physics.[317] The MFI existed for 22 years, until it was abolished during the reorganisation of TNO in the 1980s. It seems not to have flourished in the ways hoped by Polman. Although the MFI created a network in the scientific and medical world, clinical hospital departments independently established stronger ties with academic research groups in medical physics. The MFI especially failed to establish a productive network in the Dutch medical-technical industry,

315 Albert Polman, "Het klimaat voor medisch wetenschappelijk onderzoek," *Nederlands Tijdschrift voor Geneeskunde* 99, no. 4 (1955): 282–85.

316 NA, OKW-HOW, 2.14.58 inv.nr. 155, Report of a meeting about the Medical-Physical Institute and the Department Health Technics of TNO, 4 October 1955.

317 Mathematician and physicist Burger had obtained his PhD with Ornstein, in Utrecht, and worked a few years for Philips at the start of his career. In 1950, he became special professor for medical physics in Utrecht. See Ad Maas, *Atomisme en individualisme: de Amsterdamse natuurkunde tussen 1877 en 1940* (Hilversum: Uitgeverij Verloren, 2001), 168–70.

which showed little interest in the new technologies that the institute, by law, had to offer to them first.[318] The ministerial worries about the monopolising effects of a physical MFI appear thus unwarranted. Or rather, the opposite seems to have happened, where university departments flourished instead.

The MFI raised, in very concrete terms, the question *what* scientific work (testing, regulatory work or research; where the latter could be applied or fundamental, free or demand-driven, specialised or societally relevant) should be conducted *where*, and *who* could decide what it had to be about. In an article about the appropriate 'environment' for medical-scientific research, Polman preferred 'for practical and organisational reasons' to draw these lines between types of research only 'in pencil'.[319] The prospect, and practice, of a building solidified fluid associations and vague boundaries between academic and sponsored research and between science and society. In this case, this did not produce the desired result of a flourishing medical physics department at TNO. But within this dissertation on utility spots it is more important to note that the spatial issue about the organisation of medical physics was an occasion for the Ministry of Education and Science to explore the boundaries between academic and sponsored research more generally, by sending around a questionnaire, to which I turn in section 3.6.

3.5 Spatiality of Sponsored Research: The Technical-Physical Service

The Medical Physical Institute as virtual possibility demonstrated the stakes of the Ministry, the universities and TNO in the organisation of research. H. J. Woltjer, the policymaker responsible for Higher Education and Science (HOW) at the ministry of OKW, in 1955 was also engaged in another discussion about the organisation of contacts between science and practice. More specifically, this discussion dealt with the relations of the polytechnic 'to third parties'. A central concern and example was the tangible space of exchange between TH Delft, TNO and industry: the Technisch Physische Dienst TNO-TH (Technical Physical Service, TPD).[320] Whereas no TNO departments existed for research related to oil or electrical engineering—the research laboratories of Philips and Shell provided this—the TPD is exceptional in its close ties to both of these multinationals.[321] Before I turn to the discussion group that Woltjer gathered in 1954 around this issue, I will introduce the TPD.

In 1941 the TPD was formally established as a TNO organisation that linked industry to technical physics research at the polytechnic. The Technical Physics department itself fostered close relations to industry since its establishment, which was

318 Houwaart, "Medische techniek," 243–44. See also: https://www.etnos.nl/tno_onderdelen/medisch-fysisch-instituut (Accessed 2 June 2020).

319 Polman, "Het klimaat voor medisch wetenschappelijk onderzoek."

320 Hans Buiter, "Hightech systemen," in *Tachtig jaar TNO*, ed. H. W. Lintsen (Delft: TNO, 2012), 78–80.

321 Lintsen et al., *Tachtig jaar TNO*, 50.

supported by financial endorsements from Shell and Philips. At both firms physicist engineers were in high demand. Several professors had themselves been recruited from their industrial research laboratories, and many students of technical physics would later become 'captains of industry'.[322] Shortly after its establishment, an increasing stream of industry requests for research prompted several professors in the 1930s to propose a separate organisation to manage this contract research: the Technisch Physische Dienst. Not all involved parties welcomed the TPD. Philips research director Holst thought that research for third parties (other than Philips and Shell) could make the department lose its useful focus and in parliament J. Schouten (also a TNO board member) convinced the minister of OKW that purely industrial research should not take place in the polytechnic's buildings. An advisory committee, and a few years, later, the TPD was finally established on the grounds that professors would participate voluntarily. And at first the professors in Technical Physics at the TH Delft were indeed closely engaged in its works, but over time TPD developed an independent position and 'scientific culture'.[323]

The TPD represented the broader reinforcement of relations between the polytechnic and national industry during and after the war. The appointment of Gilles Holst as president-curator of TH Delft in 1946, after he retired from NatLab, is a telling sign in that respect. Also atomic physicist H. B. Dorgelo embodied the academic-industrial network. In the 1920s, he transferred from the Philips NatLab to Delft, where he designed the technical physics programme and initiated the TPD. He acted as chairman of the (executive) board of governors of TPD, which oversaw the research of the service and acted as link with the polytechnic's expertise. He only left Delft and the Technical Physics department to return to Eindhoven, where he was appointed rector of the newly established polytechnic in 1956.

The TPD was a meeting place for the heterogeneous actors from science, TNO and industry, both in the boardroom and in the lab. The director of the Philips NatLab (successively Holst and Hendrik Casimir) and the president of the Central Organisation TNO (successively Hugo Kruyt and Casimir) had a seat on the (supervisory) board of directors. For a large part of the TPD activities, one could read Philips, Koninklijke/Shell and a few other large companies wherever it said 'national industry'. The 'electron microscope institute' in the TPD, formed by J. B. Le Poole, is instructive in that respect: the Koninklijke Nederlandsche Gist- en Spiritusfabriek, Philips, Heineken, AKU (nylon) and TNO where the first investors in the construction of electron microscopes, and BPM, Unilever, DSM and Organon quickly followed with annual contributions. Especially Philips, despite initial hesitancy of Holst in the 1940s, profited from this collaboration as it established a successful commercial line of microscopes.[324]

322 Henri Baudet, *De lange weg naar de Technische Universiteit Delft Dl. I De Delftse ingenieursschool en haar voorgeschiedenis* (Den Haag: Sdu Uitgeverij, 1992), 463–66.

323 G. A. van de Schootbrugge, *50 jaar TPD in beweging. Een halve eeuw natuurkunde voor de praktijk* (Delft: W. D. Meinema, 1991), 13–18.

324 Schootbrugge, 35–44.

The TPD research was closely aligned with the expertise of the Technical Physics department, which was mirrored in the housing of the service in the same building. From 1941 onwards, it occupied more and more space in the Technical Physics laboratory. First it had its own room on the first floor, and later it expanded into an entire (attic) floor, a former student lab and a temporary shed in the courtyard. In 1962, the TPD would move along with the Technical Physics department into a new building, where it was allocated its own wing.[325] Actors from all over the Netherlands, with various technical and scientific occupations, contracted research or even visited the Delft premises. The focus was initially on heat conduction, sound, electron microscopy and x-rays. Increasingly, more public organisations (academic laboratories and various ministries), public-private research associations (like the Geluidsstichting for sound research, established by former Philips employee Prof. Zwikker, the Warmtestichting for heat research and KEMA) and private companies (especially Shell and Philips) sent their staff to TPD to conduct research there.[326] The access to the specialised equipment, instruments and expertise at TPD was of use to these organisations. The TPD grew rapidly after the war: from 16 to 75 employees between 1945 and 1955, of whom respectively 7 and 17 were academically educated. Already in 1950, the largest part of the budget came from different kinds of contract research (60%), with the remaining part subsidised equally by TNO and TH Delft.[327]

Apart from this contract research, the professors of the TPD board of governors also considered free research ‘so very necessary’. In 1951, they considered appointing new TPD staff ‘unhindered by contract research’ because the steady stream of commissioned projects pushed free inquiry in a corner.[328] This tension between free and contract research illustrates that the Technical Physical Service was a hybrid space in multiple ways. Originally, it had to function as organisational distinction between university and contract research, so that it was situated in between science and practice. But also the TPD itself became a hybrid of free and demand-driven research. In 1951, Dorgelo argued that the TPD mixed features of an institution of higher education, a TNO-like government laboratory and an industrial research organisation.[329] This hybridity claim served a particular purpose in an argument between the executive board of governors and the supervisory board of directors about the compensation of TPD staff. Several members of the technical and management staff received additional remuneration when they conducted contract research. According to Dorgelo, this was because that kind of work required ‘extra efforts and responsibilities’ compared to normal university work. One director argued, cynically, that the stream of assignments just ensured that people were ‘hanging around less’. Holst, and engineer C. L. de Voogt, of the board of

325 https://www.etnos.nl/tno_onderdelen/tpd-technisch-physische-dienst/ (Accessed at 1 June 2020)

326 Schootbrugge, *50 jaar TPD in beweging*.

327 Buiter, “Hightech systemen,” 85.

328 NA, THD, 3.12.08.01, inv. nr. 379, Explanation of the draft budget for 1951.

329 NA, THD, 3.12.08.01, inv. nr. 382, H. B. Dorgelo (on behalf of the board of governors) to G. Holst and Ir. C. L. de Voogt (on behalf of the board of directors), 22 November 1951.

directors had no problem with the additional compensation, but objected to the motivation Dorgelo offered: they did not accept the argument that the practice in the TPD lab was fundamentally different from other university labs. Helpfully, Holst and De Voogt offered an argument that could justify higher salaries for some staff members: to prevent the drainage of the *best* manpower to industry, TPD would have to offer competitive salaries.[330]

Henri Baudet has remarked that the cooperation of experts from the polytechnic in Delft with industrial actors was, in the 1950s, increasingly 'common' and that TNO regularly 'channelled requests and assignments'.[331] The TPD seems to be the paradigm example of this. But the issue of extra compensation at TPD hints that the intimate cooperation between TH Delft and TNO could also cause friction. When we take a closer look at this spot in particular, spatial tensions become manifest as TNO researchers and foundations moved into university laboratories, removing physical boundaries between independent and oriented research in practice. That researchers from the polytechnic would share laboratory space with TNO and industrial researchers had been not a planned development, but more of an uncoordinated, organically grown reality. When, at the end of 1954, TNO reached out to the polytechnic's board of trustees to discuss the proper relation between their institutes, president-curator Holst did not dare to meet at once. The trustees realised that they had no accurate overview of the existing cooperative activities and, put dramatically, 'of what was going on in the spaces of the TH'. They feared that TNO employees were making unauthorised use of the polytechnic's equipment and personnel. As it seemed motivated by financial incentives, this generated unease.[332]

In late 1954, a small but high-profile 'preparation committee' was therefore installed by the trustees to discuss the relation of the polytechnic to 'third parties', i.e. TNO and industry. The OKW Ministry supported this initiative and took care of practical matters. In the discussion group it was represented by Woltjer, who also served as government representative on the boards of ZWO and the TNO Central Organisation. The further composition of the discussion group reflected the tightly knit network between academic and industrial research. The chairman of the discussion group TH-Derden (third parties) was Dr. C. H. van de Leeuw, president of the polytechnic's board of curators and up to 1954 director of the Dutch cacao company Van Nelle NV. Gilles Holst, his predecessor as president-curator, also participated. Holst had stepped down as president in 1953, after he had caused some controversy by proposing in an advisory committee the decentralisation of higher technical education.[333] Another member of the discussion group was theoretical physicist Casimir, the successors of Holst as research director

330 NA, THD, 3.12.08.01 inv. nr. 382, Meeting of the Board of Directors, 24 January 1952.

331 Baudet, *De lange weg naar de Technische Universiteit Delft*, 427.

332 NA, THD, 3.12.08.01 inv. nr. 301, Report of the study group TH-Derden, 23 March 1955.

333 Baudet, *De lange weg naar de Technische Universiteit Delft*, 375.

at the Philips NatLab. Casimir was also special professor at the Kamerlingh Onnes Laboratory in Leiden and board member at the TNO Central Organisation. Lastly, four professors from TH Delft participated: mathematician and rector Oene Bottema; professor of physical chemistry and Senate secretary Willy G. Burgers, who had carried out highly regarded crystallographic work at Philips NatLab before the war; Professor Hans Kramers, who held the Shell-funded chair in Physical Technology; and physicist Dorgelo, with his aforementioned history at Philips. These professional backgrounds demonstrate that none of these actors, university professors nor *captains of industry*, was purely academic or purely industrial.

Central to their discussion about the potential for collaboration between the TH Delft and third parties was the Technical Physical Service. From the success of the TPD followed the idea that each university department in Delft could profit from such an intermediary between science and society. The question whether to organise this per department, like the TPD, or centralise it into one 'bureau for external contacts' started a discussion about the independence of the polytechnic's research. Such a central bureau would organise, stimulate and lightly direct contract research. This could support the idea that TH Delft had to remain 'master in its own home'. By administrating the external incomes of professors and registering the use of university buildings by parties like TNO, there would be insight in, and thus control over, the relations with third parties. Above all, it implied that it was too risky to leave it to the individual initiative of professors.

The discussion group observed an increasing emphasis on the 'quick transfer of results from scientific research conducted in the TH Delft to society' which led some to suggest fundamental reforms to university structure. Dorgelo lamented that currently the institutes of higher education were completely based on the needs of teaching. The critique was twofold. On the one hand, this led to reinforcement of strict disciplinary boundaries, and on the other hand, it continued an individualised approach to research. This hindered the development of the 'so very important teamwork'. Holst joined the attack on the disciplinary organisation of research. Professors who worked for just one industrial sector were 'frustrating a healthy development of the TH'.[334] Multidisciplinary teamwork for multiple third parties was the implied ideal for the organisation of societally useful research. This also became evident when, in a later meeting, Woltjer stressed that the 'scientific task' of the polytechnic became increasingly important and necessitated a switch from a passive attitude to 'the construction of a clear and active science policy'. Rector Bottema understood this in the traditional academic way where the initiative for opening up new fields of research lay with individual professors, which

334 NA, THD, 3.12.08.01 inv. nr. 301, Report of the study group TH-Derden, 12 January, 3 February 1955.

Senate and trustees then endorsed. 'No', explained Holst, policymakers 'rather seem to mean *teamwork*, because in cooperation one can achieve more than alone'.[335]

The TPD, as concrete space of exchange, was not just a model within the polytechnic in Delft. For Woltjer, it was also instrumental in a first attempt at a national science policy. At one of the meetings, the policymaker downplayed the meaning of their get-together: he preferred to speak of a 'discussion group', because with a 'committee' he would be running ahead of the Minister's views. The received view is that, in the Netherlands, there was not yet serious attention on a ministerial level for science policy issues in the 1950s.[336] On the one hand, Woltjer's remark about the discussion group underwrites that view. But, on the other hand, the active involvement of a high-ranking policy official in these discussions should direct our focus one organisational level lower: policy officials, industrial research managers and university governors *were* actively dealing with science policy issues of coordination, independence and societal relevance. It must have been Woltjer, therefore, who added, in pencil, a note to 'his excellency' Minister Jo Cals on the letter about the relations between TNO and universities, which was sent in his name: 'an initiative from your side is expected.'

3.6 Practical Tensions between Free and Sponsored Research

The controversial status of a virtual or physical institute of medical physics at TNO and the spatial aspects of the co-operation between TNO and the polytechnic in Delft made the OKW Ministry, inspired by Woltjer, call into question the status of TNO subsidies to university researchers altogether. The initiative to apply for such subsidies could come from TNO departments as well as university scientists. Sometimes TNO organisations acted as coordinating bodies that aimed to employ academic expertise and instruments by sponsoring specific projects. Although this could concern contract research, in most cases, this will have concerned the 'collective' TNO research, the content of which was the result from the 'mixed' discussion, by science, industry and the state, in the TNO special organisations. But sometimes university scientists reached out to TNO to explore a new, societally relevant research topic. It was therefore not always unambiguous who was really determining the agenda of university research.

The Ministry hoped to clear up this diffuse situation, starting with the collection of data through a national questionnaire. In the accompanying letter, Minister Cals—but in effect Woltjer—situated the issue in a wider cultural and economic context:

335 NA, THD, 3.12.08.01 inv. nr. 204, Report of the study group TH-Derden, 19 April 1955

336 Most literature dates the beginning of science policy in 1963. See for example: Brookman, *The Making of a Science Policy*; Stuart S Blume, *The Development of Dutch Science Policy in International Perspective: A Report to the Raad van Advies Voor Het Wetenschapsbeleid.* (Zoetermeer: Raad van Advies voor het Wetenschapsbeleid, 1985); Baggen, Faber, and Homburg, "The Rise of a Knowledge Society," 309; Van Berkel, *De stem van de wetenschap*, 338–44.

> On the one hand, the role of science in society is becoming more and more meaningful. On the other hand, experience from other countries has taught us that the scientific potential of a population is limited, or at least is not in correspondence with the growing societal need for scientific powers.[337]

Not only did the TNO issue revolve around the question of the coordination and orientation of university research—there was also a concern about scientific and technological manpower: what was the most appealing place for academically trained scientists to work? These questions arrived at the boards of trustees, who then inquired within their organisations about the data and ideas on sponsored research. In Leiden, for example, the trustees copied most of Cals' letter when they forwarded the Ministry's request for information to the university senate.[338] In addition, the trustees translated the questions into four sub-questions, on the content, budget, duration and 'character' of the research projects. On the last question, they invited 'elaborate motivations'. To the frustration of the board of trustees it took the Leiden senate more than a year to collect and compile responses at the faculties of Medicine and Natural Science.[339] Chemistry professor A. E. van Arkel (again, someone with ties to the Philips NatLab, where he cooperated with Willy Burgers before the war) concluded that no 'completely clear image' arose: five professors explicitly approved 'this form of subsidies' by TNO, while nine others preferred subsidies to be distributed by the university itself.

As argued above, this ministerial request was orchestrated by policymaker Woltjer in response to spatial tensions at the Technical Physical Service and the physical potential of an Institute of Medical Physics: what kind of research belonged in what kind of spaces? From the discussions about these places as well as from the geographically dispersed responses to the ministerial questions, four conditions for the 'character' of university research can be discerned: independence, temporality, materiality, and circulation. The responses to the questionnaire demonstrate that the debate on the organisation of academic research in the 1950s was widespread and practically oriented. The national debate about the organisation of sponsored and free university research first of all was embedded in very local situations, but also related to international discussions about the ethics of sponsored research.

Independence of Research

Many turned to the common argument of freedom or independence of research to distinguish academic work from oriented work at TNO and in industry. A clear task allocation existed when relevant results from university research were taken up by TNO and from there disseminated to industry. For some, this mapped on to a principal distinction between pure and applied

337 AUL, Archief van Curatoren en College van Bestuur (AC4), inv.nr. 2236, Minister of OKW to Board of Trustees, Leiden University, 26 May 1955.

338 AUL, ASE, inv.nr. 82, Board of Trustees to Senate, 24 June 1955.

339 AUL, ASE, inv.nr. 85, Senate to Board of Trustees, 24 June 1956.

research, analogous to the institutional boundary existing between ZWO and TNO. Professors from the faculties of natural science of Groningen and VU Amsterdam, for example, thought that TNO made 'science serve the common good'; the university was implied in this achievement because of the 'natural' link between pure and applied research. It is telling however, that this principal view came from faculties where the intensity of contracts from TNO was quite low.[340] Mostly, these professors were echoing the official rhetoric that also the Central Organisation of TNO used in their reply.[341]

Those who harboured more experience with sponsored research often had to muddle such clear distinctions. In the discussion group at TH Delft, Philips research director Casimir for example concluded that 'all research work is in a way oriented… even *free inquiry* is still oriented at a certain industrial sector'. When Dorgelo challenged him on this point, Casimir specified that detaching research from societal needs was context-dependent: surely it would be more difficult in Delft than 'in the laboratories of Leiden University'.[342] It was also discipline dependent: Woltjer repeated Polman's argument that a distinction between pure and applied was particularly 'artificial' in medical research.[343] And indeed, to many medical researchers it seemed to make little sense to separate pure and applied research strictly or institutionally.[344] In the spirit of freedom, many expanded university territory to the whole range of research, from pure to applied.

As the university territory was marked liberally, also the terrain of activities for TNO came under discussion. The Central Organisation of TNO presented the official policy ideal of the task division between TNO and academic laboratories: although close ties to 'the economic and social life' were 'useful and required' for the oriented research of TNO, such ties might frustrate the freedom of university research.[345] Leiden professors D. J. Kuenen (zoology) and T. H. van den Honert (botany) defended a similar middle way, where TNO mediated the relations of university research to practice (e.g. agriculture), enabling a 'harmonious development' and 'stimulation' of science.[346] But for staff at the medical faculty of VU Amsterdam, TNO's meddling was considered an obtrusive element that might curtail 'the absolute academic freedom'. This was not because they put them into contact with society; rather it was the requirement to provide a research budget and planning—to organise research.[347]

A more fundamental challenge to the task division came from Leiden, where the university carried as motto 'Praesidium libertatis' (bastion of freedom). Professor C. J. Gorter, of the Kamerlingh Onnes Laboratory, claimed that the interest of industry in academic research was actually decreasing because TNO's mediation interfered in existing networks. The extent and strength of these relations must have been considerable,

340 NA, OKW-HOW, 2.14.58 inv.nr. 155, Responses from Groningen, 6 September 1955, and VU Amsterdam, 8 October 1955.

341 NA, OKW-HOW, 2.14.58 inv.nr. 155, Central Organisation TNO to Minister of OKW, 12 September 1955.

342 NA, THD, 3.12.08.01 inv. nr. 204, Report of the study group TH-Derden, 1 June 1955.

343 NA, THD, 3.12.08.01 inv.nr. 301, Report of the study group TH-Derden, 3 February & 13 May 1955.

344 AUL, ASE, inv.nr. 82. Responses to questionnaire from the Medical Faculty at Leiden University (Prof. J. E. Dinger, Prof J. Mulder, Prof. H. A. Snellen and Prof. J. Dankmeijer).

345 NA, OKW-HOW, 2.14.58 inv.nr. 155, Central Organisation TNO to Minister of OKW, 12 September 1955.

346 AUL, ASE, inv.nr. 82. Responses to questionnaire by Prof. D. J. Kuenen and Prof. T. H. van den Honert.

347 NA, OKW-HOW, 2.14.58 inv.nr. 155, Letter from VU Amsterdam Medical Faculty, 12 July 1955.

if a physics professor from an experimental laboratory at the oldest general university argued that the societal relevance of academic research was threatened by an organisation for publicly funded applied research. In Delft the concerns about the appropriate relations between the different types of research were expressed spatially. The proximity and frequent contact between TNO and TH Delft researchers were not only fruitful, it could also be dangerous if the two institutions were too close to each other. The trustees therefore had started procedures to remove TNO institutes from polytechnic spaces, like the Rubberdienst (rubber service). Groningen University, on the other hand, still hoped that new TNO institutes would at least be located in university towns. It seems an equilibrium between proximity and distance was required to maintain independence.

Temporality of Research

Instead of the principled and institutional distinction between pure and applied research, many professors used a practical distinction between temporary and permanent projects to distinguish university research from TNO research. The applied and contract research at TNO institutes was largely uncontroversial, although some even considered this an intrusion. But TNO institutes could also pursue more fundamental, or free, research questions. In addition, experience with hybrid spaces in-between university and TNO had dissolved the self-evidence of the coincidence of *place* and *character* of research. Representatives from industry, university and TNO instead put their hopes on temporality as distinguishing feature of different research types and epistemic spaces.

The Leiden Senate for example told the Ministry that 'research with a distinct temporary character' had to be financed through TNO and ZWO, while research that 'would recur regularly, for the progress of science and teaching had to remain 'within the borders of the university'.[348] Industrial researchers (with strong academic links) such as (former) Philips research managers Holst and Casimir agreed. The latter maintained that the *only* tenable distinction was between research on the relatively certain short term, and high-risk research without a clear awareness of possible applications, which was the domain of university research. Casimir praised the freedom of problem formulation in the universities, to which industrial problems should serve only as inspiration.[349] And, in the words of Holst, the university should focus on the 'problems of the future', because 'the problems of the present' would swamp them.[350] Professor Polman, chair of the Gezondheidsorganisatie TNO, analogously allocated the tasks between university and TNO based on the 'speed with which the questions that society asks us have to be answered'.[351] Based on this argument, he legitimated the existence of the extra-academic Gezondheidsorganisatie, which could provide

348 AUL, ASE, inv.nr. 85, Prof. A. E. van Arkel to Board of Trustees, 24 June 1956.

349 NA, THD, 3.12.08.01 inv. nr. 204, Report of the study group TH-Derden, 1 June 1955

350 NA, THD, 3.12.08.01 inv. nr. 301, Report of the study group TH-Derden, 4 March 1955

351 NA, OKW-HOW, 2.14.58 inv.nr. 155, Report of a meeting about the Medical-Physical Institute and the Department Health Technics of TNO, 4 October 1955.

short-term and flexible funding, oriented to the needs and problems that arose from society.[352] In principle, performing research on a pressing or less urgent societal problem fitted well within the category of academic research.[353] According to Casimir, Holst and Polman, it was only the temporal horizon and practical organisation of the research that distinguished academic from TNO research.

Many indeed perceived the benefits of this flexible, short-term role for TNO. Several university professors gave examples of research projects that started with support from TNO and which were now continued within the university because of their scientific importance. Here the short-term projects through TNO were used to 'test new directions' in research.[354] Many actors believed that such flexible funding could overcome inflexibilities in academic structures: the slow bureaucracy of the Ministry and the lack of adaptability in universities. TNO and ZWO grant applications were quick, easy, and expert-based: professionals, practitioners and peers, rather than trustees or policymakers, reviewed applications for funding. According to Polman, the funding organisations could also remedy the ill of 'forgotten areas' in research: the freedom of professors did not guarantee that all important topics were being studied.[355] Ideally, a Leiden professor replied, additional ministerial funds would become available to continue successful TNO initiated projects within the universities.[356]

Others, however, feared that this proactive role gave the funding organisations unwanted directive power. The universities of Leiden and Groningen for example perceived the 'external' support of more permanent projects as an infringement on their independence. Some of the subsidies by TNO covered several years of research and could implicitly force the university to guarantee continuation of such projects. Dramatically, this could lead to the termination of existing work or the neglect of more urgent priorities.[357] Maintaining a temporal distinction between independent and sponsored research in the university, as long- and short-term, could prevent this.

Material and Manpower for Research

If different epistemic spaces were defined by their temporal horizon, material conditions should support these activities. The purchase of an expensive instrument, for example, in itself directs research on the long term. Actually, in line with the temporal distinction of research practices, TNO did not supply subsidies for such investments at 'external' institutions (in casu universities). Still, some universities complained about this. Where many academics were in dire need of new apparatus to catch up with the advanced international developments in their fields, facilities at the separate institutes of TNO were sometimes more advanced. The material differences translated

352 Albert Polman, "De Gezondheidsorganisatie TNO," *Nederlands Tijdschrift voor Geneeskunde* 95, no. 8 (1951): 644–47.

353 NA, THD, 3.12.08.01 inv. nr. 204, Report of the study group TH-Derden, 1 June 1955.

354 AUL, ASE, inv.nr. 82, Responses to the questionnaire by Prof. W. F. Suermondt, Prof D. J. Kuenen, and Prof. S. E. de Jongh, July 1955.

355 NA, OKW-HOW, 2.14.58 inv.nr. 155, Report of a meeting about the Medical-Physical Institute and the Department Health Technics of TNO, 4 October 1955.

356 AUL, ASE, inv.nr. 82, Response to the questionnaire by Prof. D. J. Kuenen, 5 July 1955.

357 NA, OKW-HOW, 2.14.58 inv. nr. 155, Response by Groningen to OKW, 6 September 1955.

into a concern that TNO would lure away the scarce resource of qualified graduates. This fear was reinforced by rumours that it was financially more attractive for university researchers to work on externally funded projects, or to take up positions at TNO.[358] According to professors like Polman and Gorter, this battle for manpower, fought with material resources, was the primary ground for the conflict between research organisations and universities.

The manpower issue was a central concern for the Delft discussion group too: the extraction of scientific personnel by TNO could 'prove fatal' to universities and the TH Delft, turning them into teaching institutions.[359] At TH Delft, the president-curator and retired industrial researcher Holst therefore drafted a memorandum about the criteria for acceptance of contract or sponsored research from external parties. These criteria were strongly based on the material conditions of the laboratory. As long as no university instruments or spaces were involved, professors were free to provide advice, coursework or presentations. He also considered it acceptable to respond to a short-term request when the required apparatus and set-up were already in place. As soon as it concerned longer-term research projects for which a special set-up of the instruments was needed, the epistemic goal of the project mattered. It should be accepted only if it could lead to new insights and methods. Testing and inspection requests therefore had to be definitely denied. Lastly, although just determining one specific value was not of interest, it could lead to new insights if a great number of measurements had to be performed.[360]

Circulation of Sponsored Research

In these practical discussions about the organisation of research, very local issues and examples were used rather than idealised, international examples. However, the gaze was turned abroad for the issue of the circulation of useful university research, in particular the legal and ethical aspects of patents and secrecy in contractual relations between universities, professors and sponsored research. In Delft, policymaker Woltjer and industrial researcher Casimir introduced American examples. In Leiden, university rector J. N. Bakhuizen van den Brink and a trustee introduced the results from a conference organised by the Western European Union in Cambridge.

Following Holst's criteria, the discussion group in Delft speculated that some 'code of honour' was required to control interactions of professors with external parties. From personal experience, several foreign examples were given both for the legal and ethical side of the issue.[361] Woltjer referred to the Rules and Procedures of Yale University as example for the formal organisation of external relations of professors. Professor Casimir wondered whether these rules were initiated by cooperation with the non-profit 'Research Corporation',

358 Cf. the remuneration issue at TPD in 1951. NA, OKW-HOW, 2.14.58 inv.nr. 155, Response by Groningen, 6 September 1955, and VU Medical Faculty, 12 July 1955.

359 NA, OKW-HOW, 2.14.58 inv. nr. 155, Response by TH Delft, 5 September 1955.

360 NA, THD, 3.12.08.01 inv. nr. 301, Report of the study group TH-Derden, 23 March 1955

361 NA, THD, 3.12.08.01 inv. nr. 301, Report of the study group TH-Derden, 23 March 1955.

about which he had learned during a visit to Princeton University. Chemist Frederick Cottrell established this independent organisation in 1912 from a (quite widespread) fear that profitable patents might increase commercialism, competition and secrecy at universities. From 1937 onwards Research Corporation managed all patenting and licensing activities for MIT and by 1950 it fostered formal patent management agreements with about 50 US research universities.[362] It took care of the exploitation, patenting and licensing of new inventions by university professors and invested all its profit into new scientific research. This last aspect also made industrial partners quite willing to take out licences from them. Casimir had learned that the contracts with Research Corporation 'simplified' the relations between professors and third parties. Since its director, a 'Mr. Baker' (sic) had visited the Netherlands, Casimir even suggested that Research Corporation could act as foreign agent for Dutch inventions.[363]

The rapid post-war growth of Research Corporation—connected to up to 200 universities by 1960—mirrored the dominance of (government) 'sponsored research' in 'the pursuit and support of post-war science, in both word and deed', as Forman has put it.[364] As category, sponsored research replaced the interwar ideal of cooperative research, where industrial and academic actors shared costs and concerns. The trustees of Leiden University also adopted the term 'sponsored research' to stress to the Minister that a lot of the subsidies of TNO were to be regarded in this way. The Dutch had learned about this research category at the Cambridge Conference of 1955, which had been organised by the Western European Union, a transnational governmental body uniting France, the United Kingdom, the Netherlands, Belgium and Luxemburg since 1948, and Italy and West Germany since 1954. One of its goals was to promote cultural exchange. The Dutch secretary-general of the Ministry of OKW, H. J. Reinink, initiated meetings in the early 1950s to discuss 'university problems' internationally. The main outcome of this initiative was the conference of European university rectors and vice-chancellors in Cambridge in July 1955.[365] References to this conference thus carried great weight at the ministry.

In Cambridge, the rectors discussed sponsored research in relation to the freedom of university research. Sponsored research concerned 'grants to a particular faculty of individual professor for research into a particular project specified by the donor of the funds', which could be the state, a private foundation, or an industrial organisation. 'Grave worries' had arisen about sponsored research that mirrored the Dutch discussions: sponsored research could compromise the independence of researchers; it could fuel competition for resources and manpower between universities and extra-academic institutes. Moreover, contracts might prohibit professors from following

362 David C. Mowery and Bhaven N. Sampat, "Patenting and Licensing University Inventions: Lessons from the History of the Research Corporation," *Industrial and Corporate Change* 10, no. 2 (2001): 317–355; Berman, *Creating the Market University*, 96–98.

363 Joseph Warren *Barker*, the president of Research Corporation between 1946 and 1957, had previously worked as professor of electrical engineering at MIT, in the Navy during the war and was later dean of engineering at Columbia University.

364 Forman, "Behind Quantum Electronics," 181.

365 H. R. Leech, ed., *Report of the Conference of European University Rectors and Vice-Chancellors, held in Cambridge, 20th–27th July, 1955* (London, 1955).

their natural inclination to redirect research in new directions, threatening the progress of knowledge. Furthermore, the issues of secrecy and profit came up concerning the publication and exploitation of results. Lastly, the rectors from European universities lamented that the rise of sponsored research further overshadowed the development of humanities and social sciences. It was of course more likely that external funds were acquired for research into the 'fatigue of non-ferrous metals' than for a historical project about 'Scaliger's work'. Rhetorically, the rectors pondered which of the two was closer to the ideal of the university. The trustees from Leiden fully endorsed all these concerns and conditions for sponsored research set at this conference.[366]

The concerns aired in Delft and through the questionnaire circulated in the Dutch scientific world. A telling example is a similar discussion about relations to third parties in institutes funded by ZWO for 'pure' research.[367] In 1956, prominent voices were again Holst and Woltjer, this time as members of the ZWO board. Two concrete cases of direct relations between 'pure' research and commercial use were reason to discuss the tensions between independence, secrecy and utility. First, there was the contract that Philips had proposed for research at the Laboratory for Mass Spectrography of Prof. Jaap Kistemaker—it included secrecy measures and the obligation to inform Philips of similar assignments from other industries. All board members objected to the restrictions on the public nature of ZWO-funded research and the possible monopoly for Philips. But most also agreed that a compromise, 'a middle way' in the words of chairman Wagenvoort, had to be sought to make useful results or pure research available for application—'to assist in the industrialisation of the Netherlands'.[368]

The second case led to more concrete suggestions: the Rekenafdeling (computing department) of the Mathematisch Centrum (MC) had designed an 'electric calculator', or computer, which had aroused the interest of an insurance firm.[369] The funding from TNO and ZWO, and in which way this supported pure or applied research, was not distinguishable in this department. Still, ZWO considered it desirable to separate them as much as possible, because it was unacceptable if its funds were used for applied research. Holst repeated his temporality argument in a new form: ZWO should fund long-term research, while TNO should respond to problems that required immediate solution. To increase the authority of this view, he not only referred to his experience at the Philips research lab (where these tasks were divided between mid-level managers and researchers) but also to the US where this was 'the greatest concern: how to organise [research] in such a way to play a role in the future, while there are so many problems to be solved in the present?'[370]

366 AUL, AC4, inv.nr. 2236, Board of Trustees Leiden to Minister OKW, 4 July 1956

367 NA, Nederlandse Organisatie voor Zuiver Wetenschappelijk Onderzoek 1947–1988 (ZWO), 2.25.36 inv.nr 6, official minutes and verbatim report of the ZWO Board meeting, 3 March 1956.

368 Ibid.

369 Alberts, *Jaren van berekening*, 241–47.

370 NA, ZWO, 2.25.36 inv.nr 6, minutes of the ZWO Board meetings, 3 March 1956.

At ZWO, they were definitely relieved that the construction of calculation machines would soon be housed in a separate company, established by the insurance firm, and from which the MC would still receive profits.[371] But for future cases—which were unavoidable, according to Holst—a spatial solution was proposed by classicist Wagenvoort: to house application-oriented research and production in 'auxiliary branches' to such institutes, funded not by ZWO but by TNO or industry. Two other humanities scholars from the board, Bakhuizen van den Brink and H. H. Janssen, supported this proposal. But industrialist Holst was sceptical: such an annex could still shape the research in its 'scientific' mother institute, when a 'moral bond' remained intact. In the official minutes that summarised these discussions, the issues of the independence, secrecy and utility of pure research appear as rather abstract ideas of a detached 'pure' scientific elite. When one looks at the verbal report of the meeting, however, it becomes clear that such ideas were situated in concrete examples, pressing worries about material and manpower, as well as context-specific spatial solutions.

3.7 Architectures for Extra-Academic Research: Para-University Institutes

At the beginning of 1955, policymaker Woltjer joined the academic and industrial researchers in their discussions on third parties at TH Delft with the message that finance was 'not the bottleneck' for university development. Rather, he stated that manpower and space were the 'prohibiting factors'.[372] The discussion of the 'TNO issue' has demonstrated that this was not just restricted to the situation at Delft, but dominated a debate about the planning and organisation of scientific research all over the Netherlands—and across Europe. This is also evidence that a concrete debate about the planning and value of research was taking place, perhaps not on the level of the ministry, but definitely when one directs attention to a level lower, to university governors, industrial research managers, and high-ranking policy officials. As mentioned above, with the TNO issue Woltjer tried to demand attention for science policy from Minister Cals. In 1957, Woltjer prepared another memorandum, which was backed by the ZWO board in which he also had a seat.[373] But before he could discuss this with Cals, the minister endorsed a bottom-up and field-specific request: the Casimir committee on the organisation of scientific research in the natural sciences.[374] Many of the concerns raised in the TH Delft discussion group were transferred by Casimir into this committee that focused only on the *natural* sciences. This crossed Woltjer's initiative to make the character and place of *all* university research a political concern. Ultimately, Woltjer found another venue to bring these ideas to the attention: the Kronig committee.

371 NA, ZWO, 2.25.36 inv.nr 6, minutes of the ZWO Board meetings, 19 March & 23 April 1956.

372 NA, THD, 3.12.08.01 inv. nr. 301, Report of the study group TH-Derden, 12 January 1955.

373 NA, OKW-HOW, 2.14.58 inv.nr. 38, Memorandum on 'Commissie Geesteswetenschappelijk Onderzoek', H.J. Woltjer to Minister Cals, 26 July 1960.

374 Baneke, "De vette jaren."

The Kronig committee, neglected in Dutch historiography, was established in 1959 at the Interuniversitair Contactorgaan (interuniversity contact organ, IUCO) to reflect on the relations between university and extra-university research.[375] A trustee from Nijmegen, Baron van Voorst tot Voorst, had tabled the issue of extra-university research at the IUCO. His concern stemmed from developments in psychology research at his university, where professors established several extra-university institutes and foundations for societal goals.[376] Committee members were prominent voices in the public debate about science policy, namely J. H. des Tombe and H. H. Jansen, and experts in the relations between university and extra-academic research, like the chairman of the Central Organisation TNO, Prof. H. W. Julius, and the rector of the TH Delft, Ralph Kronig.[377] Kronig, born in 1904 in Germany, was a prominent theoretical physicist who had worked with Werner Heisenberg and Wolfgang Pauli, had extensive foreign experience– at Columbia University, ETH Zürich and Imperial College London—and now held a chair in theoretical physics at the Technical Physics department. Although his specialisation was particularly theoretical (electron spin, quantum mechanics), this position also put him in close proximity to the TPD.[378] In addition, the Kronig committee had direct connections to the preceding Delft discussion group: besides Woltjer, there was involvement of Oene Bottema (who was then acting rector of Delft) in the smaller preparation committee that arose in 1958.

Several recommendations from the Kronig report, which was published in October 1963, clearly linked to the 'third parties' discussion group and the national questionnaire of 1955.[379] First of all, the committee concluded that universities were *not* the exclusive place for fundamental research. It observed, like many survey respondents, that the boundaries between fundamental and applied research were blurring: more and more 'hybrid forms' existed.[380] In an attempt to demarcate the territory of academic and industrial research, the report cited Casimir and Frits Böttcher as authoritative experts: one an industrial physicist with a special chair at Leiden University, the other a physical chemistry professor at the same institution with an advisory position at the Shell research laboratory. Böttcher pointed out that the expansion of industrial research was swamping academic research, and that laboratories like the one at Shell were increasingly conducting fundamental research because they 'could not wait for university research' to deliver the results. Both argued with hybrid academic-industrial tongues that the main difference between academia and industry existed in the 'climate': freedom and lack of control of the researcher at the university versus direction of the fundamental researcher in corporate laboratories. Or, in the words of the report itself:

375 The IUCO had been established in 1956 by Dutch universities to coordinate faculty appointments.

376 Psychology professor Rutten (also minister of OKW between 1948–1952) for example established the Gemeenschappelijk Instituut voor Toegepaste Psychologie (collective institute for applied psychology) to help firms select appropriate personnel. J. F. M. C. Aarts, "'Rutten, Franciscus Josephus Theodorus (1899–1980),'" in *Biografisch Woordenboek van Nederland*, 2 (Den Haag, 1985).

377 J. H. des Tombe (1904–1989) was trustee of Utrecht University. Prof. H. H. Janssen (1910–1982) was a Latinist at the Catholic University Nijmegen and served as ZWO board member. Brookman, *The Making of a Science Policy*, 317–29.

378 Baudet, *De lange weg naar de Technische Universiteit Delft*, 408–10; H. B. G. Casimir, "Levensbericht R. Kronig," in *Levensberichten en herdenkingen* (Amsterdam, 1996), 55–60.

379 By the time that Kronig presented the first results, in 1961, minister Cals had replaced the bottom-up IUCO with a new inter-academic coordination organ, the Academische Raad (Academic Council, AR).

380 Academische Raad, *Wetenschappelijk onderzoek aan en buiten de universiteit*, Publikatie van de Academische Raad 1 ('s-Gravenhage: Academische Raad, 1963), 34.

> The leader of university research is not only formally free, he also feels truly free. There is no real control. He can be an example of efficiency and organisation, but nobody prohibits him to work in the most chaotic or illogical ways. It is precisely this freedom … that has not uncommonly lead to surprising inventions and brilliant theories.[381]

In addition, the committee concluded that, above all, a nurturing exchange between academic and extra-academic research had to exist. It was beneficial to keep the university 'fresh' and connected to actual problems. Apart from these benefits the committee also identified risks of contact with external parties:

> When certain boundaries are crossed, each form of contact with third parties can infringe core academic values, such as … the independence of the university, the public nature of academic science and the freedom of choice in the pursuit of research.[382]

As precaution, the committee quoted in full the advice from the WEU Rectors Conference at Cambridge about sponsored research, which the Leiden Senate had brought to the attention in 1955. The spatial-material dimension of these perceived risks again came to the fore: university authorities had a responsibility 'for ensuring that university facilities are used only for their proper purpose' and should be consulted about 'contracts or regulations referring to sponsored research to be carried out with the use of university facilities'.[383]

With the advice to establish 'para-university institutes' the Kronig committee focused on the spatial organisation of the appropriate relations between universities and extra-academic institutes. More specifically, it advised moving knowledge transfer activities to such independent institutes, which would remain closely associated with particular universities.[384] This created a 'clear demarcation between vital and derivative tasks' of the university. Derivative tasks concerned knowledge transfer to society: post-academic and adult education, contract research and consultancy. Derivative here was not meant in a derogatory sense; rather, knowledge transfer was considered of central importance to the modern university:

> The vital function of science and her application in and for current society makes transfer of the results of that science to the next generation alone insufficient … The university cannot withdraw from her responsibility to also inform society of her newly acquired insights.[385]

The 'hybrid form' of the institute would serve both societal and academic interests, and function as a place of exchange between teaching, research and society. As examples were

381 Academische Raad, 34–35.

382 Academische Raad, 34–35; 'Versterking universiteiten tegenover industrie nodig,' 28 November 1963, *De Waarheid.*

383 Academische Raad, 37.

384 'Commissie Kronig bracht rapport uit,' 28 November 1963, *Algemeen Handelsblad.*

385 Academische Raad, *Wetenschappelijk onderzoek aan en buiten de universiteit*, 28–29.

mentioned academic hospitals, psychology institutes, an economic institute at Rotterdam and several TNO institutes surrounding the polytechnics –including again, and perhaps of course, the TPD.[386] In conclusion, the committee once again referred to a recommendation from a WEU Rectors Conference (Dijon, 1959):

> … that universities and governments will give urgent attention to means of establishing liaison between non-university centres and universities themselves … Not only does the quality of university work benefit thereby, but the danger that the universities might lose the prestige of advanced research to outside centres is avoided, and the university career becomes more attractive.[387]

The Kronig committee paid attention to endogenic changes of, and external pressures on, the academic community. The primary actor in this logic was the overburdened professor whose tasks were ever increasing—teaching, research, management—while the contacts with the 'outside world' asked more of his time as well. Not only did this put stress on current professors, it also made the job unappealing in comparison with extra-academic research positions. The proposed solution of a para-university institute would make the professor more conscious of his time investment in, for example, contract research when he literally had to leave the university for it. Ultimately, this had to protect and improve the 'academic climate' so that it would be attractive again to highly skilled manpower.

The Kronig report emphasized the importance of taking care, especially in spatial terms, of the relations between science and society. Or, more specifically, of the collaborations between institutes of higher education and extra-academic research institutes, like TNO. The issues of independence, temporality, material conditions and secrecy originated in concrete spaces of exchange—the hybrid space of the Technical Physical Service in Delft and the virtual possibility of a physical TNO institute for medical physics. The para-university institute was modelled after such utility spots, albeit slightly idealised: the housing of the TPD, for example, in various rooms of the Technical Physics laboratory was precisely a type of impurity that the Kronig committee advised removing.

Was this advice ever implemented? Unlike the high degree of causality ascribed to the Casimir report, which David Baneke has recently questioned, there exist practically no references to the Kronig report in Dutch historiography.[388] This neglect could be explained in two general ways. On the one hand, it could be that the report had no historical impact whatsoever. Of course, that in itself would require explanation: was the Interuniversity Council a powerless body altogether; did the transformation

386 Academische Raad, 39–40.

387 Quoted in the Kronig Report: Academische Raad, 40–41.

388 None of the histories related to Dutch science policy, including those of ZWO, TNO, KNAW or THD, discusses the Kronig report. For the impact of the Casimir report, see: Baneke, "De vette jaren."

of the IUCO into the AR cause the report to pass unnoticed; or were the recommendations unwelcome at the Ministry, the universities or in industry? On the other hand, it is possible that the report had some effects, but that historians have overlooked them. Potentially, this is an artefact of the focus of many studies on *either* academic, TNO or industrial contexts, instead of their multiple intertwinements. I will demonstrate that the neglect of the Kronig committee in Dutch historiography is unwarranted, because it did play a role in later, spatial developments.

3.8 Geography of Extra-Academic Research: Decentralisation of TNO

There is at least one case in which the recommendations of the Kronig report circulated: the decentralisation of TNO in 1963. Although the report was published only in the autumn of 1963, it circulated in policy circles before that. TNO used the report in a memorandum about their planned decentralisation, which helped raise awareness at the Ministry of OKW. Representatives of the polytechnic were especially fond of the proposal to establish para-university institutes between university, TNO and industry. But disagreement existed about the social-epistemic effects of the location of these hybrid spaces. Whereas the ministry and the universities believed that proximity catalysed interactivity, TNO separated the questions of location and collaboration. Proximity turned out to matter in multiple ways.

Why did TNO have to 'decentralise' at the beginning of the 1960s? Already in the 1950s, buildings were the greatest concern for TNO. The work of the organisation and its institutes had grown rapidly since 1945. In the memorial volume of 1957, Th. J. Kasteel (head of Publicity at TNO) reasoned that for TNO to fulfil its task of 'providing many good services to the Dutch people' further expansion was necessary but 'unimaginable without new buildings'.[389] At the same time, he admitted, this desire for spatial expansion was at odds with the general housing shortage in the Netherlands. This struggle for space became explicit in Delft, where TNO at first hoped to open new institutes. Until the 1960s, a large part of the applied research activities of TNO was geographically concentrated at, or around, the TH Delft. By 1963, however, difficulties arose for further expansion in the 'Zuidpolder'. First of all, there was not enough space in Delft: not for housing or parking, let alone for new TNO buildings. But, secondly, the needs of TNO seemed to have lower priority than those of the polytechnic and the potential establishment of the European Space Research and Technology Centre (ESTEC). Basically, TNO had no choice but to move their activities out of Delft, and out of the densely populated west of the country altogether.[390]

389 Th. J. Kasteel e.a., *Een kwarteeuw TNO 1932–1957, gedenkboek bij de voltooiing van de eerste 25 jaar werkzaamheid van de organisatie TNO op 1 mei 1957* (Den Haag: TNO, 1957), 39.

390 NA, OKW-HOW, 2.14.58 inv.nr. 155, Ministry of Public Housing to Ministry of OKW, 31 May 1963; Prof.ir. L. Troost to A. J. Piekaar, 11 October 1963.

Why did the Ministry of OKW care about decentralisation? In 1956, minister Cals had installed the Piekaar-Neher committee on the 'dispersion of higher education' in the Netherlands.[391] This committee studied spatial resolutions for the predicted steep rise in student numbers up to 1970.[392] The subcommittee on technical education concluded that an additional polytechnic university was required. This advice to decentralise (technical) higher education not only responded to capacity problems at existing universities but was also motivated by the aim to benefit social and economic well-being in the Dutch provinces. The idea that the production of new scientific and technical manpower stimulated underdeveloped geographical areas materialised in several European countries. Already in the early 1950s, various public-private regional associations made economic-geographical cases for the establishment of a second polytechnic in their area.[393] In 1963, the partly necessary decentralisation of TNO was thus also an opportunity for committee chair A. J. Piekaar, who succeeded Woltjer as director of Higher Education and Science at the ministry, to increase the geographical dispersion of scientific activities.

What was at stake for the universities and polytechnics? Dispersion plans were typically not warmly welcomed in academic spheres. The Casimir committee, for example, emphasized the benefits of centralisation rather than regional dispersion for the development of research fields. However, academic institutions generally preferred their own expansion over the establishment of new universities. Already in the early 1950s the decentralisation of polytechnic education became a sensitive issue when the president-curator of the polytechnic in Delft, Holst, had recommended not only expansion of Delft, but also the establishment of a new polytechnic elsewhere—a position for which he encountered some opposition at home.[394] In 1960, thirteen professors from all Dutch universities aired strong criticisms of Piekaar's plans in a special issue of the professional journal for institutes of higher education, *Universiteit en Hogeschool*.[395] Especially the establishment and location of the third polytechnic made the feelings run high: a new polytechnic on the estuary of the river IJ would reinforce the monopoly of the west, while a university in Deventer would be a mere patched-up polytechnic. Kronig, as rector of the TH Delft, claimed that there were enough technical schools: it was better to educate a handful of excellent engineers than an army of average ones. More generally, he believed it was not wise to use geographical 'planning arguments' in higher education policy. The rector of the polytechnic in Eindhoven, chemist Kees Posthumus, proposed as alternative to provide all existing universities with a technical faculty, and the two polytechnics with a 'scientific' faculty. Ultimately, minister Cals made his own call and decided to locate a new polytechnic in the former

391 Dr. Lambertus Neher (1889–1967) was the former director-general of the Dutch postal services, PTT, and vice-president of the Koninklijk Instituut van Ingenieurs (Royal Institute of Engineers, KIVI).

392 A. J. Piekaar and L. Neher, eds., *De spreiding van het hoger onderwijs tot 1970: advies*, Ministerie van Onderwijs, Kunsten en Wetenschappen (Den Haag: Sdu, 1959).

393 Jorrit de Boer, *Een kleine en kwetsbare instelling: een geschiedenis van de Universiteit Twente, 1961–2011* (Enschede: Ipskamp Printing, 2011), 25–54.

394 Baudet, *De lange weg naar de Technische Universiteit Delft*, 374–75.

395 *Universiteit en Hogeschool,* 1960. 'Kritiek van dertien hoogleraren op "spreiding hoger onderwijs,"' 4 February 1960, De Volkskrant. 'Twaalf hoogleraren geven hun oordeel over rapport—soms lang niet mals,' 4 February 1960, Algemeen Dagblad.

textile region of Twente. He became convinced by the local enthusiasm to experiment with an American 'campus' model, including on-site student accommodation and connections to industry and institutes of applied research.[396]

What conflict did the decentralisation question then create? TNO, the polytechnics and the Ministry of OKW actually agreed on a lot of things. Nobody questioned, for example, that industrialisation was the shared goal of TNO, its Industrial Organisation and the polytechnics (*and* universities, added TNO director Laurens Troost). Just in 1963, the last Industrialisation Memorandum had appeared that concluded that the government policy had largely been successful. Still, more science could be applied in industry to increase the 'knowledge intensity' of products.[397] Nor was there really disagreement about the methods to achieve this political-economic aim: 'cooperation with technology and business' and more research for industry by the polytechnics. Although they shared an understanding of the *utility* of scientific research—as contribution to industrialisation, through university-industry cooperation—they diverged in their views *how* and *where* this was ideally organised.

In 1963, the decentralisation of TNO concerned the displacement of two institutes: the Metaal Instituut (Metal Institute) and the Centraal Technisch Instituut (Central Institute) and the Centraal Technisch Instituut (Central Technical Institute, CTI). The first was an example of a 'mixed organisation', where the interests of public and private actors in the metal sector were being served by relatively short-term and routine research. The second performed less directive projects in a longer term and offered chemical and physical technological support to the more specialised TNO institutes.[398] Both were located in Delft and fell under the responsibility of the Nijverheidsorganisatie (Industrial Organisation, TNO-NO), which was directed by Prof. ir. Laurens Troost. The board of TNO-NO approached the move of the two institutes with a broad geographical scope and an outlook to the east of the country: the polytechnic cities Eindhoven and Enschede were options, but they also took Apeldoorn, Arnhem, Utrecht and Zwolle into consideration. Hoping to lure high-skilled man-power to their regions, several cities sent 'very appealing offers' to TNO.[399]

The polytechnic cities of Enschede and Eindhoven motivated a move to their towns with reference to the potential for collaboration. Perhaps many professors and rectors at the newly established polytechnic colleges (unconsciously) relied on the spatial organisation in Delft, where many of them had studied and worked at the polytechnic in close proximity to TNO institutes. Or they relied on their experience with the organisation of research at the corporate laboratories of Shell and Philips.[400] The trustees and senate of the TH Eindhoven stressed that the 'techno-scientific climate' of the city—with the

396 De Boer, *Een kleine en kwetsbare instelling, 51–54.*

397 Faber, *Kennisverwerving in de Nederlandse industrie*, 50–57; van Rooij, "Gaps and Plugs," 32–35.

398 Lintsen et al., *Tachtig jaar TNO*, 48–52.

399 NA, OKW-HOW, 2.14.58 inv.nr. 155, Ministry of Public Housing to Ministry of OKW, 31 May 1963.

400 Some actually had ties to the TPD in Delft, like H. B. Dorgelo and C. Zwikker, who worked at the Technical Physics department before moving to Eindhoven, respectively asfirst rector and as professor. Other participants in the discussion had similar ties: prof. J. G. Hoogland worked ten years in Delft before moving to Eindhoven; trustee Theo Tromp had studied engineering in Delft and was vice-president of Philips; also H. B. J. Witte, major of Eindhoven, had studied civil engineering in Delft before the war. Many professors transferred to the polytechnic in Eindhoven from Shell or Philips, like K. Rietema and G. Rieck.

polytechnic as well as the Philips laboratories—was 'sufficient ground' for a move.[401] In addition, the polytechnic would benefit from the 'continuous and lively contact and cooperation with technology and business'. During visits to the polytechnics in the spring of 1963, Troost however felt that the professors in Twente and Eindhoven were not as keen on collaboration as their trustees wanted him to believe. In Twente there was the additional issue that only a very small number of professors had been appointed so far, so they could not guarantee that 'intimate cooperation' would develop—even though that had been promised to Cals before.[402]

Indeed, there was hesitancy amongst professors about overlapping tasks, mirroring the previously discussed TNO issue. Potentially, TNO could obstruct rather than stimulate contact between university science and industry. Collaboration was thus desirable, not just in itself, but also as a way to demarcate territory. Proximity was, in a subtle way, considered key for this contact. As Professor Posthumus of TH Eindhoven wrote: there is plenty of space available 'at a geographic distance of a few kilometres ('cycling distance') [which provides] optimal conditions for cooperation and task allocation, while retaining the character of each participant'.[403] In a later meeting, Posthumus described this in relation to a 'distance function': 'possibilities for cooperation decrease with distance.' Apparently, this function did not reach a maximum at zero, because some distance was required for fruitful collaboration: the geographical reach of a Dutch cyclist represented the appropriate degree of proximity between the academic and the industrial world. TNO representatives, on the other hand, repeatedly disconnected proximity from potential cooperation. H. W. Julius for example: 'Even if the entire organisation of TNO was concentrated in the Zuiderzeepolders, collaboration forms like the TPD would remain possible.'[404]

For similar reasons of marking one's territory through cooperation, the idea of a hybrid para-university institute between the polytechnic and TNO appealed to professors and policymakers. Notably, TNO directors introduced this suggestion during discussions with the ministries of OKW and EZ in the summer of 1963.[405] The director of the CTI, Dr. J. Hamaker, had circulated a preparatory memorandum on the relations between TNO and institutes of higher education.[406] Hamaker made a plea for a shared institute on university grounds, similar to the TPD at Delft, as the most interesting and desirable modality for long-term collaboration between professors and TNO employees. He explicitly referred to the Kronig report for this idea. But where the Kronig committee had been concerned with the overburdened professor, Hamaker reasoned from the needs of contract research: a physically separate para-university institute would ease the secrecy measures. The other TNO representative present, engineer Troost,

401 NA, OKW-HOW, 2.14.58 inv.nr. 155, Board of Trustees TH Eindhoven to TNO-NO, 7 October 1963.

402 NA, OKW-HOW, 2.14.58 inv.nr. 155, Board of Trustees TH Twente to Prof.ir. L. Troost, 'Mogelijkheden voor vestiging van TNO in Twente', 19 April 1963.

403 NA, OKW-HOW, 2.14.58 inv.nr. 155, Board of Trustees TH Eindhoven to TNO-NO, 7 October 1963.

404 NA, OKW-HOW, 2.14.58 inv.nr. 155, Meeting of TNO, TH Eindhoven and OKW, 1 November 1963.

405 NA, OKW-HOW, 2.14.58 inv.nr. 155, Meeting of OKW (Piekaar, Nittel, Stefels), EZ (Wansink) and TNO (Hamaker, Troost), 19 July 1963.

406 Hamaker based his memo also on the Wilgress report issued by the OECD. NA, OKW, 2.14.58 inv.nr. 155, Dr. J. Hamaker, 'Advice from the Advisory council of the Chairman of the Industrial Organisation TNO concerning collaborations with institutes of higher education', 9 August 1963.

suggested in a similar fashion to copy the American example of Departments of Industrial Research, which 'each university there has', to coordinate and administrate contract research. Also, these would safeguard the creative freedom of university research.[407] Piekaar's enthusiasm for what he alternately called 'divisions of sponsored research' and 'departments of industrial research' is evident from his repeated appeals to Hamaker to include also Troost's suggestions in his memorandum, and the circulation of both of their texts to the polytechnics in Twente and Eindhoven.[408]

The suggestion of a para-university institute caused confusion and conflict, and later Hamaker had to retract his memorandum. Because, before discussing the idea any further, the board of TNO-NO chose Apeldoorn as (geographically more central) location for the CTI and Metaal Instituut. The Ministry of OKW and TH Eindhoven were shocked. They had come to believe that TNO too considered proximity to a polytechnic pivotal. But in the (mixed) board of the industrial organisation of TNO, explained Troost to Piekaar, 'objective' considerations of spatial planning, room for expansion, geographical location and land prices had trumped 'subjective' considerations of 'techno-scientific climate' and proximity to a polytechnic.[409] Piekaar asked Troost to reconsider this 'very important decision' and steered towards a location close to a polytechnic.[410]

In the preliminary advice for Apeldoorn, one backdoor had been left open by TNO: '*if* one of the polytechnics, in a short timeframe, explicitly propagated a broad cooperation (in the sense of TPD) in the domains of the Metal Institute or the Central Technical Institute', *then* they would be susceptible to the proximity argument.[411] The TPD again functioned as organisational model for the interactions between academic and extra-academic research. The TPD's Rules & Regulations, drawn up in the discussion group of 1955 by Woltjer, Casimir, Holst and others, were the starting point for a first attempt at reconciliation between TNO (Troost and Hamaker), TH Eindhoven (Posthumus) and the Ministry (Piekaar). But its applicability outside Delft was questioned by both TNO and TH representatives. Chemistry professor ir. J. G. Hoogland uncovered the 'Achilles heel' of this collaborative form: it could limit the freedom of university researchers in their contacts with industry, because all their contract research would have to run through the TPD organisation. Troost, on the other hand, was not convinced that there was enough scientific and technological potential in Eindhoven for this type of collaboration: at Delft it relied heavily on the orientation, by way of a 'gentleman's agreement', of all technical physics professors to industrial concerns.[412]

In a final attempt to convince TNO, the TH Eindhoven added two new spatial arguments. They followed TNO's logic about a central geographic location but shifted the focus:

407 NA, OKW-HOW, 2.14.58 inv.nr. 155, Troost to Piekaar, 'The function of research at institutions for higher technical education,' 15 August 1963. Troost repeatedly referred to his experiences at MIT, where he worked as Head of the Department of Naval Architecture and Marine Engineering between 1951 and 1960, during which time he also functioned as advisor to the American Ministry of Defence concerning nuclear submarines.

408 NA, OKW-HOW, 2.14.58 inv. nr. 155, Correspondence between Piekaar and Hamaker, 1963.

409 NA, OKW-HOW, 2.14.58 inv.nr. 155, Troost to Piekaar, 'Motivering van de keuze van Apeldoorn als plaats waar de Nijverheidsorganisatie TNO een tweede vestiging wil oprichten', 11 October 1963.

410 NA, OKW, 2.14.58 inv. nr. 155, Piekaar to Troost, 15 October 1963.

411 NA, OKW, 2.14.58 inv.nr. 155, Troost to Piekaar, 11 October 1963.

412 NA, OKW, 2.14.58 inv.nr. 155, Meeting of TNO, TH Eindhoven and OKW, 1 November 1963.

from a European perspective, the province of Noord-Brabant was centrally located and its industry could obtain a 'bridge function in the New Europe'. And to lure the TNO institutes to Eindhoven, its mayor, also a trained engineer, offered an alternative, larger plot of land. It was to no avail. TNO kept the 'location question and cooperation question' disconnected. In the meeting of the board of TNO-NO, two weeks after a last attempt by the Ministry to reconcile the parties, the majority of the board voted again for Apeldoorn. Only two members had been susceptible to the new 'objective' information about the available land, and the 'subjective' elements like atmosphere.

In the decentralisation discussion, we see that each party hoped to balance proximity and independence in such a way that their interests were best served. For the relatively immobile institutes of higher education this meant that TNO institutes had to be situated as close as possible to the campus. But in organisational terms some distance had to be maintained so as to secure independence. 'Cycling distance', that is. Such an arrangement had to achieve contact with practical problems, without external direction of university research; and it had to allow student internships, while maintaining supervisory oversight. But for the TNO institutes the academic environment was just one factor alongside more 'objective' grounds. Most importantly, they had a national focus on industry and business. As much as collaboration with academic research could be useful to them, their main stakeholders were medium- and small-sized enterprises all over the country. A central location could therefore be more important than the proximity to an institute of higher education. And TNO believed that if they required advice or knowledge from somewhere, they would just come and get it. Just not by bike, apparently.

3.9 Conclusion: The Spatiality of Science Policy

The TNO issue concerned the relations between academic and extra-academic research and originated in concrete utility spots: hybrid spaces of cooperation and exchange. Actors in those spaces could not distinguish the activities into abstract categories like pure and applied research. The spatial issues of the Technical Physical Service and the Medical Physical Institute led to the ministerial questionnaire, which uncovered that many university laboratories too were hybrid amalgams of long- and short-term, pure and applied, free and sponsored research. This caused some frustrations and frictions. On the lab floor, where different researchers served diverse purposes with varying remunerations. And in the boardrooms, where policymakers, professors, trustees and industrialists tried to bring order to this messy reality. In those discussions, hybridity improved one's position as expert on the organisation of free and sponsored research: academic-industrial hybrids like Holst and Casimir were practically unchallenged authorities. References to Dutch industrial organisation of research even trumped the occasional international, mainly American, examples.

Ultimately, in this chapter I have shown how utility spots are the spatial origin and battleground for abstract science policy issues and contemplative debates about the value of research. Questions about the appropriate space for different types of research and scientific activities more generally, as well as for the interactions and exchange between academic and external actors, determined the tone and content of the debate. This has two implications for the history of Dutch science policy. First of all, I have shown that the TNO issue enabled Woltjer to gain some ministerial attention for typical science policy issues of the coordination, usefulness and organisation of university research. Secondly, I have uncovered previously omitted sources, from the questionnaire to the Kronig report, which informed the later institutionalisation of science policy in the 1960s. The Kronig report was used in discussions about the decentralisation of TNO in 1963 and the establishment of the Raad van Advies voor Wetenschapsbeleid (Advisory Council for Science Policy, RAWB) in 1965.[413] In both cases, the Kronig report was used to point to the importance of the *place* of research. First of all, spatially: use-oriented and cooperative research was imagined into para-university institutes to safeguard the university as house of fundamental research. These in-between places, secondly, would have a geographical function: they contributed to the development of regional economies.

This historical exploration in the Dutch 1950s, in conclusion, can also further inform the utility spot concept. In this period, utility spots emerged at universities often out of necessity rather than desire. As academic structures were lagging behind societal developments, pockets of institutional innovation were required for defensive reasons: to control intensified interactions with industrial actors, to retain manpower for university positions and to prevent the conduct of 'academic' research elsewhere. Utility spots arose both from the bottom-up, such as the Technical Physical Service, and from the top-down, such as the plans for para-university institutes. Thus, the historical study of utility spots allows one to highlight the interactions between space and policy. In this case, I uncovered both the spatial roots and the spatial consequences of more abstract science policy debates. Lastly, as we meet actors from all sides of the government-industry-university triangle at utility spots, it offers a rich view of the intertwinement of political, economic and scientific developments.

413 Piekaar mentioned the Kronig report twice, as well as the Troost memorandum, in the discussions about the organisation of science policy, specifically when sponsored research came up. And the RAWB archived the Ministerial letter about the TNO-issue as part of the 'pre-history' of science policy. NA, Raad van Advies voor Wetenschapsbeleid (RAWB), 2.14.82 inv.nr. 1; NA, RAWB, 2.14.82 inv.nr. 6, fifth & sixth meeting about the organisation of science policy, 11 March 1964, 8 April 1964.

4. The Geopolitics of European Universities and Advanced Institutes for Humanities, 1955–1975

4.1 Introduction

In Dutch historiography, the early 1960s are usually pinpointed as the beginning of science policy. As Gerard Alberts put it, the era is known as the transition from an active (but non-interventionist) politics of science to a rationalised, interventionist science policy.[414] Previously, I have shown that an interuniversity debate about research planning and coordination was already taking place behind the scenes in the 1950s. In this chapter, I add that we should also pay attention to European geopolitics of academic research in the period that preceded 1963. Whereas the argument above was that policy issues originated in, and led to, concrete places of exchange, I will argue in this chapter that *virtual* utility spots too play an important, structuring role in policy debates. As it turns out, this is of importance not only for the natural sciences but also

414 Alberts, *Jaren van berekening*, 46–48.

for the national organisation of humanities research. Beginning with the European University, I will tie a variety of virtual utility spots together in a spatial and geopolitical narrative to arrive at the peaceful grounds of an advanced study institute in the Dutch dunes.

The exploration of organisation of the humanities will bring into view two aspects of utility in this period: the social nature of academic research and the relation between the natural sciences and the humanities. The argument for the utility of the humanities partly translated into a transition from the centrality of the individual, but 'overburdened' professor to cooperation and exchange between and beyond disciplines in organisational and spatial proposals for humanities research. On the other hand, one encounters pleas to appreciate the 'complementary' utility of the humanities: not in transferring knowledge from science to society, but in transferring values from the past to the present so as to feed reflection on contemporary technological change. Although NIAS was the outcome of these legitimations of the humanities and its main example was Stanford, where an advanced institute on the hillside looked out over the university campus and industrial park, the Dutch institute was situated quite remote from other social and epistemic actors. By sketching the arguments and social-epistemic alliances behind European and Dutch utility spots for academic research, this chapter also contributes to the emerging literature on the historically changing categories of, and relations between, the natural sciences and the humanities.[415]

First, I sketch the contours of an international policy debate in the 1960s about the value of science (4.2), after which I turn successively to specific plans for transnational universities that embodied both cultural and economic value: a European (4.3) and an Atlantic university (4.4), as well as a related Dutch plan for an international institute (4.5). This leads me halfway into the chapter to a more reflective section (4.6) on the geopolitics of utility spots in this period. From there onwards, I turn to the organisation of the humanities in science policy (4.7) and in a particular spot that was genetically related to the previous European and Atlantic plans (4.8). In conclusion (4.9), I tease out how utility spots for humanities and natural sciences are related.

4.2 Cultural and Economic Value of Scientific Research in Europe

In February 1963, Leiden University invited director-general of the Ministry of Education and Sciences Arie Piekaar to give the dies speech. In the old Academy Building on the Rapenburg canal, the high-ranking public official talked about 'the organisation of science policy'. The speech had been written

415 For the contours of this debate, see the contributions to a recent *Isis* Focus section as well as the Forum on the 'Two Cultures Revisited; The Sciences and the Humanities in a Longue Durée Perspective' in the *History of Humanities.* Rens Bod and Julia Kursell, "Introduction: The Humanities and the Sciences," *Isis* 106, no. 2 (2015): 337–340; Fabian Krämer, "Shifting Demarcations: An Introduction," *History of Humanities* 3, no. 1 (2018): 5–14.

'analogous to modern scientific research "as a team"' with one of his senior advisors, philosopher Mr. Johan Nittel.[416] This was only one way in which the speech was in tune with its times. Piekaar and Nittel presented an ambiguous mix of cultural and economic legitimations for the public funding of science. They contrasted a pre-war tradition of cultural pessimism with the post-war optimists of international science policy. Where the pessimist held that 'Western science' had produced a 'broad cultural gap' between the skyrocketing control over nature and the 'wisdom' to use this power for the 'public good', the optimists underlined the technological potential and economic benefits of scientific research.[417] Local newspapers indeed reported that Piekaar's science policy aimed to relieve the cultural crisis. But the main take-away was clearly that the economic value of scientific research had become a central concern. The *Leidsch Dagblad* quoted Piekaar in its headline: 'With sufficient guarantees, more contract research very welcome'.[418] And in his speech, Piekaar admitted that the post-colonial, resource-deficient situation of the Netherlands necessitated the government to draw on its 'human reserves, intellectual potential, its capacity for scientific research'. Brainpower was, just months before the discovery of a large reservoir of natural gas in the northern province of Groningen, the most important resource for the Dutch economy: science was 'the limiting factor for the pursuit of material wealth'.[419]

But this did not mean that the simple mobilisation of university research for industrial purposes would produce economic miracles, as some international military and economic organisations wanted him to believe. Yes, continued Piekaar, society increasingly demanded 'organised science, oriented towards societal applications [and] the solution of problems', but utility was something to be 'awaited, not expected'. Although the 'national or societal value' of the natural sciences existed in the interaction with external parties, through contract research (as described in the previous chapter), the value of the humanities existed precisely in their 'disinterestedness'. Quite visibly, Dutch science policy balanced between two discourses, different interest groups from industry, universities and politics, and various socio-cultural pillars—from Catholic conservatives to social-democrats and economic liberals. Historians of Dutch science policy have described the year 1963, beginning with Piekaar's speech, as a turning point from a 'Continental' cultural doctrine to an 'Atlantic' economic doctrine.[420] The latter was based on the macro-economic belief that technological change (through scientific research) was a main ingredient of the 'residual factor'. Robert Solow had identified this factor on the grounds that explanations based on labour and capital alone failed to account for historical economic growth data.[421] These seemingly opposite conceptions of the utility of scientific research had geopolitical connotations, as we will see

416 A. J. Piekaar, "De organisatie van het wetenschapsbeleid," *Universiteit en Hogeschool* 9, no. 4 (1963): 225–46.

417 Piekaar, 225. American sociologist William F. Ogburn defended this thesis in his book *Social Change with Respect to Culture and Original Nature* (1922)

418 'Directeur-generaal voor de wetenschappen: "Onder voldoende garanties meer contract-research zeer welkom,"' *Leidsch Dagblad,* 4 February 1963; 'Dr. Piekaar: De organisatie van het wetenschapsbeleid', *Nieuwe Leidsche Courant*, 4 February 1963.

419 Piekaar, "De organisatie van het wetenschapsbeleid," 228–29.

420 Brookman, *The Making of a Science Policy*, 332; Alberts, *Jaren van berekening*, 245–47; Van Berkel, *De stem van de wetenschap*, 338–39.

421 Benoît Godin, "The Value of Science: Changing Conceptions of Scientific Productivity, 1869 to circa 1970," *Social Science Information* 48, no. 4 (2009): 569.

below, which were particularly relevant in the 1950s: after the 'loss' of the Dutch colonies in the East Indies, a geographical reorientation of Dutch sciences was required.[422] In this chapter, I will investigate both planned and realised places of organised research and knowledge exchange that demonstrate the co-dependence of these two arguments in all fields of academic research, from the natural sciences to the humanities, in the context of post-war geopolitics.

I will start with a virtual utility spot that lies at the root of these developments: the 'European University'. The first plan for such a spot was originally proposed in 1955 at the negotiations for the European Economic Community (EEC) and the European Atomic Energy Community (Euratom). As plan it existed in various modalities between 1955 and 1961, but it was always envisaged to contribute to European cultural and economic integration. The European University thus was of geopolitical importance from its inception and it never completely escaped political considerations. In this chapter I will demonstrate how the geopolitics of the European University contributed to the nationalisation of science policy in the Netherlands. Additionally, the European University had an indirect effect on the organisation of Dutch humanities research. The eventual establishment of the Netherlands Institute for Advanced Study in the Humanities and Social Sciences (NIAS) in 1970 is usually described as outcome of the Wagenvoort committee, which reported on the organisation of humanities education and research in the Netherlands in 1965. Modelled on American examples at Princeton and Stanford, it has been considered an epitome of the cultural value of 'pure' research conducted by individual scholars on an isolated reserve. In this chapter I will claim instead that the history of NIAS is entangled with European geopolitics, the national organisation of research and also its economic value. International examples from the US indeed shaped the discussions, but this time not to increase the interactions between academic research and society. Instead, examples from Stanford and Princeton were hailed to remove geopolitical, organisational and economic aspects from preceding virtual utility spots.

4.3 The European University, 1955–1961

One concrete, virtual, institute shaped the international debate about useful university research between 1955 and 1961: the European University. In 1955, German representatives coined the idea at the Messina meeting, where the six members of the European Coal and Steel Community (ECSC) and the UK (as observer) met to discuss further economic and technological integration of Europe. Here, the first steps were taken towards

422 Van Berkel, *De stem van de wetenschap*, 275.

the creation of the EEC and Euratom.[423] The Germans reasoned that a pan-European University with four faculties (law, humanities, medicine and natural science) would complete these plans by establishing also a 'Community of Intelligence'. They expected two beneficial effects of the transnational university. On the one hand, it would function as 'model for innovation' that could break the scientific isolation, disciplinary specialisation and conservatism at national universities, particularly in Germany. Also, it could help overcome the perceived gap between European and North American science. The proposal was much to the surprise of the other member states. But it survived this meeting, as the French did not vehemently oppose, while the Netherlands supported the plan (as long as it would not cost much) and so did Italy, on condition that the university would be located in Florence.[424]

The European University ended up not, as intended, in the EEC treaty but in the Euratom treaty. In the ensuing policy elaboration of this meeting Belgian foreign minister Paul-Henri Spaak put time pressure on the drafting process.[425] Spaak assembled a small group of experts from various national ministries to work out the treaty and one French official rather ad hoc linked the university proposal to a different, French proposal for a research and training institute in nuclear science. This was specifically tied to Euratom and would have to support the 'technical requirements of an industrial sector'. A similar section had existed in the ECSC treaty, which made European support of research and training on the 'old' resources of coal and steel possible. The European University was taken up in article 9(2) of the Euratom Treaty of 1957, as the intention to set up 'an institute of university status'.[426]

Unintentionally, the European University idea thus became tied to the euphoria surrounding the economic potential of nuclear power.[427] A first elaborate plan (the Merdi Report) for the transnational institution made it instrumental to European integration and this new industrial revolution: nuclear physics and adjacent fields would be the main focus of its training programmes, whereas the humanities would be offered only as optional courses. Moreover, research would be oriented primarily to industrial applicability. In this way, the university contributed to the production of theoretical expertise and useful knowledge in the energy field, both of which benefited economic prosperity. It would also offer courses for political officials and diplomats. This first design for the university was quickly shelved, as direct control by the EEC Commission was opposed by the French.

In general, there was a lot of opposition to the plans that the Foreign Ministers had concocted at the EEC and Euratom meetings. Most importantly, criticism was aired by rectors and vice-chancellors of leading universities in Europe, which eventually had impact on the various national government

423 Jean-Marie Palayret, *A University for Europe: Prehistory of the European University Institute in Florence:(1948–1976)* (Italian Presidency of the European Union, 1996); A. Corbett, *Universities and the Europe of Knowledge: Ideas, Institutions and Policy Entrepreneurship in European Union Higher Education Policy, 1955–2005* (Palgrave Macmillan UK, 2005), 25–45.

424 Lars Lehmann, "The Controversy Surrounding the Idea of a European Supranational University," in *The Informal Construction of Europe*, ed. Lennaert van Heumen and Mechthild Roos (London: Routledge, 2019), 75–91.

425 Corbett, *Universities and the Europe of Knowledge*, 29–32.

426 Treaty Establishing the European Atomic Energy Community (EURATOM), 1957, Art. 9(2).

427 Lehmann, "The Controversy."

positions on this issue. First of all, many of these university representatives feared infringement of their autonomy and academic freedom when international organisations like the EEC and Euratom interfered in the organisation of universities. Many referred to the resolutions of the 1948 Congress of The Hague, where not only the beginnings of the Council of Europe and the EEC were established, but also the promise was made to create a 'federation of European universities' that guaranteed their 'freedom from state or political pressure'—an implicit reference to the situation of science under the Nazi regime. Second, various transnational initiatives in cultural cooperation had sprung from this resolution, like the European Cultural Foundations in Amsterdam and Bruges. The European University, and its economic and political appearance, was an unwelcome rival to these existing institutes.[428] Lastly, and perhaps most importantly, many universities, researchers and governments considered the European University a threat in terms of resources: it could attract the best students and teachers, and divert financial, infrastructural and personnel resources from member countries to a transnational institution.[429]

The academic resistance against international organisation of research and education paradoxically stimulated international cooperation amongst university representatives. This coalition was forged at the conferences of university rectors organised by the Western European Union (WEU). This transnational governmental body brought together France, the UK, the Netherlands, Belgium and Luxemburg since 1948, and Italy and West Germany since 1954. Although established primarily as defence alliance, it also aimed to promote cultural exchange. The WEU had to find its niche in the busy post-war European policy realm. To that end, it organised a conference for European university rectors and vice-chancellors in Cambridge in July 1955.[430] Some academics were at first suspicious of discussing university issues through an organisation oriented to military security, and many perceived such events as 'propaganda for European integration'.[431] In practice, it provided university representatives with a forum to cooperate that was supportive of their resistance towards governmental initiatives in science and education policy, like the European University. For example, the Westdeutsche Rektorenkonferenz (West German Rectors Conference, WRK), which passionately opposed these plans, used the transnational endorsement to strengthen their position in national debates. Most importantly, the German rectors could oppose European initiatives without coming across as nationalists, which was a particularly sensitive issue in war-torn West Germany.

The European Universities Committee of the WEU subsequently put political pressure on Euratom and its university plans. Their main point of criticism was the,

428 Corbett, *Universities and the Europe of Knowledge*, 36–37.

429 Corbett, *Universities and the Europe of Knowledge*, 42–43; Lehmann, "The Controversy."

430 Leech, *Report of the Conference of European University Rectors and Vice-Chancellors, Held in Cambridge, 20th–27th July, 1955*.

431 Lehmann, "The Controversy."

in their eyes, problematic institutional background for the European University: no representatives of universities, not even Ministers of Science and Education, had been involved. As alternative, they issued a plea to strengthen existing university infrastructure and to establish highly specialised joint European research centres. Above all, they defended the national and regional systems of higher education and universities. The Italian, Dutch and Belgian governments increasingly expressed these worries about the diversion of resources in international political discussions of the European University.[432] For example, the Dutch Minister of Science and Education, Cals, sided with the academic critics of the European university plans. The increasing activity of international organisations in the field of education and research had worried him, especially because the Minister of Foreign Affairs ended up discussing topics within his portfolio. In particular, he referred to the EEC and Euratom. By 1961 he also included the Organisation for European Economic Co-operation (OEEC) and the North Atlantic Treaty Organisation (NATO).[433] Instead, Cals preferred to use either the Cultural Committee of the Council of Europe or the European Universities committee of the WEU for the organisation of a transnational university.[434] This was also motivated by the Dutch argument that 'truly European' cooperation in higher education was necessary, meaning that the organisation should have a wider geographical scope, at least including the UK.[435] The intensive international attention for scientific research and education raised the concern that efforts would be duplicated if no coordination took place.

Apart from this practical concern, Cals identified a special task for the Ministers of Education, Culture and Science: to defend the *cultural unity* of arts, education and science.[436] This fitted his Catholic outlook on science and society. Wary of establishing science as a foundation for society, he hailed the 'harmonious development of man' as highest value to which technical and scientific sophistication were subservient. An economic focus on applications of science and technology to improve material well-being would 'disrupt' society.[437] To drum up transnational support for this mission, Cals organised an informal conference in The Hague for European Ministers of Education. The meeting in November 1959 concluded with a dinner at the Rijksmuseum, hosted by the Dutch government. The prime minister, psychotechnician Prof. J. E. De Quay, addressed the political representatives in French and welcomed them in a 'typical Dutch home that also could be called a typical European home', referring to the many works by European masters held at the national museum.[438] After this informal conference, the Council of Europe asked Cals to chair a new 'European Committee on Higher Education and Scientific Research', which resulted from the conferences for university rectors organised by WEU in 1955 and 1959.[439]

432 Corbett, *Universities and the Europe of Knowledge*, 42–43; Palayret, *A University for Europe*, 46.

433 Rijksbegroting 1961 (OKW), Memorie van Toelichting (explanatory memorandum), Parliamentary Papers 1960–1961, 6100 (VI–2), pp.21–27.

434 Palayret, *A University for Europe*, 63.

435 'Nederlandse regering niet voor volwaardige universiteit der Zes,' *Algemeen Handelsbolad*, 23 April 1960.

436 'Europese organisaties werken langs elkaar,' *De Volkskrant*, 30 September 1960.

437 Paul F. van der Steen, *Cals. Koopman in verwachtingen, 1914–1971* (Amsterdam: Balans, 2004), 215–16; 'Minister Cals: betekenis van wetenschap in moderne samenleving is veranderd,' *Algemeen Handelsblad*, 4 May 1957.

438 Ministers from Belgium, Germany, England, France, Italy and Luxemburg participated—so the members of the European Coal and Steel Community plus England. 'Mr. Cals op conferentie: "Betrek ministers van onderwijs bij samenwerking,"' *De Volkskrant*, 13 November 1959; 'Onderwijs in Europees verband,' *De Tijd – de Maasbode*, 13 November 1959.

439 Reinink was still involved as vice-chair. Rijksbegroting 1961 (OKW), Memorie van Toelichting (explanatory memorandum), Parliamentary Papers 1960–1961, 6100 (VI–2), p. 27.

These conferences and the committee united university and government representatives in an international forum, to discuss the organisation of research and education with a broader cultural and geographic scope.

In 1960, the European Committee on Higher Education and Scientific Research convened for the first time in Strasbourg, with the fifteen member-countries of the Council of Europe and Spain.[440] Later meetings would take place in Rome in 1962—which included an audience with the Pope—and in London in 1964. The aim was to discuss common problems in research and education, and ultimately to come to shared research policies in Europe. Above all, it was a political move in the European debate about who had the authority (and expertise) to organise scientific research. This was played out in terms of place. First of all, it mattered *where* university research and education were discussed. The different geographical scope of, for example, Euratom or the WEU intersected with different utility concepts. Second, questions of geographical location as well as centralisation and concentration of resources were essential to these debates. Third, the debate revolved around one concrete, but virtual utility spot, a European University that could stimulate exchange of expertise within Europe, innovate existing universities, produce an intellectual European elite or stimulate the European economy through new applications. The Council of Europe, and the WEU Rectors conference, challenged the economic and political concept of utility that the transnational university implied, and instead emphasized cultural cooperation between, and academic freedom of, existing national universities. In doing so, they claimed authority for university governors, ministers of education, and academic scientists. This triple spatial entanglement is what I would like to call the geopolitics of utility spots.

The European geopolitics of organised research involved Minister Cals in a debate that he had tried to avoid back home. As discussed in chapter 3, policymaker Woltjer had failed to receive his committed attention for a general national science policy. The debate on the European University, and Cals' aversion to Euratom and the EEC, did incite action from the side of the ministry. A small interim committee was formed, with representatives from the ministry and three university representatives.[441] In the same week as the meeting of education ministers in November 1959, Cals convened 'experts' from Dutch universities to discuss the European University proposals. At very short notice, seven professors and TH Delft trustee Holst met with OKW policy officials in Utrecht, a meeting that was chaired by secretary-general, and WEU figurehead, Reinink.[442]

A day before this meeting, the report on the organisation of natural sciences research by the Casimir committee, installed by Cals two years before, appeared. The committee

440 'Europees comité voor hoger onderwijs en onderzoek,' *Algemeen Handelsblad*, 13 June 1960.

441 Respectively secretary-general H. J. Reinink and dr. A. J. Piekaar (1910–1990), and Prof. J. P. Koksma (1904–1964; mathematics, Amsterdam), prof. mr. C. H. E. Polak (1909–1981; Law, Leiden) and A. H. M. Wijffels (1906–1971, trustee of TH Eindhoven).

442 NA, OKW-HOW, 2.14.58 inv. nr. 252, Report of the meeting on fields of study for a European institute of higher education, 14 November 1959. Present were prof. C. J. Gorter (Physics, Leiden), prof. E. W. Hofstee (Sociology, Wageningen), G. J. Holst (Physics, trustee of TH Delft), prof. B. V. A. Röling (1906–1985; Law, Groningen), prof. F. J. T Rutten (1899–1980, Psychology, Nijmegen), prof. H. Smitskamp (1907–1970; History, VU Amsterdam), Prof. H. Wagenvoort (Classics, Utrecht) and prof. M. W. Woerdeman (1892–1990; Anatomy, GU Amsterdam & KNAW).

stressed that many university institutes had a lack of space and they argued against decentralisation, or spread, of natural science research over the country. Instead, they claimed it would be best for the quality of natural science to centralise research activities and merge small institutes into larger ones.[443] Alarming headlines spoke of 'grave shortcomings', a warning against 'fragmentation' and the need of many millions of guilders for new laboratories.[444] Coincidentally, this news was reported on the same page in the newspaper as the informal ministers' conference. As geographical dispersion was already opposed nationally, one would not expect much enthusiasm for international organisation of research that put more stress on the limited personnel and material resources.

At the Utrecht meeting, much discussion stalled on the professors' feeling of being passed over by the Euratom initiative. Classics professor Wagenvoort, also president of ZWO at the time, fumed that the hasty establishment of a European university was the best way to thwart cultural integration. Still, an attempt was made to come to practical recommendations about desired fields of study that a potential European University should focus on. This depended on two desiderata: that they contributed to European integration and that they increased exchange and understanding between '*alpha*' and '*beta*' scientists, that is, humanities scholars and natural scientists. Apart from a suggestion by Prof. Rutten to conduct comparative cultural-psychological studies of the societal effects of European integration, few aired concrete suggestions in this direction. Still, the Dutch professors concluded that three general areas had to be brought to the attention of the European committee: studies of 'juridical, ethnological, psychological, social, political (administrative) and economical' problems of European integration; exact sciences without material needs; and experimental sciences whose material needs surpassed the budget of single countries.[445] The first and the last types of international scientific cooperation had practical and geopolitical goals.

But, after a lofty introduction by Reinink on the particularities of European politics, it was clear that the professors instead preferred to discuss an alternative organisational model for a European University. The first thing that polemologist Röling suggested was a 'European Princeton'. Eventually, the professors agreed that the Council of Europe should establish an international academic centre for post-graduate research, oriented to problems of European integration. Along the lines of the Princeton Institute for Advanced Study, Reinink wanted to have annual research themes. Everybody agreed (once again) with Holst when he backed the plan as long as it focused on research, not teaching. Only then, it would bring 'something new'.[446]

443 H. B. G. Casimir, ed., *Voorzieningen ten behoeve van de research binnen de faculteiten der wis- en natuurkunde der Nederlandse universiteiten* ('s-Gravenhage: Sdu, 1959); Baneke, "De vette jaren."

444 'Natuurwetenschappen aan universiteiten. Ernstige tekortkomingen in de ontwikkeling,' *De Tijd – de Maasbod*, 13 November 1959.

445 NA, OKW-HOW, 2.14.58, inv.nr. 252, Memorandum of the Dutch members of working group A with respect to the choice for fields of study c.a. for a European institute for higher education, November 1959.

446 NA, OKW-HOW, 2.14.58 inv. nr. 252, Report of the meeting on fields of study for a European institute of higher education, 14 November 1959.

The plan for a European Princeton in the Dutch polder was developed further by the Leiden Senate.[447] They imagined a network of large supranational, 'or European if one likes', institutes of advanced study, preferably proximate to existing universities. The research done at these institutes would focus on European problems, expensive projects and fields in which Europe was trailing—like fundamental research in chemistry and nuclear energy. University senates at Utrecht, Delft and Amsterdam endorsed the plan. The Utrecht senate stressed that 'like in Princeton' human and exact sciences ought to be treated equally, and the Amsterdam senate believed that the concentration of research would be stimulating to young researchers and 'of vital importance to Europe'.[448] Ultimately, attractive institutes of advanced study could also prevent a brain-drain of talented researchers to the US. The virtual European University thus led Dutch professors and policymakers to envision a transnational research institute where a heterogeneous pool of scientists and scholars from all over Europe could mix and mingle, with the ultimate aim of strengthening Europe's culture, science and economy. Although these characteristics also made it to a later European proposal, these plans still leaned mostly on higher education and required a complex governance structure. In Wagenvoort's reading it was a 'typical example of overorganisation', which would prevent sufficient autonomy of the university. Also the planned location in Florence, as claimed by the Italians, was unfortunate: it was difficult to recruit suitable chancellors for such an 'excentric location' (sic).[449]

By April 1960, there was quite suddenly a new plan on the table at Euratom. It resembled the Dutch ideal but had required an American intervention. Etienne Hirsch, former ESCS and current Euratom president, was chairing the international interim committee on the European University quite dispassionately. But this attitude changed after a visit to the Institute for Advanced Study at Princeton.[450] President Eisenhower had sent the official invitation and at Princeton Hirsch met with, amongst others, Robert Oppenheimer, who chaired the General Advisory Council of the Atomic Energy Commission. The Americans convinced Hirsch to let go of the link with nuclear science—the US always had an interest in controlling the production and circulation of this (geopolitically sensitive) knowledge—and to focus instead on 'the idea of an innovative university' at which future European Community leaders would train, work and live together on site.[451] The eventual European plan was indeed inspired by the Princeton Institute for Advanced Study, and focused on residential two-year postgraduate courses with 'particular relevance to European integration'. This campus-model European University would be a university with six departments (law, economics, social

447 NA, OKW-HOW, 2.14.58 inv.nr. 252, Senate to Board of Trustees, Leiden University, 12 January 1960.

448 NA, OKW-HOW, 2.14.58 inv. nr. 252, responses from Utrecht University senate and Municipal University of Amsterdam (GUA) senate to the Leiden plan, 1960.

449 NA, OKW-HOW, 2.14.58 inv.nr. 252, H. Wagenvoort to the interim-committee, 31 March 1960.

450 Corbett, *Universities and the Europe of Knowledge*, 43–44.

451 For the interests and strategies of the US and European countries in controlling nuclear sciences, see: Krige, *American Hegemony*; Van Dongen and Hoeneveld, *Cold War Science*.

and political science, history, mathematics, theoretical physics) that offered interdisciplinary programs and excluded experimental natural sciences that required material investments.[452] Although this virtual utility spot again raised hopes for a New Europe, it died in vain. International politics swamped the negotiations: in September 1960, French president Charles de Gaulle challenged all supranational collaborations in Europe, preferring intergovernmental actions that did not threaten national sovereignty.

4.4 An Atlantic University, 1959–1964

Simultaneous with the European University initiatives, the NATO Science Committee developed plans for a transnational institute on the European continent, an 'Atlantic University'. Not only the structure and usefulness of this virtual utility spot, but also the geopolitics would mirror the European University: again, a veto by De Gaulle put an end to the speculations, in 1964. The Atlantic University had been the boldest recommendation of a report, published in 1960, on the effectiveness of Western science.[453] Dutch physicist and Philips research director Casimir had introduced the idea in the international discussion group that drew up the report.[454] Casimir alluded to previous discussions about, and universities' resistance to, a transnational university, referring to the plans at Euratom, the EEC and the WEU. Louis Armand, the chairman of the NATO discussion group and former Euratom director, had never propagated the university idea very powerfully at Euratom. But he did repeat some of the arguments, for example that the Atlantic university would stimulate 'cultural and economic unity', but now in the Western world as a whole, by training a new professional elite with thorough understanding of Western culture.[455]

Besides international cohesion, Casimir claimed that an Atlantic university would 'challenge existing universities and shake them out of their complacency'.[456] The group of elite scientists considered this necessary, as they diagnosed that failing European science systems prevented their societies from increasing the (material) standards of living. American institutions served as examples of the 'tremendous influence' universities could have on the development of science, technology and the economy. According to Krige, this was mainly a reference to MIT and its economic impact on the Mile 128 area.[457] This American ideal became explicit in the subsequently founded high-level working group: its chair was Dr. James Killian, the president of MIT between 1948 and 1959, and the group of five (including Casimir and French official Pierre Piganiol) met for the first time at the centenary celebration of MIT in Cambridge.[458]

452 Palayret, *A University for Europe*; Krige, *American Hegemony*, 224–25.

453 *Increasing the Effectiveness of Western Science* (Brussels, Belgium: Fondation universitaire, 1960).

454 Krige, *American Hegemony*, 209–25. Other scientists involved were Isidor I. Rabi and Frederick Seitz (US), Sir John Cockcroft and Solly Zuckerman (UK), André Danjon (France), Paul Bourgeois and Jean Willems (Belgium).

455 Corbett, *Universities and the Europe of Knowledge*, 40.

456 Quoted in Krige, *American Hegemony*, 211.

457 Krige, 212. Confusingly, Krige also mentions Caltech and Silicon Valley, which are geographically distant, and the Palo Alto region was not yet know by that name in the 1960s.

458 Krige, 213. The other members were Cockcroft, Piero Caldirola (Milan), A. Rucker (Munich) and Pierre Piganiol, a French senior science policy official who reported directly to the prime minister.

The NATO initiative to establish an Atlantic University became widely known as the 'Killian plan'. Government officials were enthusiastic about the idea of a 'European MIT'. The working group envisioned the 'International Institute of Science and Technology' (IIST) to consist of five interdisciplinary faculties and, again imitating the Princeton example, a centre for advanced study.[459] They envisioned large-scale research facilities with close ties to society in ways that were already quite common in different countries: visiting professors from industry, opportunities for external consultancy, sponsored research and summer schools would all cement the relationships between science and industrial society. The IIST imitated an American model of graduate education and research. It had to be everything that the most prominent post-war US universities had become, shaped and supported as they were by the military-industrial complex. And the IIST in its virtual existence was everything the pillaged European universities were arguably not—even though most of the proposed interactions with industry already existed at European universities (see the previous chapter). The IIST had many similarities to the virtual 'European University' and created similar concerns. Universities opposed the plans for an 'Atlantic university' because it could become a dominant rival in terms of reputation and material resources. But others, like Casimir, supported it precisely for this reason. The IIST had to be a source of inspiration for existing universities in Europe—and underdeveloped regions more generally—to become more internationally oriented, interdisciplinarily organised, and societally relevant.

A familiar geographical issue stood central in the international debates about IIST, running from 1961 to 1963: centralisation or dispersion. While the Americans preferred one central, Anglophone campus near Paris, the French promoted the idea of building a decentralised network with existing centres, and the British proposed a compromise of central headquarters and dispersed faculties. The French were also sensitive to the issue of international knowledge transfer: the involvement of the US in the institute would give them access to European research, which they could exploit much faster than anyone in the Old World. Of course, divergent views existed also within national political-epistemic communities: amongst French scientists there was, for example, a faction who had spent time at American institutes and argued for a centralised institute with American involvement.[460] But, again, De Gaulle would not have it.

Correctly, Krige has argued that the specifics of the plan's failure are less interesting than the fact of its perceived potential. As far as the Dutch position on the IIST is concerned, he has referred to the energetic promotion and support for the idea by Casimir. Of course, Casimir was an extremely influential industrial-scientific statesman in the Netherlands,

459 The interdisciplinary faculties mentioned were applied mathematics and theoretical physics; technological processes and systems; materials research; earth sciences; and life sciences. Krige, 214–17.

460 Krige, 219–22.

but it would be too simple to reduce the Dutch standpoint to his views. The main scientific bodies in the Netherlands extensively discussed the IIST as well as the related report on the effectiveness of Western science. At the Ministry of OKW, the announcement of the Atlantic University in the report found little fertile ground, especially because they felt surpassed by NATO and the Dutch Ministry of Foreign Affairs, which both acted without consulting them.[461] OKW was especially frustrated that the Foreign Minister crossed their activities in 'cultural affairs' at several occasions. Piekaar installed biweekly meetings to coordinate international activities—preventing duplication of efforts between EEC, Euratom, NATO, OECD and the Council of Europe—and fight their departmental ground in The Hague. The feeling of neglect remained and even a personal visit by NATO science adviser Prof. William Nierenberg could not resolve this.[462] At ZWO the main issues with the IIST were its 'political' and 'pragmatic' nature; instead such transnational cooperation had to be based on scientific grounds only and pay due to the cultural 'civilisation' aspect of science.[463] Here, Julius defended the plan, speaking from his experience in the NATO Science committee. NATO had moved onto civil territory because the OEEC appeared in retreat and had aimed to keep politics out of the science committee. Also, Julius clarified, effectiveness was to be considered in terms only of scientific output, not of economic profit.

By 1964 it became clear that the IIST would never materialise. According to Krige the failure is to be ascribed to the relative blindness of the American initiators to local conditions at home and abroad. That is, they did not realise enough that the transfer of research and research organisation is not simply about theories, floor plans or methods, but especially about a set of social relations. The relations that characterised the military-industrial-academic complex in the US were of such a particular nature that they were not easily, or even potentially, reproduced elsewhere.[464] For example, European scientists opposing this American model of research organisation—closely tied to industry or to the military—often hailed the principle of academic freedom. But this principle meant different things on the two sides of the Atlantic. Where US institutions had advocated independence from federal intervention before 1940, the role of the federal government became more and more pervasive after the war. But in Europe, state funding of science was much more common, and the use of private funds traditionally more suspect. American and European researchers felt that they lived in different worlds after the war, so that they appreciated particular forms of spatial organisation and societal embedding differently. Thus, it is remarkable that the *institutes for advanced study* model, which hails an ideal of academic freedom, would travel from west to east.

461 NA, OKW-HOW, 2.14.58 inv.nr. 255, International Affairs, minutes of first meeting, 11 November 1960.

462 NA, OKW-HOW, 2.14.58 inv.nr. 255, International Affairs, minutes of eighth meeting, 14 April 1961.

463 NA, ZWO, 2.25.36 inv.nr. 8, Minutes of ZWO board meeting, 16 January 1961; NA, ZWO, 2.25.36 inv.nr. 210, Minutes of ZWO council meeting, 4 February 1961.

464 Krige, *American Hegemony*, 225–27.

4.5 A Dutch European University, 1960–1964

In between the geopolitical waves of European and Atlantic universities, Dutch plans for an institute for advanced study survived. The potential establishment of a 'European Institute for Higher Scientific Study' followed from these geopolitical developments: it was progeny of the European University plans at Euratom, EEC and the Council of Europe, and the likelihood of its existence depended on the status of alternative plans, like NATO's Atlantic University. Piekaar, for example, hoped to mobilise support for a European place of scholarly exchange in the Netherlands by claiming that that utility spot would be 'confronted' with the plans for the IIST.[465] Besides European politics, the Dutch debate about the virtual institute was shaped by American examples, even though the intention was aired multiple times not to 'imitate' them.

The idea for an internationally oriented advanced institute as organisational model was endorsed in 1961 by Minister Cals, after he had visited the Princeton Institute for Advanced Study.[466] 'Inspired' Cals briefed Dutch journalists, who awaited his return at Schiphol airport, about his embryonic plans for a 'superuniversity'.[467] Similar to Princeton, he imagined an international, but European, scientific centre where the most excellent scholars from different fields could devote themselves to their research and study without the worries of teaching and administration. Many Dutch scholars were convinced, he said, of the necessity of such an 'independent' institution, 'unconnected to industrial contracts'—a twist that distinguished this superuniversity from previous plans in Europe, and from existing practices and concerns in the Netherlands (c.f. the para-university institutes of the previous chapter). Earlier that year, the minister had convened a working group to investigate the establishment of a European Institute for Higher Scientific Study in the Netherlands. This group could continue the work of an existing coalition of academics and policymakers that had formed around the preceding European plans. So, even virtual utility spots had real organisational effects.

Before Cals imagined the superuniversity, Leiden scholars had outlined a research institute in response to both the European University debate and the Casimir report. One chemist (Egbert Havinga) and two law professors (Carel Polak and Ivo Samkalden) argued for a permanent research institute that would contribute to international contacts, intensive cooperation and interdisciplinary exchange.[468] Starting with forty researchers, they eventually wanted to form a real 'community' around a small permanent staff and a pool of visiting scholars. The European character of the spot was maintained through a connection with the Council of Europe, which would play a part in the selection of fellows. The envisioned institute housed scholars from both humanities and natural sciences

465 NA, OKW-HOW, 2.14.58 inv.nr. 656, A. J. Piekaar (OKW) to Board of the KNAW, 22 January 1962.

466 Van der Steen, *Cals. Koopman in verwachtingen, 1914–1971*, 262.

467 'Europees wetenschappelijk centrum in Nederland? Geleerden zouden er in alle rust moeten kunnen werken,' *De Tijd – Maasbode*, 6 November 1961.

468 Egbert Havinga (1909–1988; organic chemistry), Carel Polak (1909–1981; agricultural and administrative law) and Ivo Samkalden (1912–1995; international law, and member of the upper House of Parliament). NA, OKW-HOW, 2.14.58 inv. nr. 656, E. Havinga, C. H. F. Polak & I. Samkalden to Presidium of University Leiden, 25 October 1960.

and would also require modest facilities for experimental research. The latter was presented in relation to the lack of laboratory facilities, as identified by Casimir in 1958. Havinga claimed that Leiden deserved compensation in its research infrastructure, because it was the only academic town without an interuniversity institute. They assured the readers (mostly academics from other cities and national policymakers) that it was no 'local chauvinism' when they argued that the institute was best located somewhere in the 'triangle' Leiden, The Hague, Delft: this enabled scholars to profit from existing libraries and laboratories in the region. The ministry of OKW, in the person of Piekaar, and the KNAW, through Prof. B. A. van Groningen, stressed however that this had to be discussed as a 'national issue'—although its envisioned location seemed to remain Leiden.[469]

The intention to *avoid* an imitation of American examples was most prominent in the national working group that Piekaar convened in 1961, to follow up on Cals' enthusiasm.[470] Europe was scanned for rival institutes, with attention for their disciplinary and geographical focus: Nordita in Copenhagen focused only on theoretical physics and on Scandinavia, the European University Institute in Florence was politically up in the air, while the Italian initiative for an 'Instituto Internazionale Galileo Galilei' in Pisa closely mirrored the Princeton institute in its attention for theoretical physics and mathematics. The committee identified a need for a place of free study in a calm environment, where knowledge exchange between scholars was possible, but not mandatory: the retreat atmosphere was primary. Group size and building structure would have to respond to both needs: on the one hand to stimulate discussion, especially for natural scientists, and on the other hand to allow isolation, for humanities scholars. Ultimately, the aim was not 'scientific production', as the NATO plan envisioned, but an increase in 'spiritual value'. In the final 'Piekaar report' experimental facilities did not fit in this utility spot. But experimental scientists were welcome to come to reflect on the theoretical foundations of their field and visit laboratories in the vicinity.

Although an American copy was to be avoided, the committee did inform themselves extensively about the well-known institutes at Princeton and at Stanford, where the Center for Advanced Study in the Behavioral Sciences was located. Several booklets, budgets and floor plans were obtained through the post. Especially the Stanford institute aroused the interest of the Dutch committee. The published west coast experiences of Prof. A. D. de Groot were circulated in the group.[471] Amsterdam-based psychologist De Groot explained that the Ford Foundation had helped establish the centre in 1955 as a counterpart of Princeton. The choice for Northern California was motivated by the agreeable climate,

469 E. M. Uhlenbeck, "The Birth of NIAS," in *22 1/2 Years of NIAS*, ed. Wouter R. Hugenholtz (Wassenaar: NIAS, 1994), 15–24.

470 NA, OKW-HOW, 2.14.58 inv.nr. 656, Minutes of the first meeting, 25 February 1961. Members of the working group were A. J. Piekaar (OKW, chair), ir. J. J. M. Aangenendt (director-general of Government Building Department), prof. J. de Boer (1911–2010; Theoretical physics, GU Amsterdam), prof. O. Bottema (1901–1992; Mathematics, Delft), prof. B. A. van Groningen (1894–1987; Classics, Leiden), and, again, prof. C. H. F. Polak (Law, Leiden).

471 NA, OKW-HOW, 2.14.58 inv.nr. 656, A. D. de Groot, 'Een sabbatical year in Californië. Het Center for Advanced Study in the Behavorial Sciences,' reprint from *Folia Civitatis*, 10 December 1960.

the proximity of two prominent universities (Stanford and Berkeley) and an available plot of land on the hill behind the Stanford campus. In 'efficient and appealing low rises', fifty study cells were situated amidst Californian flower gardens—a description almost identical to that of the Stanford Industrial Park, which was established around the same time and place (see chapter 2, section 7). Perhaps partly in comparison to this embryonic science park, right across campus, the function of the Center for Advanced Study was a topic of debate: from exemplary and productive research institution at one end, to a place of peace for the overburdened professor on the other. In between was the option of a place of exchange, from which new ideas could develop. According to De Groot, the centre had become a hybrid of the last two options, where seminars and interactions were optional, but freedom and concentration were the basis. What De Groot appreciated most, however, was the lack of obligation to participate in anything, including social events: 'there was no rat race, no competition, no hierarchy-one-should-always-be-aware-of'.[472]

The Stanford centre therefore fulfilled an important need in the life of the modern professor. De Groot sketched a worrying picture of the 'overburdened' professor, whose teaching and admin duties, as well as editorships and recruitment, left little time for their original calling: research. Even though the professor's reputation depended on it, research was performed mostly during holidays and weekends. At Stanford, a break from this rat race was possible: a sabbatical year of freedom, isolation and interaction with colleagues. Still, this atmosphere of freedom had been difficult to realise in the first years of its existence, not because of external pressures, but because researchers did not know how to deal with this sudden 'obligationlessness'. A group dynamics emerged that put pressure on fellows to demonstrate the fruitfulness and the productivity of the place: show that it 'was worth all that money'. De Groot recalled the story that only the visiting psychoanalysis scholars really knew what to do: 'they welcomed the fellows who couldn't deal with the freedom (and its group pressure) on their sofa'.[473] Although isolation in the study cells was possible, cooperation and contact were clearly stimulated. 'Rightly so, with the current trend in science', commented De Groot.[474] In the centre there was great disciplinary diversity amongst the fellows, from psychology and economics to botany and philosophy. To facilitate interaction, the annual selection was based roughly on overarching themes and theoretically inclined generalists were more welcome than narrow specialists.

Another, and influential, advocate of the Stanford Center for Advanced Study was Bob Uhlenbeck, professor of Javanese language and culture in Leiden. He more or

472 Ibid.

473 Ibid.

474 Ibid.

less stumbled into Stanford and happened to be connected to several of the committees that discussed the plans for an international institute between 1961 and 1970. In the summer of 1961, Uhlenbeck visited a friendly colleague at the Stanford centre, which, in his own recollection, felt like entering 'a scholar's paradise'.[475] When, upon his return, he was appointed to the Wagenvoort committee on the (national) organisation of the humanities, he was able to revive interest for an Institute for Advanced Study in the Netherlands. It ended up as one of about twenty recommendations in the final report, published in 1965. By then, the virtual structure of the institute had changed significantly: it dropped its European signature and would open its doors no longer to all sciences, but primarily to the (Dutch) humanities and social sciences. This new plan was explicitly based on American institutes. The Stanford centre actually functioned as concrete spatial example for the first designs of the Dutch institute. In the ministry's search for a suitable country estate that would not necessitate the construction of additional buildings, the calculation of the required floorspace was based on the Stanford centre.[476]

According to Uhlenbeck, the difficult geopolitical stumbling block of comparisons with other international plans was removed by limiting its focus to the social sciences and humanities. The relation to the NATO plans had been the central criticism of the envisioned European Centre for Higher Scientific Study from the 'Piekaar Report', which was published in 1962. One vital characteristic of the European University survived: bringing together eminent European scholars from all disciplines. The epistemic aim was the study of the foundations of, and the relations between various disciplines. Even though the Dutch plan and the NATO plan differed on essential points—the first focused on academic freedom rather than industrial connections, and reserved a central place for the humanities and social sciences rather than natural sciences and technology—the KNAW still doubted whether there was sufficient 'international basis' for the institute.[477] In July 1964, this issue came up again, when Piekaar tried to push the institute onto the ministerial agenda. A former student sanatorium, which was located between Amsterdam and Utrecht, became available and had the right size and floor plan. Piekaar hoped to convince the government to use it for the advanced institute precisely *because* the stalled Killian plan at NATO provided a unique window of opportunity.[478] Although this first Dutch attempt to attach the ambition to an actual building failed, it would play out in a similar way in 1969, when a building was finally acquired for what later became known as the Netherlands Institute for Advanced Study in the Social Sciences and Humanities.

475 Uhlenbeck, "The Birth of NIAS," 18.

476 NA, OKW-HOW, 2.14.58 inv.nr. 656, R. C. Kwantes (OKW) to ir. J. J. M. Aangenendt, 16 May 1961.

477 Uhlenbeck, "The Birth of NIAS," 16–17.

478 NA, OKW-HOW, 2.14.58 inv.nr. 656, Piekaar to Minister Council, 10 July 1964.

4.6 The Geopolitics of European Utility Spots

Between 1955 and 1970, spatial proposals and concerns popped up whenever the organisation of scientific research, in both naturally and culturally focussed disciplines, was discussed in international fora like EURATOM, EEC, NATO, the Council of Europe and the OECD. Ideas circulated about the spatial distribution of scientific efforts: the intellectual benefits of concentration and centralisation were contrasted with the positive socio-economic effects of dispersion and decentralisation. Often, such ideas were translated into concrete proposals for new institutes outside existing university structures. These imagined places symbolised the desired relations between knowledge production, transfer, and societal use. As such, they were utopias, concrete nowheres.

What kind of utility these virtual spots entailed depended on the politics of the overarching international organisation that proposed them. Each stood for a different world view—both in terms of geographical scope and in terms of value concepts. The aspired value was often understood in economic terms, already in the 1950s, at organisations like EURATOM, EEC and later OECD. But EURATOM also valued contributions to European energy independence, while EEC hoped that a scientific centre would promote social and cultural integration of the new Europe. The Council of Europe, on the other hand, would always defend the principal cultural meaning of science. And NATO could never be detached from their principal concerns for (international) defence. In the discussions surrounding a European University, we have seen how these diverse views on the utility of science translated into different designs for hybrid spots of research and exchange.

In addition, these useful places of knowledge production had geopolitical meanings: EEC spots excluded the UK, OECD places represented an Atlantic form of science, while the Council of Europe included the UK but excluded the US. Ultimately at stake was who could cooperate with whom, what kind of knowledge could circulate through these spots, and from where to where. Especially for fields like nuclear physics, there was as much concern for the inhibition as for the promotion of circulation. Secrecy requirements were omnipresent in the Cold War period and always had a strong geopolitical component. Specific international spots, therefore, could function both as halfway houses and safety vaults, stimulating *and* interdicting knowledge transfer.[479] Or, as Krige notes in the introduction to *How Knowledge Moves*, the creation of a space for the transnational circulation of 'basic' knowledge legitimised 'tighter controls on socially useful products and processes'.[480]

Also after 1964, when the discussion of the European and Atlantic universities ended, transnational utility spots would continue to be proposed in international organisations.

479 Peter Galison, "Removing Knowledge," *Critical Inquiry* 31, no. 1 (2004): 243.

480 John Krige, "Introduction: Writing the Transnational History of Science and Technology," in: *How Knowledge Moves: Writing the Transnational History of Science and Technology* (Chicago: Chicago University Press, 2019): 1–31 (8).

For example, a 1965 OECD report on the organisation of fundamental research (known as the Maréchal report) recommended the establishment of 'centres of advanced study and research' to enhance the quality of European scholarship, mainly in the natural sciences. And in 1967, the Scientific Education and Research committee of the Council of Europe—the only international committee in which both governments and universities were represented—presented a comparable plan to create 'Centres for Confrontation and Research'. These would promote 'closer scientific cooperation between member countries' for the 'efficient use of scientific potential' of a 'European academic community'.[481] And, between 1967 and 1969, the OECD attempted to establish a 'European Institute of Technology', which would focus on research management. None of this ever materialised.

The reasons for the failure of the centres of advanced study and research at the OECD are instructive.[482] In 1966, ministers of science policy had agreed with the conclusion of the Maréchal report that each country needed a 'sound basis of fundamental research activity ... to innovate, to apply, to manage, and even to market ... and to select from the reservoir of world research'. The institutional recommendations were considered too timid, as they did not challenge the 'rigidities' of university structures or offer ways to orient fundamental research to, and use it for, socioeconomic objectives.[483] A special committee therefore had to elaborate alternatives, informed by an independent study by Prof. Joseph Ben-David.[484] Central to the committee's diagnosis was the claim that the cultural value of university research dominated both academic and government circles. Universities were not 'flexible' and 'entrepreneurial' enough: their focus on individual autonomy, traditional disciplines and cultural contributions prohibited attempts at geographical concentration, multidisciplinary research, and the efficient use of expensive equipment. The proposed remedy—the establishment of 'centres of excellence' within and between countries—caused a lot of resistance. As mentioned earlier, national governments always suspected that such transnational centres would put a strain on already scarce human and material resources. The epistemic argument that transnational concentration of a certain 'critical mass of brainpower' was required for really creative research could not trump the apparent national drainage of brains and money.[485] Even the watered down versions of these plans, which concerned the creation of European institutes by baptising existing high-quality institutes as European centres, were not warmly welcomed. Dutch scientists, for example, feared that such 'Europeanisation' could lead to unwanted 'institutionalisation of scientific fame'.[486]

In the draft memoranda on fundamental research, the OECD concluded that the establishment of new institutes was therefore not the most important or likely step in Europe.

481 NA, ZWO, 2.25.36 inv. nr. 406, O&W to ZWO & KNAW, 'Raad van Europa; Centres for Confrontation and Research', 2 February 1967.

482 OECD Archive, Committee for Science Policy (CSP) SP(67)20, 'Draft report on the promotion and organisation of fundamental research', 20 December 1967.

483 Benoît Godin, *Measurement and Statistics on Science and Technology: 1920 to the Present* (Routledge, 2004), 298–99.

484 Joseph Ben-David, *Fundamental Research and the Universities: Some Comments on International Differences* (Paris: OECD, 1968).

485 OECD Archive, CSP SP(67)20, 'Draft report on the promotion and organisation of fundamental research, first revision,' February 1968.

486 NA, ZWO, 2.25.36 inv. nr. 406, KNAW to Ministerie van Onderwijs en Wetenschappen (Ministry of Education and Sciences, O&W), 8 December 1965.

Instead of centres of excellence, an 'integrated European network of research activity' could stimulate exchange between elite institutions. In that way, existing academic institutions—the bearers and custodians of scientific fame and its usefulness—were least threatened. Still, transnational centres were envisioned on the periphery of the academic realm and university structures. Potentially, structural reforms could be attempted 'on a pilot basis … especially in the new universities'. And multidisciplinary centres could also be established, in particular to 'encourage scientific entrepreneurship in support of applied research of significance to industry and national development'.[487] When viewed from a spatial perspective, the international science policy debate transformed between 1955 and 1970 from relatively blunt proposals to establish copies of American institutes or rivals to existing institutions, into the attempt to establish small-scale niches: places of international, interdisciplinary and sectoral exchange that did not directly threaten existing structures. Ultimately, these niches aimed to provide an example for a new and transformed atmosphere, culture and environment of scientific research as a whole.

4.7 'Place and Function' of the Humanities

The Dutch academic elite took a very specific stance in these geopolitical discussions. On the one hand, they were indeed as inflexible as could be expected from the academic establishment. The proposal for Centres of Confrontation, by the Council of Europe, was fundamentally questioned: 'it is a misconception to think that expansion of scientific contacts is necessarily useful.'[488] On the other hand, the representatives of Dutch scientific bodies were keen to defend, in international meetings, the importance of the humanities and social sciences for a harmonious development of European societies. Already in preparatory committees for the first OECD ministerial meetings, Dutch policymakers raised issues with the limited 'Anglo-Saxon concept of science' and minister Cals disliked the economic focus of the meeting: 'Prostitution of science!', he apparently fumed over lunch against OECD Secretary-General Thorvild Kristensen, in an attempt to make him call off the meeting altogether.[489] Although British policymakers considered these concerns 'linguistic obscurities', Dutch policymakers believed their early stance on a broad conception of 'science' had led to two OECD reports on government policy in relation to fundamental research (Maréchal report, 1965) and the social sciences (Massart report, 1966).[490]

The discussion of both reports in the Dutch context demonstrates how also in the humanities and social sciences practical issues of organised research ultimately overlapped with spatial imaginaries of useful knowledge production. The 1965 proposal

487 OECD Archive, CSP SP(67)20, 'Draft report on the promotion and organisation of fundamental research,' 20 December 1967.

488 NA, ZWO, 2.25.36 inv.nr. 406, ZWO to KNAW, 29 March 1967; KNAW to O&W, 3 April 1967.

489 Brookman, *The Making of a Science Policy*, 332; Alexander King, "Scientific Concerns in an Economic Environment: Science in OEEC–OECD," *Technology in Society* 23, no. 3 (2001): 343.

490 NA, ZWO, 2.25.36 inv.nr. 406, Minutes from ZWO council meeting, 20 December 1965.

of Maréchal to establish 'centres of advanced study and research' ignited both concerns. The Ministry for Education and Science (O&W, the successor of OKW) asked the Dutch scientific bodies for comments on the report, which policy officer Joost Nittel summarised in a long list of proposals. The academy (KNAW), research council (ZWO) and the relatively new Academische Raad (academic council, representing the universities, AR) all agreed that the humanities and social sciences required more attention. They emphasized several possible functions of these fields of study: to reflect on the rapid development and effects of science and technology; to create new insight in the increasing 'interdependence' of all knowledge, both pure and applied. Policy was also inevitable because interuniversity organisation and 'planning' were already a reality for fundamental humanities research.[491] The 'weak tone' of the OECD proposal to include social sciences and humanities in the centres of advanced study at a later stage stood in stark contrast to their 'explicit' standpoint on the societal importance of these fields. 'This will not surprise anyone', continued ZWO director Bannier at a council meeting, because instead of the English or French 'science', the Dutch concept 'wetenschap' included them on principle.[492]

The Massart report on the organisation of the social sciences was also a reaction to the overemphasis on the natural sciences at the initial OECD meeting on science policy. Biochemist Lucien Massart of the Belgische Nationale Raad voor Wetenschapsbeleid (Belgian National Council for Science Policy, NRWB) chaired this committee. Already in 1963, he had observed that the humanities and social sciences lacked 'a true structural organisation ... [scholars] are too individualistic and refuse a priori to participate in well-organised teamwork'.[493] The final Massart report distinguished three levels of social scientific research: of a general character oriented at social change, of a specific character oriented to high-level policy problems, and of a practical character oriented to policy execution. It concluded that there was too much emphasis on the last, practical category of research, and too few possibilities to do fundamental research. A conclusion that the director and board chairman of ZWO, Bannier and theologian Bakhuizen van den Brink could easily agree with. But the practical usefulness of social sciences was not ignored:

> Also in the Netherlands, there is a need for the dissemination and application of social scientific knowledge ... which can be employed as instrument at the service of societal bodies that make decisions on the short and long term.[494]

No new institutes were suggested as a measure, but the stimulation of cooperation between researchers was deemed essential for the coordination and interdisciplinarity of research—both

491 NA, ZWO, 2.25.36 inv. nr. 406, Carolina MacGillavry (KNAW) to Ministry of OKW, 8 December 1965; Minutes from ZWO council meeting, 20 December 1965.

492 NA, ZWO, 2.25.36 inv. nr. 406, minutes from ZWO Council meeting, 20 December 1965.

493 E. Haas, "Geesteswetenschappelijk onderzoekbeleid," *Forum der Letteren*, 1975, 1–14. NA, OKW, 2.14.58 inv.nr. 38, Information document NRWB, 'De betekenis van de geesteswetenschappen' (The meaning of the humanities) by prof. L. Massart, 16 October 1963.

494 NA, ZWO, 2.25.36 inv. nr. 406, Meerum Terwogt to Bakhuizen van den Brink, 22 December 1966.

of which were considered conditions of possibility for utility to emerge. Although quite some 'interdisciplinary research plans' were submitted to the research funder, this was often followed by a 'not very integrated cooperation' in actual practice. Through intra- and interdisciplinary coordination this could be stimulated, also by identifying scientifically and societally important 'complexes' of research.[495]

The European ambitions for new spaces of exchange and niches for cultural changes, as well as the concerns for fundamental and humanities research, coincide in the history of the Netherlands Institute for Advanced Study (NIAS). This institute is tied both to the series of virtual utility spots in the Western European context and to the European debate about the organisation of research in the human and social sciences. Before I discuss the establishment and spatiality of the advanced institute, I expand on the discussions about the functioning, organisation and usefulness of the humanities and the social sciences in the Netherlands between 1960 and 1975.

The Wagenvoort Committee, 1960–1965

Many of these issues about the organisation and underappreciation of the humanities were already tabled in May 1960 by the KNAW and ZWO when they asked the Ministry of OKW to establish a committee on humanities research.[496] This deserved attention, they argued, after the organisation of natural, medical and agricultural scientific research had been discussed in respectively the Casimir, Querido and Koningsberger committees. They feared that the rapid growth of the natural sciences would overrun the humanities because this was typically the least 'organised' of research fields. From the request, the preliminary and final reports, and various responses, we can distil several aspects of the functioning, usefulness and organisation of Dutch humanities research, which were tied together in the establishment and legitimation of NIAS.

Around 1960, many Dutch scholars, politicians and policymakers claimed that the humanities were in crisis. The 'place in the organism of science and society' of traditional humanities disciplines, like philosophy, theology, history and linguistics, was no longer well-defined, claimed Minister Cals at the installation of the Wagenvoort committee in 1961.[497] Going further, he wondered whether the humanities were still 'in contact with actual life, which has become so dominated by natural science and technology'.[498] In this view, the humanities participated in a broader cultural debate that infected Western societies at least since the end of the 19th century: the identification of a 'cultural lag' between technological change and spiritual development by pessimistic thinkers like Ferdinand Brunetière, Ludwig Klages, and José Ortéga y Gasset. More recently, C. P. Snow had touched upon the same issue, although he explicitly sided with the natural scientists who he regarded as being more

495 NA, ZWO, 2.25.36 inv. nr. 406, Bakhuizen van den Brink (ZWO) to Minister of OKW, 'Rapport Massart', 23 January 1967.

496 NA, OKW-HOW, 2.14.58 inv.nr. 38, KNAW and ZWO to Ministry of OKW, 24 May 1960.

497 NA, OKW-HOW, 2.14.58 inv.nr. 38, Installation lecture by Cals, 6 July 1961.

498 Ibid.

in tune with the times.[499] In addition, there was the post-war rise of the social sciences, like psychology, economics and sociology, which threatened the academic position of traditional humanities. Wagenvoort qualified these developments, in his reply to Cals, as a momentous shift in the appreciation of the humanities and the natural sciences: where the former had been dominant at Dutch universities around 1900, by 1945 the natural sciences set the tone. In terms of funding, the humanities were well behind the natural sciences: both at international organisations, like UNESCO and OECD, and national ones, like ZWO, they had to make do with small percentages of the budget and attention.[500] The Netherlands was also about to fall behind internationally, because of decreasing student numbers and difficulties of finding new faculty in these fields. Undeniably, Wagenvoort argued, the underappreciation of humanities had effects on the 'spiritual habitus of the people'.[501]

Several prominent humanities scholars, replying to a first memorandum by Wagenvoort in 1962, questioned this state of crisis. Uhlenbeck, for example, stressed that internationally it did not exist. If things were otherwise in the Netherlands, this had probably to do with the limited time professors had available for research due to growing teaching duties: more and more the demand arose to organise education in smaller classes instead of mass lectures.[502] Historian Pieter Geyl warned against exaggerating the repression of the humanities, especially when considered in the Cold War context: only under totalitarian regimes was the freedom of research really restricted, and it would be 'ungrounded depression' to claim anything alike was the case in the Western world.[503] Geyl's remark can be read as a response to Wagenvoort who, in his opening address, cited Soviet leader Nikita Khrushchev as saying that the humanities were mere 'artistic recreation'.[504]

Policymaker Woltjer agreed with the criticisms and considered Wagenvoort's image of the humanities too 'defensive'. Instead, these scholars should claim their place in society 'with confidence'.[505] According to Woltjer, the humanities had an important, higher function: 'not utility, but raising consciousness about the higher values in life'. This understanding of the value of humanities research was widespread amongst policymakers and scholars. Also the representatives of the scholarly community that initially requested policy attention for the humanities had been motivated by the importance of 'harmonious development' of the humanities for healthy societal growth: to adjust to the rapid changes caused by science and technology, humanities research could strengthen spiritual, cultural and social values.[506] The policymakers at the Ministry deemed this, ultimately subservient, task vital: bringing 'modern man to self-consciousness' about the place of his technical powers 'in the scheme of higher values'.[507] Practical utility and rational reflection, material and spiritual well-being,

499 Baneke, *Synthetisch denken*, 119–42; Rupp, *Van oude en nieuwe universiteiten*, 193–98.

500 NA, OKW-HOW, 2.14.58 inv.nr. 657, L. Brummel (Royal Library) to E. Haas (OKW, secretary of the Wagenvoort committee), 5 March 1962.

501 NA, OKW-HOW, 2.14.58 inv.nr. 38, Installation lecture by Wagenvoort, 6 July 1961.

502 NA, OKW-HOW, 2.14.58 inv.nr. 657, E. M. Uhlenbeck to E. Haas, 13 March 1962.

503 NA, OKW-HOW, 2.14.58 inv.nr. 657, reply by P. C. A. Geyl, March 1962.

504 NA, OKW-HOW, 2.14.58 inv.nr. 38, Installation lecture by Wagenvoort, 6 July 1961.

505 NA, OKW-HOW, 2.14.58 inv.nr. 657, H. J. Woltjer to H. Wagenvoort, 9 March 1962.

506 NA, OKW-HOW, 2.14.58 inv.nr. 38, KNAW and ZWO to Ministry of OKW, 24 May 1960.

507 NA, OKW-HOW, 2.14.58 inv.nr. 38, Woltjer to Minister Cals, 26 July 1960. The same phrasing was used by Cals in his installation lecture in 1961.

were connected. This increased the urgency of stimulating the humanities, as exemplified by Cals in 1961: 'the power of the atom bomb was realised before the political effect of the invention was understood.' The responsibility of science had become so immense that it could not be answered by these scientists themselves. The humanities were required to determine the 'place of man' in this modern, 'pragmatic' world.[508]

With 'cultural transfer' [*cultuuroverdracht*] the humanities could help locate the place of humankind. Minister Cals introduced this term at the installation of the Wagenvoort committee and it probably was a product of policy officer Woltjer's pen. Whereas the natural sciences' practical meaning followed from knowledge transfer, from science to society, the humanities had to secure and sustain the transfer of cultural values from the past to the present. As 'guardians of culture', scholars in the humanities could adjust classic values to modern times. However, according to Woltjer, many scholars had failed this societal task because they were absorbed in disciplinary specialisation.[509] He considered two epistemological reforms as possible improvements to the useful cultural transfer of the humanities. First of all, overspecialised Dutch universities should adopt the 'spirit of Oxford', that is, emphasize 'broader development'. This would support more effective cultural transfer to new generations and help 'cultural forms' adapt easier to new (technological) developments. Second of all, the objects of study could be chosen closer to home. The 'displacement' towards study of present man and society, ignited by the rise of the social sciences, challenged the traditional focus on the past.[510] Ultimately, this had consequences for the perception of the usefulness of all human sciences: also historical humanities could be connected better to present issues.

In a way, Woltjer was stirring up the decades-old debate about the tension between societal value and specialisation, which existed in similar but context-specific forms elsewhere in Europe, like the 'two cultures' debate that Snow initiated around that time in the UK.[511] Also Dutch humanities scholars, classicists, philosophers, literary critics, observed a certain 'anti-science' [*anti-beta*] mentality amongst their colleagues. However, the subservient role of the humanities in relation to the societal consequences of the natural sciences was seldom openly challenged in the 1960s. Many of the prominent scholars gathered in the advisory committees even argued that a mentality opposed to the natural sciences was outdated. Uhlenbeck wrote for example about the 'great importance' of collaboration with natural scientists, however difficult that may be.[512] Linguist Stutterheim claimed that the disciplinary differences were even bigger *within* the diverse field of humanities research, at least when one took a broad conception as the Wagenvoort committee did: all research at law, literary, theological, economic, social and 'inter' faculties.[513]

508 NA, OKW-HOW, 2.14.58 inv. nr. 38, Installation lecture by Cals, 6 July 1961.

509 NA, OKW-HOW, 2.14.58 inv.nr. 657, Woltjer to Wagenvoort, 9 March 1962.

510 NA, ZWO, 2.25.36 inv.nr. 8, minutes of ZWO board meeting, 4 February 1961.

511 David Edgerton, "CP Snow as Anti-Historian of British Science: Revisiting the Technocratic Moment, 1959–1964," *History of Science* 43, no. 2 (2005): 187–208.

512 NA, OKW-HOW, 2.14.58 inv.nr. 657, Uhlenbeck to Haas, 13 March 1962

513 NA, OKW-HOW, 2.14.58 inv.nr. 657, C. F. P. Stutterheim to Committee Humanities, 7 March 1962.

Wagenvoort himself claimed that an all too strict distinction between the humanities as 'pure rational reflection' and natural sciences as 'experiment and deduction' had obstructed exploration of the 'boundary region' between the two.[514] Quite some scholars argued that a strict epistemic boundary between the two was disappearing. They observed that problems of the human and natural sciences coalesced more and more, so that they could 'fertilise' each other. ZWO and KNAW cited examples like phonetics, economics and archaeology where natural science methods were used to study typical humanities problems. One cultural anthropologist, Professor G. W. Locher from Leiden, even claimed that the ontological boundary between nature and culture had evaporated: instead, culture was a continuation of nature.[515]

Ultimately, what distinguished the study of nature from the study of culture in the 1960s was collaboration. Its ubiquity in the natural sciences explained its success, whereas the humanities' backwardness was rooted in its fundamental individualism. When cooperation was discussed as remedy for the sorry state of the humanities this was not just about cooperating *with,* but first of all, cooperating *like* the scientists from the natural scientific and medical faculties. The organisation of much scientific research in *teams* around *interdisciplinary* subjects was claimed to be the rationale for the practical success and strong public image of these fields. Cals went as far to say that not the material benefits produced by the natural sciences, but their 'homogeneous culture'—a clear method, shared experimental objectives and intensive cooperation—had strengthened their position in society. Opposed to that were the heterogeneous, fragmented humanities, where individual life principles (or in the Dutch context, the values of one's societal pillar) trumped shared methods or values. Different approaches enriched each other only in a complementary way. The fundamental individualism of many humanities disciplines was considered an 'organisational weakness' that was becoming untenable in modern times.[516] In Wagenvoort's first memorandum, from 1961:

> The scholar [*geleerde*] in his study is a vertebra in the backbone of our science. But at the same time, he is a lone wolf [*eenling*] ... who runs the risk of missing important objectives and problems.[517]

According to historian P. J. Bouman this 'problem blindness' contrasted with the 'pioneer mentality' of natural scientists to explore 'border areas'.[518]

The lack of collaboration and contact between scholars from different universities and different specialties was pinpointed as the central problem for the humanities. The need for and functioning of cooperation was different for the 'new' social sciences, both within and between disciplines.

514 NA, OKW-HOW, 2.14.58 inv.nr. 657, Woltjer to Wagenvoort, 9 March 1962.

515 NA, OKW-HOW, 2.14.58 inv.nr. 657, G. W. Locher to Haas, March 1962.

516 NA, OKW-HOW, 2.14.58 inv.nr. 38, Installation lecture by Cals, 6 July 1961.

517 NA, OKW-HOW, 2.14.58 inv.nr. 38, First memorandum of the Humanities Committee, 20 July 1961.

518 NA, OKW-HOW, 2.14.58 inv.nr. 657, P. J. Bouman to Humanities Committee, 5 March 1962; P .J. Bouman, 'In de ban der geschiedenis', reprint from *De Gids* 125, nr.1 (1962): 48–56.

Responses from economics faculties made clear that joint publications, research projects and teaching programmes were more common between law, economics and sociology scholars—even though this kind of social scientific research had not yet claimed its academic terrain.[519] Although some, like Uhlenbeck, reported similar cases of collaboration for the more 'traditional' humanities disciplines, the main demand was to balance effective organisation with the goal of maintaining the 'spiritual freedom' of the scholar.[520] Some disagreed strongly that planning and individualism could be reconciled: for this reason, Prof. Bernard van Groningen had tried to obstruct the request for the Wagenvoort committee at the KNAW.[521] The resistance against collaboration and organisation was a phenomenon that scholars involved in the organisation of academic research, like Uhlenbeck and Bakhuizen van den Brink, observed more generally: 'many professors are fearful of intruders on their terrain' and 'hide themselves'.

The Casimir report on the organisation of the natural sciences had paid much less attention to questions of the social functioning of research and focused instead almost entirely on manpower and material resources. But for the humanities there was obviously less need for instruments, expensive materials or new laboratories. According to Cals, the 'flowering of the spirit' was more important than such material conditions. The epistemic focus on cultural, rational and spiritual objects engrained a disdain of the material world, of practical organisation. When Wagenvoort turned to discuss the material shortcomings for the humanities he apologised that 'it might seem we descend to much lower levels'.[522]

Humanities Research Policy, 1975

By 1975, the disdain for material conditions of research could still be observed in discussions on the organisation of the humanities. And so were comparisons to the natural sciences. A special issue of *Forum der Letteren* discussed 'humanities research policy' [*geesteswetenschappelijk onderzoekbeleid*], a term barely used a decade before. Literary scholar A. Cohen, from Utrecht, quoted industrial-academic physicist Casimir: 'science policy is impossible but necessary.'[523] Several texts in the issue proved this statement also for the humanities—demonstrating that a decade after the Wagenvoort report not much had changed.

The necessity for humanities research policy followed from an observation of policymaker E. Haas in 1975 that the ills identified by Massart in 1965 still applied. Notwithstanding the recommendations of the Wagenvoort committee (of which Haas had been the secretary), an 'organisation structure' for comparison and evaluation of activities in the humanities still did not exist. Also interactions with the natural sciences were not yet at the desired level. The 'gap' between them had to be bridged,

519 NA, OKW-HOW, 2.14.58 inv.nr. 657, F. de Jong (RUG) to E. Haas, 5 March 1962. See also Rupp, 1997.

520 NA, OKW-HOW, 2.14.58 inv.nr. 38, Installation lecture by Cals, 6 July 1961.

521 NA, OKW-HOW, 2.14.58 inv.nr. 38, Woltjer to Minister Cals, 26 July 1960

522 NA, OKW-HOW, 2.14.58 inv.nr. 38, First memorandum of the Humanities Committee, 20 July 1961.

523 Antonie Cohen, "Poging tot concretisering van een wetenschapsbeleid binnen een Faculteit der letteren," *Forum der Letteren*, 1975, 121–33.

especially because the sciences (and society) needed the humanities in order to design more 'meaningful' planning and to employ technology for general use. To that end, Haas posited, the humanities should be more 'extravert, respond to dissatisfaction out there, make clear what one is doing'.[524] A. Cohen demonstrated the necessity and impossibility of policy at the level of his faculty of letters: a 'research climate' was painfully absent, but the faculty research committee was too poor and powerless to improve it.[525] Other reasons for the impossibility of organised research were enduring cultural tropes, amongst scholars, and in society. Samuel Dresden, professor at Leiden and chairman of the literary studies division of the KNAW, observed that many scholars would not accept being called 'scientist' or 'worker', or consider the possibility that their activities could be ordered and organised. Spirit [*geest*] trumped matter, and organisation plunged it into dogma, normalisation and academism. The spatial imagination of 'monastic cells and study rooms' therefore still, often in repressed state, informed the epistemic ideal of most humanities scholars.[526]

Dresden, however, claimed that organisation of the humanities was not just possible, albeit in idiosyncratic ways, but also indispensable: even 'loneliness presumes and demands a form of presence of others'.[527] He envisioned national documentation and coordination of humanities research, to prevent duplication of effort (even though this risk might be low for the humanities), institutional (i.e. regional) specialisation in specific (sub-) fields and inter-institutional contact to coordinate and stimulate research. Together, this call for regional specialisation would not restrict freedom of researchers, but rather enlarge it: experts would spend less time on teaching general subjects and other experts would be close by. Uhlenbeck argued in favour of teamwork as well. He did not accept the argument that individuality followed from the nature of the research object, but rather thought scholars were unaware of the potential benefits of collaboration. In order to realise this potential, he issued a plea for the concentration of humanities research in locations where 'the organisation structures are available for high quality and efficiency'.[528] If the universities did not correspond to this new spatial image, some interuniversity institutes would.

In the context of Dutch university research in the 1960s and 1970s a variety of arguments in favour of the utility of the human sciences was aired. Most of these arguments related implicitly or explicitly to the organisational structure of the natural sciences. The rapidly emerging social sciences held an interesting hybrid position within this discourse, as they were seen to mimic both the collective nature of the natural sciences and the value-ladenness of the humanities. But in terms of utility, the social sciences strongly resembled the humanities, and this was not limited to the Dutch situation. This becomes clear from Thomas Gieryn's study of the US context, in

524 Haas, "Geesteswetenschappelijk onderzoekbeleid."

525 Cohen, "Poging tot concretisering van een wetenschapsbeleid binnen een Faculteit der letteren."

526 Samuel Dresden, "Organisatie van de Geest," *Forum Der Letteren*, 1975, 28–41.

527 Ibid.

528 Uhlenbeck referred to a 1972 RAWB advice. E. M. Uhlenbeck, "Wetenschapsbeleid en geesteswetenschappelijk onderzoek," *Forum der Letteren*, 1975, 15–27.

which the case for public funding of the social sciences, at the National Science Foundation, was made by way of 'complementary utility'[529] This argument changed shape between the 1950s and 1960s. First, social sciences were required 'to keep peace' and 'realise fruits' in relation to newly acquired technological powers or scientific results. From the 1960s onwards, however, the NSF would support both natural and social sciences because all societal problems existed in border areas between them. Interdisciplinarity, rather than reflection, was now the keyword. The utility of the social sciences, and the humanities, was consistently defined not on its own, but in relation to the dominant natural sciences; however, the epistemic relation between the two domains could change shape depending on context.[530] At one epistemic extreme, the human sciences reflected on the established facts of the natural sciences; at the other extreme, they co-produced new hybrid knowledge in response to the complexity of societal issues.

4.8 Places with a Function for Humanities & Social Sciences, 1970–1992

The Wagenvoort report had identified four structural shortcomings in the organisation of the humanities and the social sciences, mainly in contrast to the existing organisation of the natural sciences: lack of interuniversity contact, lack of interdisciplinary collaboration, lack of international outlook and lack of relevance for societal problems. Two concrete spots addressed all these ills. One was established in the 1950s, the Institute for Social Studies (ISS), and the other traced its history to that decade but was established only by 1970, the Netherlands Institute for Advanced Study in the Social Sciences and Humanities (NIAS). Where ISS was the outcome of decolonisation and mirrored colonial organisation of research, NIAS was the indirect consequence of European integration and mirrored American examples of organised research. Both were explicitly meant to be meeting places, function as spaces for cooperation, and create societally relevant research in the humanities and social sciences.

As said, the origins of the ISS are tied to the practical context of colonial administration. Until 1950, there existed in the Netherlands two places to study 'Indology', that is, the study of the culture, law, language and natural environment of the Dutch Indies. Graduates were trained to take up positions in the Dutch colonial administration. After Indonesia fought to independence and ended Dutch colonial rule in 1949, so ended the direct utility of these Indology studies. The two departments for Indology, in Leiden and Utrecht, joined hands in the creation in 1954 of one new interuniversity institute, the ISS, based in The Hague, where the development and public

529 Thomas F. Gieryn, *Cultural Boundaries of Science: Credibility on the Line* (Chicago: University of Chicago Press, 1999), 75–87.

530 Ibid.

administration of countries in the 'third world' would be studied with a social scientific and technical approach. Only from 1958 onwards was it also a research institute, following the recommendations of a group of international experts (from France, the US and UNESCO). The first ISS research project was a multidisciplinary study of the social and economic development of the Mediterranean area. As a whole, ISS did not only copy colonial Dutch approaches, but also relied heavily on British examples, from LSE and Cambridge.[531] In the 1960s discussions about the organisation of the humanities, Prof. H. Dooyeweerd (Law, VU Amsterdam) pointed to the interdisciplinary development research at ISS in The Hague as example of collaboration.[532] He especially praised the fact that ISS had 'brought into practice' an interdisciplinary approach to socio-economic problems of development, organised by cooperative teams of social scientists from public administration, urban planning, economy, sociology, sociography and religious studies.

The place and function of ISS in Dutch post-war society are clearly aimed at usefulness, albeit for decolonising, low-income countries. But also an institute as arcane and apparently isolated as NIAS was, I argue, a utility spot—a place where the function of the humanities (and the social sciences) was up for discussion, because it strove to stimulate new relations and interactions beyond the existing academic culture. In the case of the humanities, that meant the creation of contact between scholars from different universities, specialisations and countries. Ultimately such places had to orient these scholars and open their fields to societal problems. Compared to the ISS, the organisation of research at NIAS was less explicit, but its goals were alike. Both spots had to stimulate interactions, coordination and interdisciplinarity in the humanities by bringing scholars from different specialties physically together.

One person knew both types of organised research very well: indologist Bob Uhlenbeck. According to him, neither ISS nor NIAS was an attempt to mirror external developments like the success of the collaborative natural sciences. Rather, they were responses to an internal shift. Previously, humanities and social sciences had been 'geographically organised'—like Indology, for example—but now fields were increasingly specialising along disciplinary lines: historians mainly published for other historians, and the same applied to linguists, sociologists and economists.[533] In this way, humanities scholars perhaps interacted less with scholars at their own universities who shared an empirical focus on a certain area, but at the same time became more involved with theory development and the conceptual and methodological relations to other disciplines. This actually enabled cooperation in larger wholes among diverse specialists, instead of the quaint image of the humanities as obsessed with collecting cultural

531 Rupp, *Van oude en nieuwe universiteiten*, 268–80.

532 NA, OKW-HOW, 2.14.58 inv.nr. 657, H. Dooyeweerd to E. Haas, 6 March 1962.

533 Uhlenbeck, "Wetenschapsbeleid en geesteswetenschappelijk onderzoek," 20.

historical '*wetenswaardigheden*' (bits of information). ISS also significantly broadened its geographical focus: whereas the previous Indology departments related directly to the (colonial) problems of government in the Dutch Indies, the refurbished ISS generalised its orientation to all developing countries—the, in many cases recently decolonised, Global South. Based on the same belief that specialisation in the humanities could stimulate cooperation, NIAS focused on interdisciplinary exchange in general.

The Wagenvoort report contained a recommendation to establish NIAS, but funding for the acquisition of a building proved an insurmountable obstacle. The government did not warmly welcome any recommendation with financial consequences and Education and Sciences minister Diepenhorst even emphasized that he did not support the plan for an institute for advanced study.[534] The political-epistemic alliance for humanities research in the 1960s was clearly weaker than, or at least different from, that of the natural and technical sciences in the 1950s, discussed above. Where 'finance was not the bottleneck' for Woltjer, and Casimir (arguably successfully) demanded new buildings, the humanities' appeal to cultural transfer of values did not suffice in 1965.

This manifested itself again when the advocates of the Stanford centre appealed to national industries to foot the bill. In 1960, psychologist De Groot ended his report with the rhetorical question whether there were 'Philips, BPM, AKU, Verolme, DAG, KSG or EEC funds available for an analogous initiative'.[535] Linguist Uhlenbeck actually tried to raise funds from large multinationals in the Netherlands in the late 1960s. After another, longer, stay at Stanford in 1965–1966 he revived the idea of the institute in the local 'Gespreksgroep Toekomst Universiteit' (Discussion Group Future University) that had been meeting since 1964 at Leiden University. His enthusiasm plus the contingency of a large villa for sale in wealthy and quiet Wassenaar, proved to be the conditions of possibility for the establishment of an institute for advanced study. Uhlenbeck and chemistry professor Egbert Havinga, who lived around the corner from the villa, shared their 'discovery' with Piekaar. Although the policymaker was still in favour, he could not promise state support and advised the two to turn to industry. Subsequently, Uhlenbeck used his personal network to reach Dutch industry leaders. However, he was met with 'unexpected' refusals from the large multinational companies, like Unilever, Philips and DSM.[536] Where Cals had once stressed the absence of ties to industry as the potential selling-point of the Dutch advanced institute, by the late 1960s scholars and policymakers hoped that industry would do for the humanities what it had done for the natural sciences: invest in research without expecting direct benefits. The fact that they tried shows that they truly believed that the cultural and economic value of

534 NA, OKW-HOW, 2.14.58 inv.nr. 38, Meeting of the Cabinet, 7 May 1965.

535 NA, OKW-HOW, 2.14.58 inv.nr. 656, A. D. de Groot, 'Een sabbatical year in Californië. Het Center for Advanced Study in the Behavorial Sciences,' reprint from *Folia Civitatis*, 10 December 1960.

536 Uhlenbeck, "The Birth of NIAS," 19–20.

different *wetenschappen* were connected; the fact that they failed, suggests that industry did not share this belief.

Finally, it was the high-ranking public official Piekaar, representing the Ministry of O&W, who did see the value of an organised institute for humanities and social sciences, and removed the financial obstacles towards purchase of the villa in November 1969. One condition set by the Ministry was that it had to be an 'interuniversity' institute. First, Uhlenbeck tried to organise this regionally, as had been the original plan for the 'Dutch European University' (see section 4.3). But the regional academic partners—the polytechnic and economics colleges in Delft and Rotterdam—showed no real interest. Instead, the agricultural university of Wageningen, in the person of sociologist E. W. Hofstee, became the first partner to join. Later that year, the universities of Utrecht, Tilburg, Nijmegen and Amsterdam (VU) as well as the young polytechnics of Twente and Eindhoven and the Rotterdam medical faculty joined the discussions.[537] As *interuniversity* institute, NIAS would function as supplement to, rather than replacement of, academic structures: it would become a place of temporary respite, for overburdened scholars on a sabbatical leave, who would return to the institutes of higher education afterwards.

It was only in early 1971 that Leiden University officially acquired the building, even though NIAS planned to open its door to the first fellows by September that same year. The villa was located in the Rijksdorp neighbourhood of Wassenaar, closer to the sea, beach and dunes than to the city centres of The Hague and Leiden, which nonetheless one could easily reach by bicycle. The newly appointed NIAS deputy director, jurist J. E. Glastra van Loon-Boon, oversaw the building process. In 1992, she recollected that 'our model was Palo Alto', the Stanford centre, 'the place where Prof. Uhlenbeck had been, the place he was still raving about!'[538] This strong relation to the American west coast was further reinforced when, in that first chaotic year, a representative of the Stanford Center happened to pass by Leiden, where she shared 'a lot of useful information' at the temporary NIAS office.[539] Glastra van Loon-Boon made sure to add a large 'common room' in the renovation plan—a meeting place for the fellows—and to furnish their separate studies with 'an individual touch in a variety of colours and materials, so that every fellow could choose a study where they would feel comfortable'. A visit to the newly constructed, modernist skyscrapers of the economics college in Rotterdam had convinced her to avoid 'rooms in a similar office style of grey metal'. Instead of a modernist atmosphere, she opted for a more traditional academic setting with antique furnishings. As example, she took the Salzburg Seminar for American Studies: a rococo palace in Salzburg, Austria, which functioned as Atlantic place of cultural exchange—'an intellectual Marshall Plan'.[540]

537 Ibid.

538 J. E. Glastra van Loon-Boon, "NIAS in Retrospect," in *22 1/2 Years of NIAS*, ed. Wouter R. Hugenholtz (Wassenaar: NIAS, 1994), 25–29.

539 P. van Breda-Burgueño, "The Take Off," in *22 1/2 Years of NIAS*, ed. Wouter R. Hugenholtz (Wassenaar: NIAS, 1994), 42–43.

540 Glastra van Loon-Boon, "NIAS in Retrospect"; Thomas H. Eliot and Lois J. Eliot, *The Salzburg Seminar: The First Forty Years* (Ipswich Press, 1987).

What kind of place did NIAS become? Its first director, economist Henk Misset (1922–2015), described it in 1975 as a place that countered the ills of specialisation and fragmentation by stimulating interdisciplinary interactions and a societal orientation in humanities research.[541] Misset explicitly addressed the function of NIAS in relation to the wrongs of the current university structure—from administrative and teaching duties to rigid organisation in faculties—that obstructed interdisciplinarity, and thus the solution of societal problems. Interdisciplinarity and societal relevance were almost synonymous in the 1960s and 1970s; fragmentation and disciplinary specialisation, on the other hand, obstructed utility to materialise. Paradoxically, the lack of interdisciplinary research in the humanities rooted in disciplinary immaturity, or the absence of collaborative research altogether. The isolation and inefficient fragmentation of the humanities was characteristic, he argued, for a 'small country with limited scientific potential': the few specialists that existed in each field were spread out over the Netherlands. This made it difficult for them to specialise collectively into 'paradigms in the Kuhnian sense', as the natural sciences had done.[542] Where such paradigms promote collaboration and the circulation of both knowledge and values within a disciplinary community, the fragmented humanities lacked such an interactive scientific environment, which isolated individual scholars. To break this isolation, contact between specialists from any one field, from different humanities and between all disciplines had to be increased. This would also create a nurturing milieu for contributions to the solution of societal problems.

As much as Misset presented NIAS as a progressive place, it was also a materialisation of the previous decade, in which elite scholars could informally convince a high-ranking policy official to push through a new place for disinterested, elite humanities research. According to one employee, the misfit between this image and the democratic 1970s made its low public profile more a trait than a problem—even to the point that 'secrecy enshrouded NIAS's existence' in the Dutch academic world.[543] Ideally, though, NIAS functioned as model for the organisation of all humanities and social sciences research in the Netherlands (and beyond). Scholarly freedom was the main organisational principle, but contact, cooperation and exchange were actively stimulated according to Misset: 'numerous have been the informal meetings between research fellows … colloquia and conferences, also with external participants.' In the first years, thirty to forty scholars were invited, of whom a maximum of fifteen came from abroad. 'For the … local colouring' of the humanities and social sciences, the 'presence of these foreigners is of great importance.'[544] In the first 25 years this international orientation was primarily Atlantic: of the foreign fellows, a third came from Western European

541 Henk Misset, "N.I.A.S. te midden van universiteiten en hogescholen," *Forum der Letteren*, 1975, 68–69.

542 Misset, 66–67.

543 J. J. M. Hooghuis, "Paradise in Perpetual Motion," in *22 1/2 Years of NIAS*, ed. Wouter R. Hugenholtz (Wassenaar: NIAS, 1994) 48.

544 Misset, "N.I.A.S. te midden van universiteiten en hogescholen," 69.

universities, and another forty percent from North American institutions. Interestingly, it were informal spaces—such as the attic for late night drinks and the sports grounds—rather than formal meeting rooms that fellows considered central to their stay. The fellows, as well as their families and the NIAS staff, warmly remembered the cultural exchange between scholars of different nationalities: informal intellectual battle afterhours was complemented with folk dance, potluck meals, music, Dutch Sinterklaas celebrations, Christmas dinners and volleyball games.[545]

Apart from international exchange, scholars from various Dutch academic institutes could also strengthen relations via NIAS. More than half of the fellows was Dutch, and ninety percent worked at a university. In addition, there were fellows who taught at high schools or worked in industry and government. So not only was it an interuniversity meeting place for like-minded specialists, NIAS also functioned as international and inter disciplinary space of exchange. Occasionally, it also facilitated ties between academic and extra-academic research—in industry, government or museums. Perhaps in planning more than in actual action, NIAS was a place of cultural exchange.

4.9 Conclusion: Advanced Institutes as Industrial Laboratories

Jan Rupp has interpreted the establishment of NIAS as representative of two shifts. One occurred in science policy, from a concern with the economic value of science to a concern with the societal effects of economic growth and technological progress, characterised by the 1971 OECD Brooks report. The other is the transition from two to three academic cultures—the social sciences acquired a place in between the humanities and the natural sciences.[546] The concurrence of NIAS's establishment with these larger developments does not really pay due to the historical and geopolitical contingencies of its origins. Instead, I have situated NIAS as one of many attempts and proposals for European and Atlantic utility spots in the 1950s and 1960s. Ultimately, spatial imagination alone did not suffice: the availability of a concrete building made all the difference. Its eventual design, mirroring but not imitating American examples, was as much an outcome of contingent events as the materialisation of an epistemic ideal of useful organised research: individualistic but cooperative scholars reflecting on technological change in modern society.

Whether this organisational model automatically reoriented the societal orientation and academic outlook of humanities scholars is difficult to ascertain. According to Misset, it did. Many fellows later reported to him that their stay at NIAS had

545 See Wouter R. Hugenholtz, ed., *22 1/2 Years of NIAS* (Wassenaar: NIAS, 1994).

546 Rupp, *Van oude en nieuwe universiteiten*, 173–200.

helped them to explore adjacent fields and that it broadened their perspective to inter- and multidisciplinary research. Misset also supported this claim by citing sociological studies of scientific work in an industrial technical-scientific laboratory. In 1966, American sociologists D. C. Pelz and F. M. Andrews had distinguished, in *Scientists in Organizations*, five elements of a stimulating organisation for research: dedication, trust, limited coordination, lively contact with a wide variety of colleagues, and a rich diversity of research methods. 'Is an extrapolation of these results to an institute for social sciences and humanities warranted?' Not entirely, concluded Misset. Future research might conclude that a humanities scholar might reach the best and most effective results in a long period of isolation. But, he continued, 'as long as such results are not in yet, it is reasonable to assume that the factors that positively influence the effectivity of scientific workers in organisations of the laboratory type also have a positive effect on researchers in the social sciences.'[547] NIAS ticked all the same boxes as the industrial laboratory for commercially useful research.

Of course, NIAS never functioned as one. But the fact that Misset compared the institute for elite individual humanities research with an archetypical ideal of useful research shows that we can understand it as a utility spot. Its history is tied to several European and Atlantic imaginations of useful knowledge production, but aspects related to the promise of nuclear power, European integration, economic impact, graduate education, and interactions between natural and human sciences gradually disappeared from the Dutch plans. NIAS ultimately found a niche in the buzzing realm of international policy and science in the 1960s as a not explicitly European or Atlantic institute for advanced research in the humanities and social sciences. As an interuniversity and international meeting place it was as much a reflection of its times as a model for, and legitimation of, social science and humanities research in the Netherlands. In that sense, NIAS was situated between individual university policies, national science policy and international developments in the organisation of research.

In the 1980s, this became painfully visible when severe budget cuts at the Ministry of Education and Science threatened NIAS's existence: universities started negotiations by proposing to abolish interuniversity institutes. Ultimately, the institute was 'saved' by 'a former fellow in a very high position in the national bureaucracy'—just like it could thank its initial existence to a high-ranking policy officer.[548] One response to this dire situation was a change in the organisational structure; since 1988, multidisciplinary 'nuclei' gather a variety of specialists from different fields around scientifically and societally relevant themes, from 'Approaching Eastern Europe' (in 1988) to 'Urban Change and Urban Policy' (1992). According to one staff member, this changed the 'atmosphere'

547 Misset, "N.I.A.S. te midden van universiteiten en hogescholen," 71–72.

548 Most probably this concerns Roel in 't Veld, NIAS fellow in the academic year '76–'77, and director-general of the Ministry of O&W from 1982 to 1988. H. F. Cohen, "NIAS at Risk," in *22 1/2 Years of NIAS*, ed. Wouter R. Hugenholtz (Wassenaar: NIAS, 1994), 49–52.

at NIAS, but not in the way intended. Where before a great thirst existed for social interaction because most work was conducted individually, now the high degree of intensive teamwork reduced the need for informal afterhours gatherings that actually had provided 'the framework for scholarly exchange'.[549] Perhaps this is a good example of 'over-organisation', for which Wagenaar had warned repeatedly thirty years before.

As NIAS moved closer to the example of the industrial research laboratory, to which it had been once compared, its culture changed. But the type of geopolitical considerations that lay at the root of its history still played a role by 1992. Demographer D. J. van de Kaa, NIAS director at that moment, situated the institute again explicitly in a European political realm. It would have to relate to demographic changes, increased competition from developing countries and a 'New Europe' without an Iron Curtain. The advanced institute would have to find a response to the emphasis on 'knowledge infrastructures' and the growing wish 'to "capture" the results of research for economic purposes'.[550] Or, what in EC circles was called *valorisation*.

From the study of European universities and advanced institutes we can draw the following lessons. First of all, virtual utility spots are *productive*: they gather political, industrial and scientific actors together around a plan, a possible place. The spatial imagination of relations between scientific research, education and society can have political traction even when it never materialises. Second, spatial models travel, as stories but also quite literally as floor plans, and always have to adapt to local interests and possibilities; in that way, these models can lose or acquire significant explicit and implicit architectural and symbolical aspects that structure scientific activity in the process. Lastly, the utility of research in humanities and social sciences too can be interpreted in spatial terms and concrete spots, even though they openly claim disinterestedness and a concern for higher values. A mismatch then appears to exist between the concept of complementary utility and the eventual, relatively remote, housing of NIAS in the Wassenaar villa. This prompts the question what would happen if reflection on modern, technological society takes place not remote from, but in the direct proximity of the places that produce this future—such as science parks. In that respect, the move of NIAS to Amsterdam city centre, in 2016, is of interest. From the 'pastoral', and elite, environment of the Wassenaar dunes NIAS relocated to the buzzing city centre of Amsterdam, neighbouring a humanities faculty, colonial heritage and the red light district. The science park at the fringe of the city is still a substantial bicycle trip away. It deserves further study how this new proximity relations altered the nature of NIAS as utility spot for the humanities and the social sciences.

549 Hooghuis, "Paradise in Perpetual Motion."

550 D. J. van de Kaa, "NIAS and the Passage of Time," in *22 1/2 Years of NIAS*, ed. Wouter R. Hugenholtz (Wassenaar: NIAS, 1994), 11–14.

In the following chapter, I will reconstruct the circulation of the spatial model of the science park in the Netherlands. This will lead to a sketch of the spatial origins and connotations of valorisation in the European policy realm. The structural aspects of the utility spot concept developed in chapters 2, 3 and 4 will all come to the fore in the last historical reconstruction of the 1970s and 1980s.

5. The Spatial Politics of Knowledge Transfer.

From Science Shop to Science Park, 1970–1985

5.1 Introduction

Actual and virtual utility spots structure science policy debates and circulate, never unmodified, between different geographical contexts. Utility spots in the post-war world express both existing tensions and desired relations between science and society. In the 1950s and 1960s, a small scientific and policy elite in Europe and the Netherlands debated the design and organisation of such hybrid places of exchange; sometimes to safeguard existing privileges, other times to make room for aberrant or new interactions between academic and extra-academic actors. This historical development of the spatiality of useful research in Europe, and more particularly in the Netherlands, reaches its conclusion at the science park. In this last historical reconstruction of Dutch utility spots, I focus on the (ambiguous) continuities and changes between the 'progressive' 1970s and 'pragmatic' 1980s in the Netherlands: science shops, transfer points, technology centres and science parks.

As I have sketched throughout this dissertation, requests and demands to tune scientific research to communal and private interests was a typical trope of the late modern Western world. Market-oriented practices, like sponsored or contract research and special professorships, have existed and often flourished at academic institutions throughout the twentieth century. Still, something is said to have changed around 1980: only since then did the 'privatisation' of universities, 'commodification' of academic research and 'commercialisation' of science and technology really take flight.[551] In chapter 2, I touched upon the historical explanations for the US case, where military defunding, legal and regulatory changes, the globalisation of production as well as changes in dominant economic ideas overlapped, and intersected physically in hybrid settings like technology transfer offices, university-industry research centres and science parks. With a spatial lens, I will also approach the extent to which the organisation and nature of academic research, as well as the identities of European universities, changed after 1980.

First, I track the Dutch utility debate between 1965 and 1985 through a series of academic events (5.2). Then I visit both science shops (5.3) and transfer points (5.5) to make visible a policy shift from societal relevance to knowledge transfer (5.4). Subsequently, I reconstruct the arrival, establishment and adaptation of science parks in the Netherlands, from a technology centre in Twente (5.6) to a national experiment in Groningen (5.7) and a bio-science park in Leiden (5.8). In conclusion (5.9), I will discuss the emergence of a new epistemology of knowledge transfer in terms of a politics of proximity.[552]

5.2 Freedom and Utility of Scientific Research in the Netherlands

Consistently, the utility of academic research is debated in relation to its freedom. Societal, political and economic developments in the Netherlands, Europe and the US change the shape of this debate. The interuniversity congress on the freedom and restrictions of scientific research in 1954 thus did all but conclude the issue and in 1965 ZWO chairman and theology professor Bakhuizen van den Brink proposed to organise a second interuniversity congress. The OECD's Maréchal report on fundamental research incited some soul-searching at the research council:

> We don't execute research ourselves, but we subsidise it, we stimulate it, we try to coordinate and promote cooperation … we criticise. Continuously, we ask ourselves, what our

551 Hans Radder, *The Commodification of Academic Research: Science and the Modern University* (Pittsburgh, PA: University of Pittsburgh Press, 2010); Mirowski, *Science-Mart*; Berman, *Creating the Market University*.

552 This chapter is an extended and translated version of Jorrit P. Smit, "Kennisoverdracht op de campus: transferpunten, bedrijfscentra en science parks in de jaren tachtig," in: Flipse, A. & Streefland, A. (eds.) *Universiteiten en hun campussen: naoorlogse campusbouw en -ontwikkeling in Nederland,* Universiteit & Samenleving 15 (Hilversum: Verloren, 2020), 119–143.

> own policy actually entails ... what do we actually do? This question ... gnaws at the root of our universities and colleges ... and will be prompted again in every phase of scientific development.[553]

The chairman of the research council considered an interuniversity congress an 'authoritative response' to the limited views represented in Dutch society, as well as at the OECD. Both considered research only 'in terms of natural science and its usefulness'. Instead, a congress could be an occasion to stress the complementary usefulness of the humanities. At the same time, the 'collective responsibility' of those scholars still had to be raised—a theoretical argument for the utility of the humanities did not necessarily match practice.[554]

In the end, no second interuniversity congress was held to discuss this question. But a decade later, in 1975, a symposium did take place on 'restrictions to the freedom of science'.[555] The venue this time was not the Zoological Garden of The Hague, but the Pieterskerk in the old city centre of Leiden; and the congress united not academics from different institutions, but rather Leiden researchers and societal representatives; and politics was this time not a priori excluded from the discussion, but rather put at the centre of debate as the relation between 'ideology' and the university. By 1975, the societal responsibility of scientists had transformed from an abstract argument into a practical reality, in tune with the relatively progressive atmosphere in Dutch society in the 1970s. After the student protests of 1968, a start had been made with the internal democratisation of the universities that had to break the power of the professors—and ultimately democratise society as a whole.[556] In 1973, a decade of liberal-Catholic cabinets came to an end when Joop den Uyl, of the Dutch labour party (PvdA), headed a progressive, social-democrat coalition. 'Dispersion of power, knowledge and income' was the new government's motto. In this ideal, universities and science could not live 'an isolated life, nor can they be directed by the needs for economic expansion. They are at the service of society, subjected to new values and norms.'[557]

Societal relevance of scientific research was a hot topic in 1975. A year before, the first full-fledged Minister for Science Policy, Boy Trip, had presented the Nota Wetenschapsbeleid (White Paper on Science Policy). After the tumultuous internal democratisation of university governance and education, Trip's central concern was the external democratisation of academic research: it had to be oriented to 'societal priorities'. Obviously, there was a politics to the priorities of society. 'In what way is "society" understood here?', asked a student member of the Leiden university council in response to the memorandum.[558] Quite conservatively, society seemed to be comprised of the business world and the state. Democratic organisations—like

553 NA, ZWO, 2.25.36 inv. nr. 406, minutes from council meeting, 20 December 1965.

554 Ibid.

555 The following section is based on: Jorrit P. Smit, "Geen waardevrij bolwerk van de vrijheid meer: De 'identiteitscrisis' van de Universiteit Leiden in de jaren 1970," in *Universiteit en identiteit. Over samenwerking, concurrentie en taakverdeling tussen de Nederlandse universiteiten*, Universiteit & Samenleving 14 (Hilversum: Verloren, 2017), 47–70.

556 Hans Daalder, "The Netherlands: Universities Between the 'New Democracy'and the 'New Management'," in *Universities, Politicians and Bureaucrats: Europe and the United States* (Cambridge University Press, 1982), 173–232; Peter Baggen, "De wereld veranderen: universiteit en overheidsbeleid in Nederland, 1960–2000," in *Universitaire vormingsidealen. De Nederlandse universiteiten sedert 1876* (Hilversum: Verloren, 2006), 93–108; Smit, "Geen waardevrij bolwerk van de vrijheid meer," 48–50.

557 Government declaration, 1973. The Den Uyl cabinet was a coalition of three 'red' parties—PvdA, PPR, D'66—and the confessional parties KVP and ARP.

558 'Wetenschapsbeleid en vragen minister Trip ter discussie in u.r,' *Acta et Agenda* 6, no.33 (2 May 1974).

unions, activist groups, political parties' research institutes, and consumer associations—were not included in the priority-setting schemes. Communist newspaper *De Waarheid* therefore interpreted Trip's policy as an 'undisguised plea for the tuning of university research to the needs of large enterprises'.[559]

The tuning of university research to societal priorities also raised, again, the issue of the nature of academic research. One could conclude from Trip's memorandum that the demand to increase societally relevant research might lead to more organised research *outside* university walls. In one voice the universities, represented by the Academic Council (AR), argued that this was based on a too traditional and isolated image of the universities. They would not accept any 'limitation to the nature of university science'.[560] Or, as Leiden University summarised the views from their different faculties, research groups and councils: 'Universities and colleges perform research on basically all terrains of science, and this research can be both fundamental and explicitly oriented to applications.'[561] The case for the university as place for useful research was made not only on the basis of its autonomy, but also with reference to its public nature, which would make results optimally available for well-being and prosperity.

The quatercentenary of Leiden University was an occasion to present a renewed image, in tune with the social-political atmosphere of 1975.[562] Opening its doors for a week-long 'open house', the oldest university of the Netherlands tried to shake off its ivory-tower image. A digital 'mass game of chance' directed visitors—mostly relatives of students and high-school pupils—in a random fashion from building to building to show them the variety of things that 'the university can do and how she thinks'.[563] Additional attempts to boost the university's image comprised an exhibition in the Rijksmuseum in Amsterdam, a weekend supplement in a national newspaper, press conferences and a summary of the final debate on national television. The lustrum committee had envisioned this debate on the freedom and utility of science as the grand conclusion of the festive week. It was organised, in the late-Gothic Pieterskerk, as a 'forum academicum': a 16th-century special court where academic ideas could be put to the test of society. With the theme 'restrictions to the freedom of scientific education and research' the organizers of the quatercentenary hoped for fireworks. The university would defend its freedom by making clear to the outside world what societal contributions resulted from it; representatives from politics and industry were invited to challenge this legitimation narrative.[564]

As in 1954, several professors (from all faculties) had prepared discussion pieces, which were published in a collected volume. This became an integral part of the university's publicity offensive. At a preceding press conference, the Leiden scholarly community had presented a joint front: ideology

559 'Plan van Regering: Wetenschappelijk onderzoek aanpassen bij concern,' *De Waarheid*, 17 December 1974.

560 AUL, Curatoren/College van Bestuur 1952–1989 (CvB), inv.nr. 4211, Academische Raad to boards of universities and colleges, 24 January 1974.

561 AUL, CvB, inv.nr. 4211, University board to Minister of Education and Science, Coordination Science Policy, 7 December 1973

562 See also: Willem Otterspeer, *Het bolwerk van de vrijheid: De Leidse universiteit in heden en verleden* (Leiden University Press, 2008), 203–207.

563 'Per computer door feestend Leiden,' *De Telegraaf*, 21 May 1975; 'Academieschouw Leiden 1975', *Acta et Agenda* 7, no. 4 (5 september 1974).

564 The representatives from society were mr. W. J. Geertsema (commissary of the Queen for the province of Gelderland), mw. mr. A. Goudsmit (former member of parliament for D'66), W. Gortzak (Wiardi-Beckman foundation of the Labour Party PvdA) and Dr.ir. A. E. Pannenborg (board of directors, Philips).

needed to be 'integrated' into scientific work under clear conditions. And after the lustrum, the university board included a copy of the collected volume, titled *Restrictions to the freedom of scientific education and research*, with their official response to Trip's Science Policy memorandum. In the volume, one historian argued that before democratising university research, an attack was required on the caricatural contra-ideology of strict academic freedom and isolated autonomy. A. J. Staverman, a part-time professor of polymer chemistry who also held a position at TNO's Central Laboratory, focused in another essay on the precise conditions for the integration of ideology. The increase of 'societally serviceable research' at universities worried him: sometimes it was more about winning arguments than finding the truth. He proposed new criteria for the evaluation of societally oriented research that integrated ideology in scientific practice: 'left-societal' criteria valued the proposal with respect to change, equality and emancipation, while 'right-societal' criteria related to existing institutions like industry, defence and health care. The university board stressed in their letter to Minister Trip that these criteria were missing in national science policy but were essential for further democratisation of university research.

The final debate on the Friday afternoon, which was aired on national television two days later, had to provide a stormy climax, but blew over. One newspaper reported how no cracking reactions from the public were to be heard in the 'hollow space of the chilly Pieterskerk'.[565] A former member of parliament, for the liberal-progressive D'66, brought the 'fuse close to the powder keg' when she described the university as an 'elite group occupied with internal fights'. And a research director from Philips killed some dreams by stating that science could not solve all societal issues. 'Nice little rockets', the newspaper concluded, but not strong enough to create a spectacle.[566] University board chair K. J. Cath, on the other hand, evaluated the lustrum as 'a party without a dissonant'. The university had 'presented itself convincingly to society'.[567]

A decade later, at the next lustrum in 1985, fireworks *did* crack in the old city centre of Leiden. De Nieuwe Lente (The New Spring), a group of activist students, obstructed a speech by the Minister of Education and Science, Wim Deetman, because they rejected his policy of university budget cuts and rising tuition fees. But that same afternoon, on the other side of the Leiden railway tracks, the state secretary for Economic Affairs Piet van Zeil spoke unhindered as he lay the foundation stone for an 'Academic Business Center' close to the university laboratories in the Leeuwenhoek polder. Instead of cuts, Van Zeil announced subsidies for the stimulation of knowledge transfer (*kennisoverdracht*). That same week, city councillor Jos Fase (Economic Affairs) presented 'the best imaginable birthday gift' to the celebrating university: two American

565 '"Vuurwerk" ging niet af op Leids slotfeest,' *NRC Handelsblad*, 24 May 1975.

566 Ibid.

567 'Penningen, prenten en boeken voor werkers voor Eeuwfeest,' *Acta et Agenda* 7, no. 39 (12 June 1975).

biotechnology companies would open subsidiaries in the Leeuwenhoek. It was the occasion to baptise the area a *Bio Science Park*. State secretary Van Zeil thought it 'uplifting' that the university was 'so open towards contact with the world of business' but, presciently, warned that science parks and business centres should not become new 'status symbols'.[568]

Societal relevance, ideology and criticism of contract research were omnipresent by 1975. By 1985, however, the societal legitimation of the university and the embrace of the commercial world went hand-in-hand. In the rest of this chapter, I follow this development from democratisation to commercialisation by visiting various utility spots and science policy concepts. I will start at science shops and societal relevance, and via transfer points and technological business centres, end up at the science park. Meanwhile, I will discuss the related concepts of knowledge transfer and innovation. During this tour of the Dutch epistemic landscape between 1975 and 1990 it will become clear that different spatial solutions were offered to what where, in principle, the same practical issues. The increasing visibility of business enterprises on the university campus of the 1980s can therefore be described both as the continuation of existing industrial-academic networks, only in a different spatial form, and as a displacement within the social networks and material flows that surround university knowledge production. The utility spot concept is helpful here to draw out the different ideals of the organisation of knowledge and society. As specific spots gather different actors and allies in hybrid situations of exchange, they can have long-lasting effects. The displacement of knowledge transfer, from science shop to science park, is thus the start of further structural discontinuities.

5.3 Science Shops in the Seventies

In response to the *verwetenschappelijking* (scientification) of society and the alleged value neutrality of scientific research, education programmes were established in the early 1970s to study the relations between research and society. This student involvement and staff engagement also fitted the democratic reorganisation, introduced by the Wet Universitaire Bestuurshervorming (WUB, law on university governance reform)in 1970. In a new type of project education, dubbed Wetenschap en Samenleving ('Science and Society'), students actively related their field of study to concrete societal problems. These programmes first emerged at chemistry departments, where awareness of the entanglement of research with industrial interests was rather prominent.[569] To try and achieve the true 'vermaatschappelijking' (societalisation) of university curricula and research, these students and staff members subsequently

568 '"Bio-science-park" in Leiden. Ruimte voor 15 tot 20 bedrijven in Leeuwenhoek,' *Leidsch Dagblad,* 7 February 1985; 'Van Zeil slaat eerste paal: "Bedrijvencentrum goed voor kennisoverdracht,"' *Leidsch Dagblad*, 8 February 1985.

569 Jan van Diepen, "De institutionalisering van twee wetenschapswinkels," in *Een deurtje in de toren: Tien jaar wetenschapswinkels*, ed. Frans Pennings and Jan Weerdenburg (Utrecht: Studium Generale, 1987), 43–50; Hutter, "Chemie, chemici en wetenschapsbeleid."

created science shops as more permanent places where the societal questions could be addressed. These spots were the direct extension of the student movement and project education.

The science shops not only followed changes within the university, but also tied in to the changing (inter)national political climate. Their ambition to make science serviceable to society was in the spirit of the relatively progressive Dutch 1970s, characterised by the first left-leaning cabinet after two decades of conservative-Catholic coalitions. The government headed by social democrat Joop den Uyl took as its motto 'spread of power, knowledge and income'.[570] From the bottom up, utility spots emerged at various universities and faculties where this ideal materialised: *wetenschapswinkels* (science shops). Before long, starting with the Universiteit van Amsterdam and Universiteit Utrecht, all Dutch universities had a science shop on campus.[571] The shops had a strong ideological and ethical basis: opposing the 'disproportional' share of the national research budget earmarked for industrial and commercial parties, the shops aimed to achieve a 'more just distribution of knowledge, income and power' and contribute to the emancipation of underprivileged groups.[572] The latter aspiration situates the science shops in a broader wave of societal engagement, like academic activists who opposed the Vietnam War and demonstrated their solidarity with North Vietnam via knowledge transfer.[573]

At these places for 'non-commercial knowledge transfer' the 'shop staff' strove to break the almost self-evidently strong bonds between institutes of higher education and multinationals like Philips and Shell. Instead, they stimulated alternative relations between knowledge and power. Science shops were not out to discredit science, but rather optimistically desired to make scientific results available to the general public and to orient research to societal concerns. Regularly, science shops were physical places on campus—buildings, offices or counters—where one could literally walk in with a question. The shops were either of a broad character, as university service, or focused on a particular discipline, like chemistry or law. Generally, the shops focused on two activities: mediation between a question 'from society' and a particular researcher or research group, and pursuit of own research projects, often shaped as some kind of co-creation with the clients. The shops in this way not only stimulated the transfer of existing knowledge, but also promoted the orientation of university research to issues that were relevant to underprivileged and less articulate groups—although questions from well-financed groups were increasingly accepted as the shops professionalised.[574]

Around the same time, other activist scientists established utility spots with similar aims, but further removed from academic sites. These activists were members of two national associations of engaged researchers, which considered the

570 Government declaration, 28 May 1973.

571 Nicole Elisabeth Farkas, *Bread, Cheese, and Expertise: Dutch Science Shops and Democratic Institutions* (Ph.D., New York, Rensselaer Polytechnic Institute, 2002), 47–87.

572 Frans Pennings, "Het deurtje in de toren. Inleiding op de bundel," in *Een deurtje in de toren: Tien jaar wetenschapswinkels*, ed. Frans Pennings and Jan Weerdenburg (Utrecht: Studium Generale, 1987), 13–26.

573 Peter de Goeje, *Met solidaire groet. Technische en wetenschappelijke hulp aan Vietnam 1971–2011* (Leiden, 2011); Smit, "Geen waardevrij bolwerk van de vrijheid meer," 52.

574 Frans Pennings and Jan Weerdenburg, eds., *Een Deurtje in de toren: Tien jaar wetenschapswinkels* (Utrecht: Studium Generale, 1987); Farkas, *Bread, Cheese, and Expertise*, 64–68; Joseph Wachelder, "Democratizing Science: Various Routes and Visions of Dutch Science Shops," *Science, Technology, & Human Values* 28, no. 2 (2003): 244–73; J. S. Sijbrandij, *Counter-Research: A History of Science Shops in the Netherlands* (Master thesis, 2017).

ministerial proposal from 1974 to tune research priorities to society insufficiently ambitious. The first was the twenty-year-old Verbond voor Wetenschappelijk Onderzoekers (Union of Scientific Researchers, VWO) founded by concerned (academic and industrial) scientists in the wake of the threat of nuclear warfare. The second was the Bond voor Wetenschappelijke Arbeiders (Union of Scientific Workers, BWA), which presented itself as a progressive reaction to the VWO: it was born in the wake of the student protests of the 1960s and called for democratisation of governance and research.[575] The two organisations joined forces in a working group on science policy and in 1977 conceived the plan to establish Instituten van Maatschappelijk Gericht Onderzoek (IMGO), or research institutes with a societal orientation. Not only did the IMGO unite the two factions within the engaged science community, but also the Minister of Science Policy, Trip, gave his approval.[576] Universities, however, were less enthusiastic: they desired to keep research of service to society (*maatschappelijk dienstbaar onderzoek*) within their own walls.

Indeed, compared to university-based science shops, IMGOs were established on an autonomous basis and focused more on their region than on research. They shared the orientation towards those groups that had little or difficult access to scientific knowledge. Such financially weak and underprivileged groups would have to be organised to a certain degree, so IMGO employees would be able to collect their questions, involve them in research and institutionalise these contacts subsequently. In practice, the four experimental IMGOs that were eventually founded functioned as 'scientific service bureaus for the people' rather than as research institutes. Their outlook was directed more to society than to science: they made knowledge *accessible* and *translated* between the world of science and the questions they received.[577] Where science shops had epistemic dreams—the societal reorientation of university science—these institutes fantasised about being as useful as possible to a local community.[578] The latter was attempted by locating the IMGO in regions without a strong knowledge base, for example the IMGO ROEM (for regional development, energy and environment) in Zeeland, or with a strong knowledge demand, like the agricultural IMGO in Wageningen.[579]

'Societally relevant research' and 'knowledge transfer' were highly controversial notions also in the Dutch 1970s. Science shops and IMGOs functioned as niches in this debate that, by way of contrast, made shortcomings of the existing system manifest. In the wider landscape of 'interface' activities in the Netherlands, as it was phrased in an evaluation of IMGOs in 1982, they distinguished themselves by their specific focus on underprivileged groups. And the initially very progressive, or strong 'leftist' character of the science shops put them at odds with the vested interests of university governors and professors.

575 T. Fortuin and T. van Oostrum, *IMGO. Een stap vooruit. Rapport van het evaluatie-onderzoek inzake het (toekomstig) functioneren van Instituten van Maatschappelijk Gericht Onderzoek* (Den Haag: Sdu, 1982).

576 Jan Weerdenburg, "Tien jaar wetenschapswinkels," in *Een deurtje in de toren: Tien jaar wetenschapswinkels*, ed. Frans Pennings and Jan Weerdenburg (Utrecht: Studium Generale, 1987), 29–42.

577 Fortuin and Oostrum, *IMGO. Een stap vooruit*.

578 H. Jacobs, "Van IMGO naar wetenschapswinkel: Kleine stappen op een lange weg," in *Een deurtje in de toren: Tien jaar wetenschapswinkels.*, ed. Frans Pennings and Jan Weerdenburg (Utrecht: Studium Generale, 1987), 51–55.

579 The other two IMGO's were located in Rotterdam (focused on mental health) and Utrecht (focused on work and health).

Some of the latter also questioned the quality of this kind of research or feared it would put fundamental research in a tight corner. But as ‘knowledge transfer’ became more strongly emphasized in university and ministerial governance, the interest for science shops amongst the established groups grew: now these shops could help them account for this demand.[580]

5.4 From Societal Relevance to Knowledge Transfer, 1970–1985

Following the international economic crises of the seventies, governments, businesses and investors all over the world put their money on technological innovations as the source of high-grade employment and ‘knowledge-intensive’ products and services. The new markets this could open would reboot the stagnating economy. The Dutch government too formulated the ambition to ‘renew’ industry. Several memoranda and committees advocated an offensive industrial policy to forestall the displacement of employment to low-income countries.[581] Where the post-war industrialisation policy of the 1950s had introduced state support for traditional heavy industries, this neo-liberal industrial renewal policy directed ‘stimulating measures’ (ranging from fiscal benefits to innovation advice) to small and medium-sized businesses. The lagging renewal of the national industrial structure was attributed to the failure to appropriately use existing scientific knowledge and technical expertise. To undo this harm, the authors of the *Innovatienota* (1979) recommended that public techno-scientific institutions orient their research more to ‘the needs of society in general, and business in particular’.[582]

The turn of Dutch university science towards industry and innovation, as prescribed in the *Innovatienota,* also did not appear out of thin air. Before the dust settled after the democratic reform of university governance in the 1970 WUB, Trip presented plans in 1974 for the ‘external democratisation’ of publicly funded research. This call for science to be of more value to society came as much from the critical student movement and activist groups geared at socio-technical issues like the environment, nuclear energy and geopolitics. At the same time, the tight-knit epistemic network between universities, polytechnic colleges and multinational companies changed shape as the research laboratories shrank in size and orientation. International competition and market saturation forced companies like Shell and Unilever to concentrate R&D activities in one location (respectively Amsterdam and Vlaardingen) and make them less specialised and less fundamental. Instead, corporate research became more responsive to the company’s production and planning needs.[583] At the same time, the central coordination role of TNO, through mixed organisations in

580 Pennings, “Het deurtje in de toren,” 14–15; Wachelder, “Democratizing Science,” 253; Sijbrandij, *Counter-Research*.

581 Important memoranda were the *Nota Selectieve Groei* (1976; presented by minister EZ Ruud Lubbers); the *Innovatienota* (1979; presented by minister for Science Policy Ton van Trier (CDA), minister Arie Pais (OW, VVD) and Gijs van Aardenne (EZ, VVD)); the WRR-report *Plaats en toekomst van de Nederlandse industrie* (1980) from which ensued the Wagner committee and that presented the report *Een nieuw industrieel elan* (1981).

582 Evert-Jan Velzing, *Innovatiepolitiek: Een reconstructie van het innovatiebeleid van het ministerie van Economische Zaken van 1976 tot en met 2010* (Delft: Eburon, 2013), 50.

583 Homburg, *Speuren op de tast*, 44–51.

various economic sectors, disappeared. After repeated criticisms of its functioning, it was reorganised into an executive applied research branch and competed with universities and polytechnics for contract research from industries that outsourced their R&D departments. This mirrored a change in policy focus at the Ministry of Economic Affairs, from support of knowledge supply to demand-side subsidies.[584]

After 1975, 'societal relevance' and 'priority setting' were increasingly replaced by 'knowledge transfer' and 'innovation' whenever the usefulness of university research was discussed. Thus, it appears tempting to draw a line between an idealistic, 'progressive' decade of the 1970s and the pragmatic 1980s. But there exist many continuities between them. This compares to David Baneke's argument that the earlier discourse of societal relevance, and the later discourse of marketization, were responses to the same organisational issues: expansion (mainly of university education), cost increases and general inefficiency.[585] In the seventies, democratisation and professional governance were both measures to change authoritarian and arbitrary power relations. By 1980, these problems were all but resolved, and so university boards adopted new, often Anglo-American, management methods, while many of the democratisation measures were reversed. Many of the structures established for idealistic motives by engaged scientists in the 1970s—such as the science shops—could be applied to much more pragmatic ends in the tougher economic climate of the 1980s: where researchers' responsibility was once ethically motivated, it was now often narrowed down to financial accountability. In this whole period, we can therefore better speak of idealistic *and* pragmatic tendencies, alliances and factions, and focus on the shifts in their relative political and rhetorical power.

A good example is the shift in the meaning of knowledge transfer, embodied in the displacement from science shops to science parks. In 1985, 'stimulation of the transfer of knowledge for the benefit of society' was adopted as additional task for universities—alongside teaching and research—in the Wet op het Wetenschappelijk Onderwijs (Scientific Education Act). But this was no longer in the spirit of Den Uyl's motto to 'spread knowledge' in society. Liberal MP Greetje Ouden-Dekkers introduced the amendment on knowledge transfer to embed bottom-up academic activities in law, with reference to science shops, but especially highlighting contract research and 'transfer points'.[586] The act itself forbad earmarking structural funds for this task because 'knowledge transfer is integral to modern ideas about the process of knowledge development, with foundational research at the basis'. The 1985 knowledge transfer act repositioned universities as an 'infra-structure' (sic) of venerable research which could 'bear fruit' in the short and long term. Ultimately, the national government denied responsibility for useful outcomes: local knowledge transfer

584 Lintsen et al., *Tachtig jaar TNO*, 54–62; van Rooij, "Gaps and Plugs," 36–38.

585 David Baneke, "De veranderende bestuurscultuur in wetenschap en universiteit in de jaren zeventig en tachtig," *BMGN – Low Countries Historical Review* 129, no. 1 (2014): 25–54.

586 *Herziening regeling van het wetenschappelijk onderwijs (Wet op het wetenschappelijk onderwijs). Amendement van het lid Ouden-Dekkers.* Parliamentary Papers 1984–1985, 16 802 (38), 15 February 1985; 'Plan universiteit: wetenschapswinkel voor regio,' *Nieuwsblad van het Noorden,* 17 June 1980.

was just a small chain in 'extremely complex', field-specific 'knowledge trajectories' that evaded control by any one country or one university. The only way to stimulate the short-term usefulness of this resource was incidental support for new activities oriented to the business world—like transfer points and academic business centres.[587] These utility spots promised control and promotion of these diffuse developments in science, society and the economy.

By the mid–1980s, ideas about the place for knowledge transfer had shifted markedly from non-commercial to commercial knowledge transfer, and from science shops to science parks. This shift is characteristic for broader developments between 1974 and 1985. As mentioned above, the inevitable budget cuts of the 1980s were partly motivated by the idea that universities were not producing enough societal returns. Although one might think that this would make the role of science shops more important, the reverse happened. On the one hand, science shops were indeed institutionalised by many universities. In 1978, it had still been a problem that non-commercial knowledge transfer did not fit the task description of the university.[588] As they transformed from bottom-up activist places into professional organisations, they let go of the political ideal of reorienting the university research agenda into more societally relevant directions and were increasingly connected to educational programmes.[589] But for a while, then, universities proudly paraded their science shops to fulfil the demand for relevance and knowledge transfer. On the other hand, research planning and accountability became stricter, so less flexibility remained for researchers to accept science shop projects.

The coalition surrounding commercial knowledge transfer, at the same time, increased in strength. The Ministry of Economic Affairs started to promote the development of transfer points (*transferpunten*) as 'little siblings' of the science shops. These were to transfer knowledge from the university to (paying) commercial parties. Ironically, these mediating organisations ran into many start-up difficulties and turned to the science shops to learn from their decade of experience with the 'societal use' of university research.[590] The eventual legislation for knowledge transfer, in 1985, is evidence, however, that the transfer point community outstripped the science shop coalition: Wilbert Gooren and Arnold Korsten advised, in a 1983 study of transfer points, embedding knowledge transfer in the law on higher education to overcome organisational difficulties (which the science shops had also experienced previously). The annual transfer point conference in 1984 came to the same conclusion.[591] This resonated with the views of the Minister for Science, Wim Deetman, who asked universities 'to do something with their knowledge'. In the aftermath of a recession every sound mind understood that it was preferable

587 *Herziening regeling van het wetenschappelijk onderwijs (Wet op het wetenschappelijk onderwijs). Vijfde nota van wijziging*. Parliamentary Papers 1984–1985, 16 802 (139), 3 April 1985.

588 'Wetenschapswinkel. Universiteit moet project schrappen,' *De Volkskrant,* 30 August 1977; 'Staatssecretaris Klein: Universiteit ging te ver met wetenschapswinkel,' *Trouw,* 31 August 1977.

589 Wachelder, "Democratizing Science"; Farkas, *Bread, Cheese, and Expertise*.

590 Pennings, "Het deurtje in de toren. Inleiding op de bundel," 20.

591 Wilbert Gooren and Arnold Korsten, *Kennisoverdracht aan kleine en middelgrote ondernemingen via transferpunten in Nederland: verslag van een onderzoek.* ('s-Gravenhage: Staatsuitgeverij, 1983), 8–20; C. M. A. de Koning, *Transferpunten in Nederland: een literatuuronderzoek naar het ontstaan, de organisatie en de ontwikkelingen* (Zoetermeer: Ministerie van Onderwijs en Wetenschappen, 1986), 29–35.

if this took place 'at a charge, which makes a huge difference for the minister's budget'.[592] At an international conference on technology transfer, in September 1984, Deetman stated his ambition to make 'external knowledge transfer' to knowledge users, business in particular, an explicit task of university staff. Without much ado he thus welcomed the knowledge transfer amendment from his fellow party member Ouden-Dekkers. By the time the new law came into effect, in 1985, most science shops were in heavy weather and transfer points, as well as the first technology business centres and science parks, took their place as spatial imaginaries of useful knowledge production.[593]

5.5 Transfer Points: Distinct Entrances for Entrepreneurs

Already in the 1979 *Innovatienota*, the minister for Economic Affairs had imagined a nationwide *transfer system* that would make the Dutch knowledge potential better accessible. Transfer points were established on the 'demand' side—at state institutions that supported industry, like the Rijksnijverheidsdienst and TNO—and the 'supply' side, at polytechnics.[594] The points would provide entrepreneurs with a 'distinct entrance' to the epistemic resource of the institutes of higher education. As 'active intermediary' the transfer points could lower the threshold between academic and societal actors, specifically small and medium-size businesses. Their questions, and the results of science, had to be translated in two directions, all as part of a national transfer network in which supply and demand were attuned in the 'knowledge circuit'.[595] As part of subsidies for the stimulation of innovation (from the department of Science Policy at the ministry of Education and Science, O&W), the state promised to finance a handful of 'transfer officers' per institution. But after a start-up period of five years, the transfer points were expected to support themselves through contract research.

These ideas for systematic access to the country's epistemic resources were proposed in the advisory committee for the *Innovatienota*. One of its members was Wim Koumans, professor of transportation technology at the Technische Hogeschool Eindhoven and a national authority in the field of knowledge transfer to small and medium-sized enterprises (SME). The 'transfer professor'—a nickname he received when he left Eindhoven for TNO—actively oriented the polytechnic to society.[596] Responding to an initiative of the local chamber of commerce and the Koninklijk Instituut voor Ingenieurs (KIVI, Royal Institute for Engineers), Koumans took a leading role in the establishment of a 'bestuurscommissie contacten bedrijfsleven' (executive committee for business contacts). Before the word existed, a transfer system materialised in Noord-Brabant:

592 'Wetenschapswinkeliers hebben het moeilijk,' *De Volkskrant*, 19 May 1984.

593 H. Bodewitz, "Wetenschapswinkels en wetenschap en samenleving," in *Een deurtje in de toren: Tien jaar wetenschapswinkels.*, ed. Frans Pennings and Jan Weerdenburg (Utrecht: Studium Generale, 1987), 79–84.

594 Gooren and Korsten, *Kennisoverdracht aan kleine en middelgrote ondernemingen via transferpunten in Nederland*.

595 *Innovatienota*, 5.4.2.2.

596 *TH berichten*, 7 January 1983.

the Eindhoven committee functioned as transfer point, linked in with regional partner institutions like TNO, the Rijksnijverheidsdienst and the economics college in Tilburg.[597] In its first year, they received 140 questions, of which 40 were disregarded, 40 sent to the Tilburg department of Business Studies, and the remaining 60 spread over other institutes.

Anticipating the *Innovatienota,* the committee's rationale was to offer the local SME better access to the polytechnic. The TH Eindhoven presented this consciously as their way of serving society. Additionally, mirroring the epistemic motivation of the science shops, they expected to benefit from the 'immaterial use from the confrontation with the problems of practice'.[598] This would 'ground' their researchers, 'despite the ivory tower the outside world pushes them in (sometimes against their will)'.[599] Koumans situated the local developments in a global context: the Dutch economic position could be strengthened by focusing on knowledge-intensive instead of labour-intensive products, for which the transfer of useful ideas from science and engineering to society was necessary.

At first, the plans for a national transfer system applied only to the polytechnics and state institutions for applied research and industrial support. The Wetenschappelijke Raad voor het Regeringsbeleid (WRR, Scientific Council for Government Policy) even strongly advised against establishing transfer points at general universities. Preferably, universities would maintain their orientation on research of a 'free fundamental' character and develop it in connection to teaching. The application-oriented nature of transfer points would only pollute that atmosphere.[600] The cautious advice of the WRR notwithstanding, within a few years most universities housed transfer points, staffed with state-funded transfer officials.[601] The universities thereby responded proactively to the recommendations of the *Innovatienota*, probably also motivated by fear of anticipated budget cuts. In Leiden, policy officer Andrieske Leistra went to great efforts to translate the government memorandum into a tailor-made model for Leiden, embedding the call for renewal and knowledge transfer in the local situation. The university board shared this internal report, which they dubbed the 'Leistra model', in the spring of 1980 with the parliamentary committee for science policy to underline that the universities too could 'play an important role in innovation'.[602]

University boards themselves shaped the usefulness of their institutions partly in the image of the polytechnics. Engineers at the same time triggered, and carved out, attention for innovation and knowledge transfer within the university. This fitted the national situation, where engineers and industrial researchers of Philips and Shell were (still) asked to chair advisory committees on the future of science and technology policy.[603] Transfer points at polytechnics and universities were based on the 'THE model' that Koumans actively spread.[604]

597 'Transferbureau gepresenteerd. Contacten THE met bedrijfsleven nemen sterk toe,' *TH berichten*, 16 January 1981.

598 'THE intensiveert contacten in de regio met bedrijfsleven,' *TH berichten*, 7 April 1978.

599 'Contacten THE-bedrijfsleven slaat in regio aan,' *TH berichten*, 24 November 1978.

600 Wetenschappelijke Raad voor Regeringsbeleid, *Plaats en toekomst van de Nederlandse industrie*, Rapporten aan de Regering (Den Haag: Staatsuitgeverij, 1980).

601 By 1981 the 'system of transfer points was completely functional'; all three polytechnics as well as the universities of Groningen and Nijmegen had established transfer points, and the remaining universities were 'pondering knowledge transfer and contract research'. *Wetenschapsbudget 1983*, Parliamentary Papers 1982–1983, 17603, p.54.

602 AUL, CvB, inv.nr. 4215, letter by College van Bestuur to chairman Vaste Commissie Wetenschapsbeleid van de Tweede Kamer, 'Innovatienota', 8 May 1980.

603 In 1981, former Shell CEO Gerrit Wagner chaired the committee that wrote the influential advisory report *Een nieuw industrieel elan*; in 1986, Philips CEO Wisse Dekker chaired the committee on technology policy.

604 Koning, *Transferpunten in Nederland*.

In Groningen, he shared his lessons for success and emphasized the 'informal, freebooting' atmosphere in the committee. Only with a pioneering attitude had they been able to leave the beaten university tracks and show scientists 'how high the [thresholds to the] ivory tower' were for local businesses.[605] And Leistra (who had an engineering qualification) invited transfer professor Koumans to discuss innovation-oriented research and transfer points. In Leiden, they hoped to reproduce his success by putting together an informal group of like-minded spirits with an interest in innovation—one of whom was an external member of the university council, and agricultural engineer, J. D. Enthoven, who had been rather early in his recognition, in October 1979, of innovation as a 'beautiful opportunity' for the university. From 1981 onwards this group gained formal status as the Commissie Contacten Bedrijfsleven (CCB, Business Contacts Committee) and included two more external members: representatives of the local chamber of commerce and the polytechnic in Delft.

These developments thus allowed Leiden University to institutionalise (and stimulate) their contacts with the business world.[606] It was also an occasion to strengthen the epistemic and organisational ties in the region, especially with the polytechnic in Delft. Via the CCB, Leiden was able to participate in the transfer point at the TH Delft. The oldest polytechnic of the Netherlands followed in the footsteps of Eindhoven when it opened such a utility spot, in January 1982.[607] At the opening, a beaming rector of Leiden University, clinical chemistry professor A. A. H. Kassenaar, declared that this interuniversity cooperation would not only benefit both institutions, but also contribute to a faster recovery of the national economy.[608] Kassenaar, who himself was rather active in knowledge transfer, claimed that Leiden, the oldest university of the country, would profit from the transfer point because it would give a boost to their somewhat professorial public image.[609] Instead of falling under the rubric of 'conservation', the university as a historical monument reminiscent of times past, the transfer point would connect it to the 'design of our future society'.[610] That would happen by facilitating and strengthening interactions with local and regional SME, for which the university could carry out useful research.

Kassenaar and his colleague from Delft presented the initiative for a transfer point as evidence of the claim that the university was embedded in 'today's society' and worth every (tax) guilder. Besides these concerns about the university's image, they also repeated the epistemic justification for increasing interactions with local businesses: it would give a much-needed impulse to the creativity and orientation of academic research. Both the image and the epistemic argument ran pretty much parallel to those for the science shops, established a few years before. But the politics of knowledge

605 'Plan universiteit: wetenschapswinkel voor regio,' *Nieuwsblad van het Noorden,* 17 June 1980

606 University historian Otterspeer treats these developments only very briefly, but quite accurately, as combination of internal and external factors. Otterspeer, *Het bolwerk van de vrijheid*, 265–268.

607 'TH Delft helpt nu ook kleine ondernemingen,' *De Volkskrant*, 16 January 1982.
608 AUL, CvB, inv.nr. 1922, Kassenaar, 'Samenwerken in een transferpunt,' 22 January 1982.

609 Otterspeer, *Het bolwerk van de vrijheid*, 225.

610 Ibid.

transfer differed fundamentally. A Groningen university working group that prepared the establishment of a transfer point in 1980 described it as 'a kind of science shop for the privileged'.[611] Such irony was wasted on most persons involved in science shops. In Leiden, the shop staff dug their heels in. In an advisory report about a possible transfer point they acknowledged that shop and point shared the objective to serve society by making academic knowledge and experience 'directly usable and applicable'. But they also stressed that it was a highly political choice *what kind of* science one made relevant to *which* (part of) society—neither concept was uncontested. In conclusion, they warned that the transfer point's overemphasis on relations with commercial parties could 'sell out science to the highest bidder'.[612] So, although university governors promoted the transfer point as a legitimate answer to the demand to increase their institution's societal relevance, many university employees disagreed.

The politics of knowledge transfer divided the academic world. Two groups stood opposite each other: 'progressives', who preferred expansion of the science shop, and 'pragmatists', who pinned their hope on a growing amount of external funding for research—'in which case the paying party (mostly industry) could profit from the creativity of the established scientists or department'.[613] The academic factions mirrored national political developments: Den Uyl's 'progressive' Labour party joined the government again in 1981, but this cabinet quickly collapsed, after which a liberal-conservative coalition under the leadership of Ruud Lubbers took over—and opened the door to 'pragmatic' neoliberal policies. In Leiden, many university council members belonged to the progressive camp. They shared the concerns of the science shop about the turn to the market and contract research, because those developments might decrease the willingness of researchers to perform (often unpaid) societally relevant research for a science shop client. At the other end, however, the mostly pragmatic members of the CCB also had to rely, in first instance, on the voluntary participation of 'enthusiastic' individuals and departments for the 'renewal process'.[614] As both the science shop and the transfer point appealed to the surplus time and labour of researchers, they inevitably ended up in each other's hair.

The opposite political-epistemic factions each hoped to set conditions for either a pragmatic or a progressive atmosphere in the university. The transfer point representatives asked the university board to promote a climate in which 'innovation stimulation has a full-fledged position within education and research'. The science shop owners, on the other hand, proposed to set selection criteria for assignments, questions and contracts from commercial parties, so as to safeguard the public nature and responsibility of university research. Especially 'anti-social, military and nuclear' projects had to

611 'Plan universiteit: wetenschapswinkel voor regio,' *Nieuwsblad van het Noorden,* 17 June 1980.

612 AUL, CvB, inv.nr. 1922, 'Notitie van de adviescommissie voor de wetenschapswinkel, inzake de instelling van een transferpunt RUL,' 8 February 1981.

613 AUL, CvB, inv.nr. 1922, Commissie voor Onderwijs en Wetenschapsbeoefening to College van Bestuur, 'innovatie-nota,' 4 May 1981.

614 AUL, CvB, inv.nr. 1922, 'Innovatie,' March 1981.

be turned down. Such progressive criticism did not find fertile ground with board chairman Cath—a former director of a paper company who was the first holder of this post at Leiden, in 1972, and became known for moving ideological discussion deftly to pragmatic terrain.[615] He sided with the pragmatic CCB and refused to set any conditions for cooperation with industry in advance. The form of innovation, Cath reasoned, had to be left to the 'freedom of the individual and the department'.[616] Thus, the board chairman employed the cherished principle of academic freedom to provide university access to the business world.

Between 1978 and 1985, thus, the majority of Dutch institutes of higher education opened their doors and vision to a new realm of commerce and industry. This was more a displacement and broadening of attention, than a radical new phenomenon. As national policy shifted from industrialisation to industrial renewal, the focus also shifted from large-scale heavy industry to small, science-based or high-tech SME. With this shift the previous (in)formal tolerance of relations between academic and commercial actors transformed into a legislative expectation and policy stimulation. Transfer points and contact committees would mediate these interactions and strengthen the ties between the two worlds. The establishment of these rudimentary utility spots, first in Eindhoven—fuelled by the local chamber of commerce and transfer professor Koumans—and later also in Twente, Groningen, Nijmegen, Delft and Leiden, fitted (and surpassed) the policy recommendations of the 1979 innovation memorandum. Even before they started to function, the transfer points had already led to increased cooperation between polytechnics and general universities with respect to knowledge transfer. Delft and Leiden, Eindhoven and Tilburg, as well as Groningen and Twente joined forces to share specialties, questions and experience.[617]

Interestingly, the universities climbed onto the innovation bandwagon before they were explicitly asked to do so. Years before 'transfer of knowledge for the benefit of society' belonged to their official task description, enthusiastic university governors and entrepreneurial professors engaged in contract research and transfer points. They justified this in the discourse of the preceding decade: contracts and contacts with industry could make departments reflect 'whether they were pursuing the right, societally relevant, fundamental research'.[618] Precisely this epistemic interpretation of societal relevance—that it was a legitimate, indirect means to orient research—caused friction within the university walls. Pragmatists, like Koumans and Kassenaar, and progressives, like the science shop representatives, mostly shared the conviction that demand-driven contact with the outside world boosted the creativity of academic research. But beyond this, their paths diverged. Where the former focused on industrial renewal and innovation, the

615 Otterspeer, *Het bolwerk van de vrijheid*, 221; Smit, "Geen waardevrij bolwerk van de vrijheid meer," 50–51.

616 AUL, CvB, inv.nr. 1922, Cath, K.J., 'Nota voor de vergadering van het College van Bestuur op donderdag 13 mei,' 11 May 1981.

617 'Universitair bureau kan overheidssteun niet missen. Emmer bedrijf schoolvoorbeeld van werkwijze Transferpunt,' *Nieuwsblad van het Noorden*, 2 February 1984.

618 Gooren and Korsten, *Kennisoverdracht aan kleine en middelgrote ondernemingen via transferpunten in Nederland*.

latter aimed for societal change and equality. The (lack of) financial support for each shows how the wind was blowing: the government offered support for transfer points, but cut the science shops budgets.

5.6 Technological Business Centres: On-Campus Innovation

Transfer points and science shops were first of all contact points between academic and non-academic actors. Their main function was mediation between the problems and questions from practice, be it from industrial or civic parties, and the methods and knowledge of academic expertise. This did not always suffice, in epistemic or financial terms. Forwarding practical questions to researchers did not solve them, nor did it generate great income. At several universities and polytechnics, more extended plans were created to stimulate the interaction and cooperation between research and entrepreneurship in concrete, hybrid spaces. For example, a business technology centre emerged in Twente, and in Leiden an academic business centre was established. I will discuss how these centres gathered new coalitions around university research, which formed the basis for the subsequent foundation of science and technology *parks* around institutes of higher education.

The Technische Hogeschool Twente (TH Twente) was founded in 1963 to stimulate regional economic development in the Eastern part of the Netherlands that had previously relied on the textile industry. By the late 1970s, the polytechnic was in tune with its times when the forward-looking rector H. H. van den Kroonenberg spread the image of an 'entrepreneurial' college. It was the appropriate location, then, for Control Data's first 'Business and Technology Centre' (BTC) on European soil. Software giant Control Data had already spread such centres all over the US and TH Twente imported the North American model of knowledge transfer focused on housing start-ups and spin-offs in its vicinity. William Norris, one of the founders of Control Data, was well known not only for microelectronics breakthroughs but also for his societal commitment: from a liberal standpoint, he reasoned that not just the state, but also entrepreneurs should stimulate the revival of deprived neighbourhoods and regions.[619] The business and technology centres that Control Data founded in the US were therefore often situated in poorer quarters and cities, so as to trigger new economic activities there.[620] Each centre consisted of shared laboratory, production and office facilities, keeping down the expenses for small businesses. In addition, computer education, technology transfer and management support had to ensure higher success rates of the start-up companies.[621] Besides sharing costs and support, ideas and knowledge had to flow

619 In the Netherlands, Control Data was a household names amongst scientists because it supplied computers and software to Dutch universities in the 1970s. See: T. van Helvoort, *Een verborgen revolutie: de computerisering van de Rijksuniversiteit Groningen* (Uitgeverij Verloren, 2012).

620 William C. Norris, "Applying Technology: The Key to the Future," *The Journal of Business Strategy* 6, no. 3 (1986): 38–46.

621 Paul Benneworth and Franziska Eckardt, "Kennispark Twente as Global Science Scape," *GSS Working Paper*, no. 5 (2017).

within the centres themselves, and around them. A 'Technology and Enterprise Match Room' enabled the exchange of information about technical possibilities and innovative products, and close relations were nourished with the surrounding knowledge institutions. Control Data's BTC was thus a utility spot that combined aspects of the science shop and the transfer point, by focusing on underprivileged groups and regions and using commercialisation as mode of knowledge utilisation.

Did this politically hybrid character survive the trip over the Atlantic? Ir. Gijs van Driem of TH Twente visited the Minneapolis Business and Technology Center in 1978 as part of a research project in cooperation with TNO. Later, Control Data helped Van Driem establish a similar spot in Europe. This support came not only in the form of a spatial model and expertise, but also as an investment of *f* 1m (around €890,000 in 2020 terms). In addition to this international encouragement, TH Twente had to make local allies. The social-economic rationale of uplifting backward areas resonated well with the objectives of the Overijsselse Ontwikkelingsmaatschappij (OOM, Overijssel Development Agency). This state-funded regional development board invested in initiatives that would stimulate economic renewal, employment and entrepreneurship. OOM was prepared to contribute the same amount as Control Data, and so did Amro Bank.[622] With *f* 3m in hand, the newly established Bedrijfstechnologisch Centrum Twente (BTC) agreed a hire-purchase plan with the Enschede municipality for a new building directly opposite the TH Twente. Similar to the original North American model, this BTC functioned in relation to an economically backward region and in close vicinity to a public source of new knowledge. The latter had to enable easy contact and knowledge exchange, which, by the way, was not merely a paper transaction. The transfer point of the polytechnic would mediate, initially at no cost, between beginning enterprises and the university departments. But a fee would be charged whenever an appeal was made to university researchers.

The BTC thus also fitted in with the local knowledge transfer environment. How this functioned in Twente had been studied by two young innovation consultants, Han van der Meer and Jaap van Tilburg. Both had recently graduated from the polytechnic with degrees in management and innovation studies. On the basis of their report, rector Kroonenberg decided to offer loans to start-up companies, which they could use for example to hire space in the BTC.[623] TH Twente later received national subsidies for this knowledge transfer support after the same consultants had presented a report on spin-offs from Dutch knowledge institutes to the Ministry of Economic Affairs. This had been requested by a project group on Technology Policy, whose main focus was industrial renewal via technological innovation. The report must have appealed to

622 'Bouw begonnen van bedrijvencentrum Twente', *NRC Handelsblad*, 30 June 1982.

623 This concerned the Tijdelijk Ondernemers Plaatsen' programme (TOP, temporary placement of entrepreneurs). Innovatie Adviesburo van der Meer & van Tilburg, *Nieuwe bedrijven vanuit en rond de TH Twente. Een onderzoek in opdracht van de TH Twente.* Enschede, 1981. Boer, *Een kleine en kwetsbare instelling*, 196.

the policymakers because the innovation advisors argued that knowledge transfer flowed not only in one way, from science to enterprises. In reverse, the adventurous spirit of American entrepreneurialism also trickled into institutes of higher education.[624] In this way, the hybrid space of the BTC could contribute to the incremental change of the universities and polytechnics themselves.

Van der Meer and Van Tilburg hailed the American cultural orientation to the 'flourishing of the individual' in connection with the growing attention for small and innovative companies as a motor of Dutch industry. Just as important, this could break the conservative culture of institutes of higher education: researchers should dare to start a business. From that perspective, Van der Meer and Van Tilburg viewed even the looming budget cuts more as an opportunity than as a problem. It would break self-evident career paths, which was a primary trigger for the emergence of new enterprises—at least according to professor of entrepreneurship Albert Shapero, whom they esteemed highly.[625] Based on their study of the TH Twente, Dutch knowledge institutes and the theoretical, often American, innovation literature, they concluded that an 'innovative climate' had to be generated around institutes of higher education, in American style: with risk capital, incubators and science parks, so that spin-offs and knowledge transfer would contribute to economic growth *and* cultural change.[626] Culturally, this embrace of American values might have breathed progress, but it did so in a political-economic pragmatic way.

In 1982, the state secretary for Economic Affairs laid the foundation stone for the Bedrijfstechnologisch Centrum Twente in Enschede. Around the same time, the first plans for a *laboratoriumverzamelgebouw* (shared laboratory building) were being discussed in Leiden. The earlier mentioned Business Contacts Committee (CCB) established a working group for this purpose with a heterogeneous composition: researchers, from natural science and economics faculties as well as the academic hospital, were joined by laboratory directors, building managers, and representatives of legal and financial departments and the local chamber of commerce.[627] The first step towards realising material structures for the transfer of knowledge had been made a year before by cell biologist Johan Ploem. This professor at the faculty of Medicine had proposed to establish a 'laboratory for application research', in a memo to the Ministry of Education and Science. At the time, the idea circulated within the pragmatic CCB, but they had not dared make it public because it deviated strongly from the 'existing structures' of the university. Internally, they therefore gathered a broad range of actors to support the idea and externally, they found support in the reports from, and meetings with, the innovation advisory

624 Innovatie Adviesburo van der Meer & van Tilburg, *Spin-offs uit de Nederlandse kenniscentra. Samenvatting van een onderzoek in opdracht van het Ministerie van Economische Zaken*. (Enschede, 1983).

625 Upon their invitation, Shapero lectured in Twente in 1983. Innovatie Adviesburo van der Meer & van Tilburg, 10.

626 Paul Benneworth and Roel Rutten, "'Individuals' Networks and Regional Renewal. A Case Study of Social Dynamics and Innovation in Twente," in *Innovation in Socio-Cultural Context*, ed. F. Adam & H. Westlund, Routledge Advances in Sociology 84 (London; New York: Routledge, 2013), 196.

627 AUL, CvB, inv.nr. 2093, subcommittee II of Commissie Contacten Bedrijfsleven to College van Bestuur, 25 August 1982. Including attachment 'Notitie Innovatief Onderzoek'.

bureau Van Meer & Van Tilburg. The spin-offs report made clear that almost all institutes of higher education were considering following the Twente example and establishing something like a BTC. Eventually, this would be remodelled for the Leiden locale as an 'Academisch Bedrijvencentrum' (Academic Business Centre, ABC), which would subsequently function as the core of a *bioscience park*.

Ploem had been dreaming of this for years. In his inaugural lecture, *Innovatie in het klein* (Innovation in miniature, 1980), he had already referred to Silicon Valley. By way of example, he focused on FACS Systems, a spin-off from a larger firm, that developed cell separators, which had many applications in Ploem's medical-biological field:

> Together with a large number of small companies—most of which are housed in low rises surrounded by gardens—FACS Systems is situated in a laboratory park close by Stanford University in California. One finds oneself here in the area now known as 'Silicon Valley', named after the material … used for the production of so-called integrated circuits.[628]

With this image, Ploem connected successful innovation to an idyllic, parklike environment. Repeatedly, he stressed the importance for innovation processes of (informal) personal contacts, which were stimulated by keeping distances small. For the Leiden situation, he translated this American dream image into an institute for application research.[629] Like the Stanford Industrial Park in Silicon Valley, this institute had the objective to intensify cooperation between university and businesses and to offer general support to smaller companies. Ploem pictured two vertical structures, or high-rises, which were connected by horizontal bridges. On the one side, there were specialised university laboratories; on the other laboratory penthouses. Commercial parties could rent the latter at the level of their choice, so that knowledge flowed effortlessly from the academic lab, through a connecting hallway, into their penthouse. Architecturally, the institute for application research would bridge the innovation gap.

This concrete spatial solution appealed to the local business community. The Leiden chamber of commerce and the regional association Fabrieken voor Rijnland (Factories for Rijnland) welcomed the ideas for buildings that mixed science and commerce. To them, it was finally a solid response to the 'communication problem' that several entrepreneurs had already identified on several occasions. Earlier plans, like the transfer point that Leistra brought to their attention, had not satisfied them. The university had to become 'much more practical', demonstrate its 'product package' and develop a 'marketing strategy'. Business leaders like A. G. Karl, director of a Mitsubishi importer and from 1984 onwards of the

628 Johan Sebastiaan Ploem, *Innovatie in het klein* (Universitaire Pers Leiden, 1980), 3.

629 AUL, CvB, inv.nr. 4215, CvB Leiden to dr.ir. B. Okkerse, 2 March 1981. Including attachment: 'Notitie betreffende het Instituut voor Applicatieonderzoek.' Rector Kassenaar, professor Ploem and transfer officer Leistra spoke in Den Haag with the director of research policy Okkerse at the Ministry of OW.

Dutch & Japanese Trading Federation (Dujat), mobilised their personal experiences abroad to argue that the attitude of Dutch researchers could be much more positive towards the commercial world.[630] Academic representatives recalled that American industry and university research were more oriented towards each other.

Over the course of 1982, professor emeritus Willy Brand introduced the idea of a shared laboratory building to the Leiden entrepreneurs. Brand, specialised in developmental economics, had recently been named chair of the CCB. He mentioned the BTC Twente as example and emphasized that also in Leiden the municipality had to take care of the 'spatial conditions (such as infrastructure)'.[631] So far, the city of Leiden had been interested only in *generic* shared office buildings, in the hope that the financial advantages would attract small business owners to the area. The university, represented by rector Kassenaar, tried to win over the local business community so that together they could pressure the municipal government into supporting a shared space for 'high technology businesses'. The plans for such a building provided concrete common ground where the local academic and commercial communities could do something about the 'communication problem'.[632]

The talks between university and business representatives took place at the Leiden chamber of commerce within the Commissie Contacten Universiteit (University Contacts Committee, CCU), which was established in early 1982 as a platform for academics to present themselves to the city's entrepreneurs. To resolve questions about the feasibility of a shared laboratory building, the chamber of commerce commissioned an advisory report from Frons, a consultancy specialised in regional economic development.[633] Social geographer S. A. van Keulen carried out a feasibility study into the 'concentration of facilities … for the purpose of effective cooperation and symbiosis between the business world and the university departments'. In the final report, *Een Know House voor de RUL?* (A Know House for State University Leiden?), he drew quite reserved conclusions.[634] Frons was 'sometimes even very sceptical' about the applicability of Anglo-American examples to the Dutch situation: both in the US and the UK, many 'science parks' emerged as part of a broader development of business parks, whose attractiveness and effectiveness was often exaggerated by project developers and regional governments.[635] Instead of dreaming big, the consultant tried to lower expectations, especially of the academics involved. The proposals of the university working group for the building were perhaps overambitious: the imagined academic business centre not only housed, but also supported and stimulated, spin offs; and it had to be a place for 'commercial production' following the results of academic research; and it had to

630 NA, Secretariaatsarchief van de Kamer van Koophandel en Fabrieken in Leiden/Kamer van Koophandel en Fabrieken voor Rijnland (KvK-Leiden), 3.17.27 inv.nr. 342, minutes Commissie Contacten Universiteit (CCU), 5 March 1982; 2 July 1982; 8 October 1982.

631 NA, KvK-Leiden, inv.nr. 342, minutes CCU, 2 July 1982.

632 Ibid.

633 NA, KvK-Leiden, inv.nr. 342, minutes CCU, 5 maart 1982.

634 S. A. van Keulen, *Een know-house voor de Rijksuniversiteit Leiden? Verkenning van realiseerbare mogelijkheden voor een advies inzake een laboratorium verzamelgebouw of soortgelijke faciliteiten ten behoeven van het bedrijfsleven, te realiseren in nauwe relatie tot de Rijksuniversiteit Leiden.* (Amersfoort: FRONS, 1983).

635 Keulen, 8–10.

be responsive to temporary research needs of existing large companies. In terms of existing utility spots, the planned Leiden centre was a combination of the BTC Twente, Ploem's institute for application research and Anglo-American science parks.

In the consultants' eyes, there was little solid ground on which to build these ambitions. The academics had not paid much attention to the match between university expertise and local industry. From quick market research, Van Keulen concluded that the surrounding region housed very little science-based industry. The available academic expertise, on the other hand, was quite specific and entailed different disciplinary demands for the new utility spot. For fields like micro-electronics and social sciences, small spaces for knowledge exchange could easily be accommodated in existing buildings. While this 'light know house' was cheap and efficient, it would not suffice for biochemical, pharmaceutical and medical technology projects. These required a 'heavy know house', in a new building and with advanced, immobile laboratory facilities.[636] But, taking the scarcity of high-technology industry in the area into account, Van Keulen strongly advised against this heavy and more expensive option. If the existing transfer point improved its 'aftercare', it would suffice as contact point for most local and regional enterprises. This aftercare consisted of putting more effort into bridging the gap between what was considered 'scientifically concluded' and what was 'ready to be applied in production'. From the other end, the SME in the Rijnland region would have to drop their initial hesitations about cooperating with the university. Only then could they really profit from the (low-cost) support from science.[637]

Frons' recommendation was a light know house: the transfer point as a distinct entrance for third parties and about fifteen small, temporary and low-tech laboratory spaces. The university working group was underwhelmed and characterised this the *kasplant optie* (hothouse plant option). At most, it was a testbed for a potential expansion at a later stage. First, small innovative businesses had to be attracted through boosted mediation activities: commercials, summer courses and 'service subscriptions'.[638] The university board was quite elated about the active involvement of the Leiden business world with their plans, and promised to keep them in the loop.[639] Also the Frons consultancy remained engaged: it secured a subsidy, of *f* 450,000, from an employability fund of province Zuid-Holland, advised about the concrete design of the shared laboratory space and undertook more elaborate market research.[640] In the midst of 1983, the actors for the first time spoke of the *Academisch Bedrijven Centrum*, or ABC (Academic Business Centre), for what they had once imagined as an application lab, BTC or know house.[641]

636 Keulen, 14–20.

637 Keulen, 45–49.

638 AUL, CvB, inv.nr. 2093, 'Rapportage door Werkgroep Laboratorium Verzamelgebouw,' March 1983.

639 AUL, CvB, inv.nr. 2093, CvB to KvK, 'Kennistransfer,' 15 June 1983.

640 Erfgoed Leiden (EL), Stadsarchief Leiden (SA VII), 1001C inv.nr. 610, Zuid-Holland Province to Leiden municipal executive, 'Toekenning subsidiebedrag project Werkgelegenheidsfonds,' 13 April 1984.

641 AUL, CvB, inv. nr. 2093, Frons, *Opzet voor een Academisch Bedrijvencentrum in de gemeente Leiden* (Amersfoort 1983).

5.7 Science Parks: National Experiments, Regional Hope

The establishment of transfer points and academic business centres in the early 1980s reflected and shaped the displacement in the organisation of university knowledge transfer mentioned earlier—from relevance to innovation. Several parties had an interest in an increased focus on exchanging knowledge *and* values with the business world in particular. Local enterprises and regional associations of SME were in need of innovative products and new markets. The ministries of Economic Affairs and Social Affairs had a stake in restraining unemployment and stimulating new 'knowledge-intensive' commercial ventures. With the help of job creation measures [*werkverruimende maatregel*], for example, innovative companies and transfer points could deploy jobless academics, who retained their unemployment benefits.[642] Banks, pension funds and foreign multinationals, at the same time, were on the lookout for the next high-tech start-up that would boost their profits in a dull market. Researchers at university departments suspected budget cuts and hoped to increase their income from the 'third stream' to ensure the continuity of their programmes. In fashionable fields, like biotechnology and micro-electronics, the idea even lived that *only* in commercial settings could certain scientific findings be developed appropriately. And surrounding all this, swarmed economic and management consultancies that advised universities, governments and businesses how to reform their practices and culture to be on the winning side.

These political-epistemic coalitions gathered around the initiatives for transfer points and business centres in close spatial proximity to university laboratories. The next step would be the creation of a *science park*, in which research, knowledge exchange and commercial development could flourish in true symbiosis. At least, that was the lesson that most local actors drew from British and American examples like Cambridge Science Park, Stanford Industrial Park in Silicon Valley and Mile 128 close to MIT. A *science* park was considered to comprise the establishment of new and existing companies, preferably in the high-tech sector, close to a scientific or technological research institution, like a university, a polytechnic or a government laboratory. Typically, not the entire company, but only its research and development department would relocate to the science park. As for the *park* aspect, lush greenery, ponds and picturesque walking paths surrounded the companies, which were housed in modernistic low rises. As a whole, the physical proximity of science and commerce in a science park produced an image of dynamic creativity, serendipitous encounters and effortless knowledge transfer. This image also appealed to the Dutch imagination, in politics, science and broader culture. Amusement park *De Efteling* planned to open

642 AUL, CvB, inv.nr. 2093, 'Laboratorium Verzamelgebouw. Nota in vervolg op nota dd. 21-9-'83.' It was reported that Leiden counted the highest number of unemployed academics (750) of all university towns.

a *Cosmo-Science Park* and the three architects competing for the Prix De Rome of 1986 were in the final round requested to design a *wetenschapspark* (science park) on the Marineterrein in Amsterdam.[643]

Again, there was a politics to proximity. Several journalists and researchers did not share the innovation enthusiasm. Cynically, they spoke of *wetenschapsplantsoenen* (science gardens), *recessietaal* (recession language) and *wildgroei* (morbid growth) whenever a municipality or university proudly announced a new science park.[644] This scepticism was not wholly unfounded, as several towns and project developers had stakes in, or speculated on, land use: 'any self-respecting municipality prefers to pass off fallow industrial terrain under the guise of science park.'[645] In addition, quite some researchers were critical of the proximity argument for economic development.[646] Local city councils and institutes of higher education maintained that this was not just a rhetorical image to safeguard ulterior interests. The proximity that characterised science parks, they stressed repeatedly, was truly crucial for smooth knowledge exchange. At first, the Frons consultants considered locations more distant from the university: cheaper, less affected by regulation and politically uncontroversial. But the board of Leiden University pressured Frons to include the proximity argument in its advisory report. Which Frons did:

> experiences abroad have taught us that the right distance is a very delicate issue, similar to shopping malls and bus stops. A researcher is as *lazy* as a bus passenger; if he has to walk more than a few hundred metres for a meeting or advice, forget about it. In that way, the knowledge potential of the university remains unutilised.[647]

Science parks also incited spatial politics on a larger, regional scale. A 'Silicon Valley on the Dinkel river', for example, was supposed to revive the Twente region in the east of the Netherlands. At the polytechnic in Enschede, the city council therefore started a Business and Science Park, around the previously founded BTC.[648] To support such initiatives geared at industrial renewal, the national government had established regional development companies. The subsequent oil crises and globalisation in general had hit regions like Twente, Limburg and Groningen hard. It made it even more difficult for them to recover from the disappearance of mining and textile industries. The development companies distributed loans and subsidies to execute 'integral structural plans'. In Twente and in Groningen the plans for a science park fitted the ambitions of the regional development companies. In these geographically peripheral, and economically deprived, regions, science parks were symbols of hope, renewal and employment—an image that universities and city councils gladly used to wrangle government funds.

643 The *Prix de Rome* organisers acted with remarkable foresight: since a few years, the Marineterrein is officially being developed into an 'urban district with space for open innovation, special forms of housing, sports, recreation and greenery', http://marineterrein.nl/en (visited June 23, 2020).

644 '"Science Park", Terlouw en Groninger hardnekkigheid', *Leeuwarder Courant*, 10 February 1983; 'De taal van de recessie,' *NRC Handelsblad,* 6 July 1983; 'Wildgroei van science parken baart wetenschappers zorgen,' *De Volkskrant*, 23 December 1988.

645 'Budel in the air,' *De Volkskrant*, 3 June 1988.

646 M. S. van Geenhuizen, "Science Parks, een eerste inventarisatie," *Stedebouw en volkshuisvesting* 68, no. 5 (1987): 168–75; Evert-Jan Witteveen, *Science parks en wetenschappenlijke bedrijvencentra in Nederland: diffusie of illusie van technologie* (Rotterdam: Erasmus Universiteit Rotterdam, 1989); Massey, Wield, and Quintas, *High-Tech Fantasies*.

647 AUL, CvB, inv. nr. 2093, Decisions and memoranda, CvB Leiden University, 22–23 maart; 22 april 1983; Frons, *Opzet voor een Academisch Bedrijvencentrum in de gemeente Leiden*, (Amersfoort 1983), 3.

648 Boer, *Een kleine en kwetsbare instelling*, 198; 'Business- & science park Enschede is succesvol,' *Nederlands dagblad*, 25 January 1986.

The science park in Groningen, for example, was sold as a 'national experiment' to the committee of the integral structural plan for the 'North of the Country'.[649] Although the experiment fitted within these regional themes and national structures, it were local individuals who fuelled it. Biochemist Bernard Witholt took the lead, in the early 1980s, and imagined a vibrant science park on the fallow university terrain called the Paddepoel. The Dutch professor, who was also a naturalised American, captured his thoughts on innovation in a somewhat woolly report. A science park in Groningen was, in his view, part of a globally interconnected system: the spread of new technologies was making the world economically homogeneous and the planet Earth increasingly became a 'completely integrated organism'.[650] This inescapable integration should not, as in the preceding decades, be left to (inter)governmental think tanks or multinationals (cf. chapters 3 and 4). Instead, in the eighties, small innovative high-tech companies would call the shots. The university was genetically related to these new world leaders: it was the 'womb and day care' for 'embryonic enterprises'. The science park, surrounding the university, was the next pedagogic step: 'an elementary school for young technological entrepreneurs.'[651]

Witholt and some other professors gathered the support of the Groningen university board, with whose help they requested government subsidies. As in the Leiden case, an economic consultancy firm functioned as hinge between academics, business leaders and public authorities. The Ministry of Economic Affairs involved Job Creation BV to evaluate the science park plans from the North of the country. In this way, the ministry explicitly placed Witholt's plans in the framework of regional economic development and employment. Job Creation namely had experience with establishing shared office buildings in response to massive redundancies in the technical sector. Both in the UK steel industry and for a data subsidiary of Philips in The Hague, Job Creation attempted to create conditions and support with which the technically skilled workers could start new firms.[652] The management advisors applauded the 'courage and imaginative power' in Groningen. But they seriously doubted the plan's emphasis on making fundamental research applicable.[653] Before, policy officers of the Ministry of Education and Science had also interpreted the optimism in Groningen as founded in 'a naïve approach to complex matters'.[654] From a management perspective, Job Creation therefore recommended that an 'energetic' professional manager, marketing support and technological entrepreneurs were added to the set-up. The ministry agreed, and made the subsidy to the university conditional on implementing the consultants' advice: extra-academic actors functioned as experts on the question of innovation on the academic campus.

649 NA, Ministerie van Onderwijs en Wetenschappen: Directoraat-Generaal voor Hoger Onderwijs en Wetenschappelijk Onderzoek 1975–1992 (OW-DG HOWO), 2.14.5168 inv.nr. 5297, 'Rijksuniversiteit Groningen: Science park experiment 1982–1984.'

650 Bernard Witholt, *Science Park Groningen. Innovatie: Waarom, hoe, waar en wat* (Groningen, 1981), p. 2.

651 Witholt, 5–15.

652 NA, Kamer van Koophandel en Fabrieken voor 's Gravenhage 1978–1989, 3.17.13.06 inv.nr. 213.

653 NA, OW-DG HOWO, 2.14.5168 inv.nr. 5297, 'Analyse van een voorstel voor een science park aan de Rijksuniversiteit Groningen,' 4 February 1983.

654 NA, OW-DG HOWO, 2.14.5168 inv.nr. 5297, Memorandum 'Science Park RUG: commentaar op het rapport van de interfacultaire commissie,' by dr. C. A. Ladage (OCW), 23 August 1982.

In subsequent years, the structural funds were diverted to establish the Stichting Science Park Groningen (SPG Foundation). As figurehead, they searched for a 'dynamic' leader with 'pronounced entrepreneurial qualities'. SPG offered a financial and organisational framework for commercialisation of scientific research, for example by tracking and supporting starting entrepreneurs with 'innovation stipends' (cf. practices in Twente).[655] As in Eindhoven and Leiden, the local city council and chamber of commerce were enthusiastically involved in the north-east of the country. Even in Groningen, which was typically of a 'red', social-democratic orientation, there were in the background only some 'whispers of criticism about the capitalistic tenor of these plans'.[656] When national budget cuts threatened the technical subjects, the chamber of commerce threw itself into the breach for the university. The controversial ministerial budget-cuts operation *Taakverdeling en concentratie* (Task division and concentration) aimed to cut back numbers of courses on offer at each university and thus distribute specialties over the country. In Groningen, applied chemistry and applied physics were on the ministerial budget-cut nomination list. The chamber of commerce argued, however, that these 'regionally relevant' subjects should stay at Groningen, especially because they were crucial to the science park in the making.[657]

5.8 Bio Science Park Leiden: Political Compromise and Risky Research

As in Twente and Leiden, in the Paddepoel in Groningen they also first built a shared office space (the Zernikom) before extending the national experiment to the establishment of new companies on a 'Zernike science park'. In Groningen, this had been the aim from the start, but in Leiden the establishment of a *bio science park* followed the transfer point and academic business centre in a more ad hoc fashion. Two factors, one local and one international, created the opportunity for the city council and Leiden university board to baptise the 'Leeuwenhoek' polder into a science park.[658] On the one hand, the zoning plan for this area, where many university laboratories were situated, was the subject of a political conflict between local politicians, the university and the business community. On the other hand, American biotechnology companies wanted to open European subsidiaries in Leiden, initiated by university professor Rob Schilperoort. Where the first issue made local actors susceptible to the idea of industrial activities around the university by way of compromise, the second pushed developments into a higher gear. Above all, the Leiden case demonstrates that the international circulation of a shiny spatial model can occur only when it fits with local networks and concerns.

655 Ton van Helvoort, "De publieke functie van universitaire wetenschapsbeoefening. Amerikanisering als leidmotif bij de scheikunde aan de Groningse universiteit," in *Onderzoek in opdracht: de publieke functie van het universitaire onderzoek in Nederland sedert 1876*, ed. L. J. Dorsman and P. J. Knegtmans, Universiteit & Samenleving (Hilversum: Verloren, 2007), 91.

656 'Een dagje campagne met de Partij van de Arbeid,' *Nederlands Dagblad,* 13 May 1986.

657 'KvK: regio-gericht beleid RUG moet worden gehandhaafd,' *Nederlands Dagblad*, 2 February 1983.

658 Leeuwenhoek refers to the early modern microscopist Antoni van Leeuwenhoek (1632–1723), but also translates literally as lion's corner.

The ground politics of the Leeuwenhoek polder played a role in the establishment of a science park. After the Second World War, all Leiden university natural science departments and laboratories were gradually relocated to this former farmland north of the Amsterdam–The Hague railway line. In this way, environmental risks from experiments and inner-city disturbances were avoided as much as possible. A decade before business centres, know houses and science parks became the talk of the town, tensions between the municipality, the university and the state started to arise about the use of the Leeuwenhoek. In the 1960s, the university aired its discontent about high land prices, which the city justified by claiming they were making big sacrifices too. In 1975, state intervention seemed to lighten the atmosphere: the government bought 31 hectares in the Leeuwenhoek to build a new academic hospital.[659] In 1977, however, the Ministry of Education and Science changed strategy and decided to establish the new buildings on the original hospital location. When they acquired the plot of land, the ministry had stipulated that it could compel the city of Leiden to buy it back. Subsequently, both the city and the university claimed to have first right to the land that fell vacant.

It was not long before the city and the university 'locked horns' about the zoning plan and property relations in the Leeuwenhoek polder.[660] They interpreted the government's intentions differently. Councillor Waal (PvdA) believed that the buy-back was clearly intended to provide the city with more building opportunities, while the university board emphasized that the area was still purposed for university use (viz. the 1975 zoning plan for the Academic Hospital). The academics planned a new faculty of Social Sciences, an expansion of the biology laboratories, student housing and the relocation of the botanical laboratory in the newly available space.[661] City counsellors, on the other hand, sought solutions for the Leiden housing shortage: between and around the laboratories they proposed to build around 2,000 homes.[662] For a short while, it even seemed like the Nederlandse Aardolie Maatschappij (NAM, Dutch Oil Company), performing a geological survey, would also get involved in this battle for the potential of the polder.[663]

The plan to build houses in the Leeuwenhoek also encountered resistance within the city council. Once, the laboratories had been moved from the densely populated city centre out of public safety concerns. Now, one would invert this logic by bringing residential areas back to the experimental spaces. And, what was more, new concerns had risen about the safety and health risks of the laboratories, as well as the storage and transport of chemicals, radioactive waste and toxic emissions.[664] A tirade by scientist Dr. S. J. Roorda, manager of the Gorlaeus Laboratory for chemical and life sciences, stirred up the debate. In the university newspaper *Mare,* he fumed that the radioactive hydrogen isotope tritium was 'belching

659 'Grondverkoop vrijwel rond in Leeuwenhoek. Voor nieuwbouw AZL en universiteit,' *Leidsch Dagblad*, 21 February 1975. This plan reserved about 11 ha for 'shopping and dwelling'.

660 'Leiden en de universiteit in de clinch over Leeuwenhoek,' *Leidsch Dagblad*, 18 December 1978.

661 'Hortus Botanicus naar Leeuwenhoek,' *Leidse Courant*, 16 July 1977; 'Universiteit wil sociale faculteit in Leeuwenhoek,' *Leidsch Dagblad*, 9 June 1978.

662 'Prijsvraag voor gevarieerde bouw in Leeuwenhoek,' *Leidsch Dagblad,* 25 October 1977; 'Gemeente wil 2458 woningen bouwen in Leeuwenhoek. Veel aandacht voor bejaarden en studenten,' *Leidse Courant,* 4 January 1979.

663 'NAM gaat bodem Leeuwenhoek onderzoeken. Metingen staan bouwplannen niet in de weg,' *Leidse Courant*, 26 January 1979

664 'Raadsleden beducht voor gevaren laboratoria. Risico's in Leeuwenhoek te groot voor woningen?' *Leidsch Dagblad*, 16 February 1979.

out of the chimney' of the Sylvius Laboratory, a biochemical research facility. Although both the public health inspector and the university board rejected these claims, the image of a hazardous area remained.[665] Additional risk analyses of the entire area, by Adviseurs voor Industriële Veiligheid (Advisors for Industrial Safety, AVIV) and the public health inspectorate, did not provide definitive answers either. To the discontent of both the university and the city council, the experts refused to burn their fingers on delicate issues like the exact radius of safe zones around laboratories. Ultimately, they declared, situating housing in the Leeuwenhoek was a *political* choice.[666]

The university put the risk analysis to good use by building a substantive argument on top of it: academic research and teaching activities might be impeded by future conflicts with surrounding residents.[667] The laboratory managers put more flesh on the bones of this argument, by claiming that the continuing development of science would create only more and more previously unknown and potentially hazardous substances. The implied unpredictable risks of innovative scientific research hinted at the broader societal discussion about recombinant DNA research, in which 'progressives' and 'nature conservers' held opposite views on the amount of restrictions on genetic manipulation.[668] This (inter)national debate also existed in miniature in the Leeuwenhoek. In the local newspaper, *Leidsch Dagblad*, progressive thinker and biochemistry professor Rob Schilperoort faced nature conservationist Lucas Reijnders, representative of Natuur & Milieu (nature and environment, a non-profit foundation). Whereas Schilperoort considered the potential environmental and ethical harm of genetic manipulation negligible, especially in comparison to 'the petrochemical industry or exhaust fumes', Reijnders took the risks and public fears much more seriously.[669] This translated into spatial terms with respect to different types of genetic research, categorised in different risk levels from C-I to C-III (forbidden anywhere in the Netherlands at that point). In the Leeuwenhoek, laboratories could not be established on the campus grounds closest to residential areas, and those more remote only allowed up to medium risk C-II research. The fact that no ordinary citizen turned up for the public hearing about plans for C-I level research in Leiden was evidence for Schilperoort that these concerns were 'fear of the unknown'. A fear that could not challenge the incredible potential of biotechnology.

The laboratory managers navigated this debate by claiming that limiting the use of such substances would infringe the 'societal obligation' of the university .[670] Thus, they capitalised on the public fears, to recommend strongly against placing housing in the Leeuwenhoek, so as to prevent future conflicts. The Ministry of Education and Sciences, still awaiting an agreement between university and city about the use of the land, endorsed this argument of the academics in a letter to

665 Tritium is a radioactive (and extremely rare) isotope of hydrogen gas. 'Raadslid wil afzien van woningen in Leeuwenhoek. Walenkamp (CDA) gealarmeerd over gevaar Sylvius laboratorium,' *Leidsch Dagblad*, 20 April 1979; EL-SA(V), 1001A inv.nr. 2930, 'Verklaring College van Bestuur Leiden n.a.v. interview met Dr. S.J. Roorda in Universiteitsblad *Mare*,' 25 April 1979

666 EL-SA(V), 1001A inv.nr. 2930, Municipal executive Leiden to AVIV, preliminary contract for Leeuwenhoek risk analysis, 17 April 1979; 'Leidse raadsleden willen vervolg-onderzoek: "Beperk risico's in Leeuwenhoek,"' *Leidsch Dagblad*, 30 January 1980; 'Na advies inspectie volksgezondheid. Leeuwenhoek in impasse,' *Leidsch Dagblad*, 11 September 1980.

667 'Woningbouw in de Leeuwenhoek niet verantwoord. Leidse universiteit vindt de risico's te groot,' *Leidsch Dagblad*, 7 March 1980.

668 B. C. J. Zoeteman, *Biotechnologie en de dialoog der doven: Dertig jaar genetische modificatie in Nederland* (Bilthoven 2005).

669 'Resterend risico verwaarloosbaar' and 'Lucas Reijnders: Gevaren worden altijd onderschat,' *Leidsch Dagblad,* 23 May 1981. See also: Rob Schilperoort, *Het Dynamisch DNA. Een molecuul met geschiedenis en toekomst.* (Leiden: Universitaire Pers Leiden, 1980).

670 EL-SA(V), 1001A inv.nr. 2932, prof. E. Havinga to CvB, 22 January 1980; *Leidsch Dagblad*, 7 March 1980.

councillor Waal: 'given the societal relations at the moment', future residents could, legitimately, sue for the closure of university buildings, based on the risk analysis.[671] It might not come as a surprise that by 1980 there was a 'slightly irritated atmosphere' in Leiden.[672]

The *innovative* landscape of a *science park* turned out to be a compromise in this long-drawn-out conflict. In the autumn of 1979, it was again Leiden professor Egbert Havinga who proposed a spatial compromise for a political-epistemic issue (ten years earlier, he had pointed Piekaar and Uhlenbeck to what became NIAS villa in Wassenaar). Concurrent with the publication of the government's innovation memorandum, Havinga suggested a science park idea in response to the risk analyses of the Leeuwenhoek. The organic chemist reasoned that establishment in the area of 'clean, advanced industries with relations to the university' was in everyone's interest. An industry park close to the laboratories would lead to:

> stimulating interactions between neighbours (industry) and university … as a consequence of the easy exchange of ideas, experience and *know how*. Industry will flourish under such beneficial conditions and will make a positive contribution to employment.[673]

After Havinga had proposed this to the spatial policy and building service of the university, he repeated his advice in a memo to the university board in January 1980. Subsequently, the proposal was forwarded to the university and city councils.[674] By that time, Havinga's plan had received support from an unexpected ally. During his new year's speech, the chairman of the chamber of commerce—A. Koningsveld, director of a Leiden plating company—attacked the city council for its lack of a daring, offensive economic policy.[675] As an aside, he elaborated upon the importance of increasing cooperation between scientists and entrepreneurs. It was his 'little fantasy' to develop an industrial park with high-end employment in the 'controversial Leeuwenhoek', similar to the 'spectacular example in California'.[676] The hope that 'something like Silicon Valley' would develop in Leiden also convinced the city politicians; after another year of tussle about the zoning plan and safety zones, the municipality agreed to the establishment of office space and industrial buildings, rather than housing.[677]

From this political perspective, the science park appears not only as a compromise in a local conflict between city and university, but also as in tune with the needs of entrepreneurs and the ministry. Similar developments at Utrecht University demonstrate that this was not just a local curiosity of Leiden. Since the first plans existed to move all university departments (since the 1950s) to an outer-city area, the Uithof, the zoning plan strained relations between the university, city politics

671 EL-SA(V), 1001A inv. nr. 2930, mr. J. Donner (OW) to Mr. C. J. D. Waal, 'Leeuwenhoek,' 11 April 1980.

672 EL-SA(V), 1001A inv.nr. 2930, Telegram by municipal executive Leiden to CvB, 17 March 1980.

673 EL-SA(V), 1001A inv. nr. 2932, Havinga to CvB and director of Spatial Policy, Buildings and Material Affairs ir. W. C. Wildervanck, 20 November 1979.

674 EL-SA(V), 1001A inv. nr. 2932, CvB to university council, 'Voorstel Leeuwenhoek,' 5 March 1980.

675 'KvK haalt fel uit naar Leids gemeentebestuur,' *Leidsch Dagblad*, 8 January 1980; 'Gedachten-experiment in Leiden. Industriepark bij Leidse universiteit?' *Chemische Courant*, 10 January 1980.

676 When policy officer Leistra took stock of possible innovation initiatives in early 1980, contacting Koningsveld was at the top of her list. AUL-CvB, inv. nr. 2415, 'RUL en innovatie,' 14 February 1980

677 'Akkoord Leeuwenhoek. Gemeente doet stap terug: minder woningen,' *Leidsch Dagblad*, 21 October 1981.

and local entrepreneurs. Early in the 1980s, the city switched from a mono-functional to a multi-functional approach to city planning. Now, the Uithof could no longer consist merely of buildings with a teaching and research function and the city council planned housing in between the laboratories. As at Leiden University, the academics at Utrecht feared the accompanying stricter environmental regulations. In line with the then fashionable 'mixed' urban development ideas, planner Groeneveld advised in his report to follow the suggestion of the local chamber of commerce: to situate small businesses oriented to the university at the Uithof. This compromise was the best way out of the 'deadlock in the decision-making process'.[678] Ultimately, in the 1980s, no science park would be developed in Utrecht, according to one journalist because the distances to the scientific institutions were already small enough.[679] The epistemic arguments applied in both the Leiden and Utrecht case—the importance of physical proximity for knowledge transfer, the unpredictable risks of new scientific developments, and the freedom from environmental restrictions required for academic work—clearly also served as support for a compromise in spatial politics.[680]

The fact that a few years later, in 1985, road signs with *Bio Science Park* appeared in and around Leiden had to do with the active involvement of one Leiden biochemist in the global rise of biotechnology. Professor Rob Schilperoort played a central role, mostly behind the scenes, in drawing American biotech companies to the Leeuwenhoek. In the late 1970s, he had been riding the international wave of biotechnology and he was praised for his scientific work on the genetic causes of plant diseases. Besides his scientific work, he became the linchpin in Dutch (bio) technology policy, especially as chairman of the Biotechnology Programme Committee (PCB). The PCB had been installed, in 1981, jointly by the ministries of Science and Economic Affairs in response to the series of innovation reports that called for a new industrial zeal. Under Schilperoort's leadership, the committee inquired amongst scientists and industrialists which knowledge and skills were required and feasible in the biotechnology field. On the basis of this survey, they developed lavishly funded 'innovation-oriented research programmes'. These had the general aim to orient scientific research more towards the market, and specifically to connect university biotechnology to existing business by way of more application-oriented research.[681] To foreign companies and investors, the PCB was introduced as some kind of *supertransferpunt* (super transfer point) for the entire field of Dutch biotechnology.[682]

Schilperoort functioned as the figurehead of this super transfer point. The Dutch commissioner's office for foreign investments used his international scientific network and excellent reputation whenever they tried to convince American biotechnology enterprises to establish branches in the Netherlands.[683]

678 J. C. Groeneveld, *Science park: mogelijkheden voor Utrecht. Een oriënterende studie in samenwerking met de Kamer van Koophandel en fabrieken voor Utrecht en omstreken en het Planologisch en Demografisch Instituut van de Universiteit van Amsterdam.* (Utrecht, 1983), 74–80.

679 'Over de zin en onzin van science parcs bij universiteiten,' *NRC Handelsblad*, 22 August 1989.

680 Today, however, the entire Uithof is dubbed a science park. See: Marja Gastelaars, "Wie er wel naar toe verhuisde en wie niet. De selectieve verhuisbewegingen van de Utrechtse faculteiten richting Uithof," in *De universitaire campus. Ruimtelijke transformaties van de Nederlandse universiteiten sedert 1945*, ed. A. C. Flipse and A. Streefland, Universiteit & Samenleving 15 (Hilversum: Verloren, 2020), 99–118.

681 Programmacommissie Biotechnologie, *Innovatieprogramma Biotechnologie. Kader, hoofdlijnen en operationeel plan.* (Den Haag, 1982), p. 11.

682 NA, Commissariaat Buitenlandse Investeringen in Nederland 1967–2001 (CBIN), 2.06.173 inv.nr. 328, 'The Netherlands offers fertile soil for biotechnology companies.'

683 NA, CBIN, 2.06.173 inv. nr. 328, Maatschappij voor Industriële Projecten, 'Eerste Amerikaanse partners voor de MIP,' 11 December 1984.

The successful persuading of Centocor and Molecular Genetics, in 1984–1985, was also one of the first significant achievements for the Maatschappij voor Industriële Projecten (Partnership for Industrial Projects, MIP), a new investment vehicle of the ministry of Economic Affairs: they invested more than *f* 3m in Centocor's move to Leiden. Also Zuid-Holland province and the city of Leiden tempted the American entrepreneurs with *f* 0.25m each. In raising these local public funds, Schilperoort again played a role by interesting Ewald Keijser, a department head at Economic Affairs in Leiden, in the bio science park formula. The biochemist had become acquainted with this phenomenon on his transatlantic acquisition travels for the foreign investments office. Policymaker Keijser quickly embraced the science park idea and beamed that biotechnology would 'breathe new life into the city' and that it would dominate its economic and societal life for the coming 75 years.[684] According to Keijser, pictured in the local newspaper next to a large fermenter for the production of penicillin, the future of Leiden depended on bringing in small and medium-sized biotechnological companies. No longer a *lakenstad* (cloth city), but a city characterised by 'pure innovation, renewal to its fullest: biotechnology'.[685]

In step with the science park ideals, Keijser was convinced that the emerging biotechnological field could be fully developed, scaled up and applied in practice only under commercial conditions. Again, Schilperoort was one of the first to realise this. Together with a board member of the paint multinational AKZO, he co-founded Holland Biotechnology (HBT), which became one of the first tenants of the Academic Business Centre. It promised to transfer and translate results from academic research to the market. Market research by Licentec (a subsidiary of Control Data) convinced, among others, Rabobank, PCB and TNO to invest in late 1984 in the new small company. University professors fuelled this initiative to commercialise biotechnological results, which put the fundamental issue of commercialisation of academic knowledge on the university agenda.[686] Centocor and Molecular Genetics joined HBT in the Academic Business Centre, which ran into the limits of its capacity by the end of 1985. The university and the city decided to erect a new building for it, and city councillor Jos Fase, for Economic Affairs, was finally able to change the zoning plan in such a way that a *bio science park* could grow. The two American biotech subsidiaries were the direct occasion for this decision.[687] As mentioned above, Fase presented the move of the American companies, and the inauguration of the bio science park, as a beautiful birthday gift to the celebrating university in February 1985.[688] The relatively ad hoc decision to baptise the Leeuwenhoek *Bio Science Park* thus symbolises the displacement in ideas about and attitudes towards knowledge transfer at the university.

684 'Bio-technologie zal Leiden nieuw leven inblazen,' *Leidse Courant*, 13 September 1984.

685 Ibid.

686 De Stichting Contacten Bedrijfsleven (SCB, Foundation Contacts Business) was established to enable the university to participate in HBT, without speculating with public funds. AUL-CvB, inv. nr. 2094, 'Nota commercialisatie universitaire kennis,' 3 October 1984.

687 EL, 1640 inv.nr. 171, Proceedings Leiden city council, 11 February and 1 July 1985.

688 '"Bio-science-park" in Leiden. Ruimte voor 15 tot 20 bedrijven in Leeuwenhoek,' *Leidsch Dagblad,* 7 February 1985; 'Van Zeil slaat eerste paal: "Bedrijvencentrum goed voor kennisoverdracht,"' *Leidsch Dagblad*, 8 February 1985.

In the collective memory, Schilperoort is remembered as the helmsman of the Leiden science park.[689] This status is not undeserved, although the prominence of his role was possible only in relation to national innovation policy, local political concerns and international technological and commercial developments. But the stories of the BTC in Twente, the Zernike Science Park in Groningen, and the business contact committee in Eindhoven also demonstrate to what extent the success of an industrial park on an academic campus relies on the efforts and enthusiasm of single or a handful of entrepreneurial professors and innovative governors. Without Witholt, Schilperoort, Koumans and Kroonenberg, there would not have been an ambitious plan to begin with.

High-tech fantasies drove both university and local governments into unknown territory—and new kinds of (financial) risks. In Leiden, policymaker Keijser thought this was part of the game; the city had to act 'inspirationally', for example by investing capital via a participation company. 'Take risks, why not.'[690] Others were a little more hesitant about the economic promises of biotechnology. Prof. Arthur Rörsch, a biochemist at Leiden and TNO, had no issue with the ethical and environmental risks of genetic manipulation. But he warned the local politicians about the science park because biotechnology was 'an extremely risk-bearing business'. Rörsch predicted that three-quarters of the starting companies would go bankrupt by the end of the first year.[691] No matter whom you asked, the Leeuwenhoek was a risky area in the eighties. Some would talk about tritium or DNA, others about spin-offs and safety zones. The projection of a *science park* onto this area, was both a cause and a solution. The architecture, planning and aesthetics of the science *park* therefore had to emanate control—over all the different types of social and environmental risks—and the promise of innovative, profitable, effortless knowledge transfer.[692]

5.9 Conclusion: Science Policy at the Science Park

Dutch spaces for knowledge exchange, or utility spots, were explicitly modelled on American ideals in the 1980s: the TH Twente would become the core of the 'Dutch Silicon Valley', the University of Groningen dreamed of 'some kind of Instrument Valley' and in Leiden 'something like Silicon Valley' had to develop.[693] The rhetoric around the plans for transfer points, business and technology centres and science parks had to gather sufficient allies and support for these new spatial modalities of knowledge transfer. The (Anglo-) American models circulated in policy memoranda, advisory reports and personal experiences between universities, polytechnics and regional business communities.

689 Recently, a special 'Schilperoortpark' has been founded in the Leeuwenhoek. See Cor Smit, *BioPartner. Startmotor en smeerolie van het Leiden Bio Science Park* (Leiden: Primavera Pers, 2020) as well as recent articles by Frank Steenkamp in local and university newspapers: 'Een loopgravenoorlog om een lege polder,' *Mare*, 21 November 2019; 'Hoe een eigenwijze prof de biotech naar Leiden bracht,' *Mare*, 30 January 2020; 'Van struikelstart tot vloeiende estafette: hoe Leiden groot werd in bioscience,' *Leidsch Dagblad,* 13 March 2020; 'Bioscience is in Leiden voorlopig nog niet uitgebloeid,' *Leidsch Dagblad*, 20 March 2020.

690 'Bio-technologie zal Leiden nieuw leven inblazen,' *Leidse Courant*, 13 September 1984.

691 'TNO-topman waarschuwt Leiden voor "sciencepark,"' *Leidsch Dagblad,* 15 June 1985.

692 Cf. Wright, "The Virtual Architecture of Silicon Valley."

693 'Vallei van de winnaars,' *NRC Handelsblad*, 13 June 1981; 'Kabinet stopt 200 miljoen in Oost-Groningen,' *Parool*, 8 March 1980; 'Vestiging van twee Amerikaanse bedrijven in Leeuwenhoek: Impuls voor biotechnologie in Nederland,' *Leidsch Dagblad,* 14 December 1984.

This knowledge about and new local experiences with the science park and business centre models circulated also within Europe. The European Economic Community organised several seminars, conferences and networks to share expertise and experiences.[694] Entrepreneurial Dutch academics presented at such occasions as well. Witholt, for example, observed that regardless of the highly organised and integrated Dutch knowledge network, no science parks had ‘developed spontaneously’.[695] But, he reflected, this was largely a terminological issue, because in a way ‘much of the Netherlands can be viewed as a science park’. The ‘national experiment’ in Groningen was the first explicit attempt to direct the existing networks into new directions. But, in 1985, it existed only as organisation with a virtual presence. To become real and effective it required:

> a concrete identifiable location … where starters and project participants can meet and exchange experiences, joy and grief, and where the community can see visible evidence of the existence and growth of a Science Park in its midst.[696]

In the Dutch situation, expertise about knowledge transfer and innovation appeared to flow from the geographically peripheral institutions to the ‘centre’ in the west of the country—whereas subsidies typically flowed the other way around, to reinvigorate these economically deprived regions. From Eindhoven, Enschede and Groningen, the experiments with transfer points, business centres and science parks spread to the Randstad, as we could observe in Leiden.

Undoubtedly, science parks symbolised the future. This progressive aura consisted partly in its American nature, and partly in its scientific and economic novelty. But of course, it was an open question *whose* future exactly. That was at issue in the politics of knowledge transfer and proximity that surrounded the clashes between science shop and transfer point, city council and science park. Who counted as a ‘progressive’ depended on the political and cultural context, and the meaning of the term was fluid. In the opposition between science shop owners and transfer point translators there was a clear line drawn between progressive and ‘pragmatic’. Progressiveness resembled 1970s social-democratic ideals of a fair distribution of power and knowledge, with a special concern for underprivileged groups, and was distinguished strongly from an orientation to the market, SME and economic growth. In the recombinant DNA discussions, however, ‘progressive’ were those scientists with a nose for the commercial potential of genetic manipulation—a context in which left-leaning environmentalists were dubbed nature conservers. Local figureheads of the progressive stance were the dynamic innovation consultants, Van der Meer and Van Tilburg. They hailed the American culture of individualism and entrepreneurialism as the desirable

694 See for example: John Michel Gibb, ed., *Science Parks and Innovation Centres: Their Economic and Social Impact: Proceedings of the Conference Held in Berlin, 13–15 February 1985* (Amsterdam: Elsevier Science, 1985); Jürgen Allesch, ed., *Regional Development in Europe: Recent Initiatives and Experiences*, Proceedings of the Fourth International Conference on Science Parks and Innovation Centres Held in Berlin, November 12–13, 1987 (Berlin, New York: Walter de Gruyter, 1989).

695 Bernard Witholt, “Science Parks and Innovation Centers in the Netherlands,” in *Science Parks and Innovation Centres: Their Economic and Social Impact.*, ed. John Michel Gibb (Amsterdam: Elsevier Science, 1985), 37–47.

696 Ibid.

future for a backward Europe. Oddly enough, they legitimised this with a reference to the 'cultural philosophy of our times', E. F. Schumacher's *Small Is Beautiful* (1973).[697] This 'slogan from the seventies' had first been embraced by ecologists and 'environmental freaks' who criticised globalisation and advocated a society on a smaller scale. While 'the men who earn the money' had neglected this idea at first, ten years later 'top industrialists' appropriated the philosophy of small is beautiful: SME as 'the most important motor of the Dutch industry'.[698]

For various actors, however, embracing the science park vision was not always born out of ideals, or even a free choice. Local businesses, regional governments, universities and the state acted out of the distress of the recession. Institutes of higher education feared budget cuts, beginning with the task division operation in 1982, which fitted in with the neoliberal ideal of a withdrawing state. The new modalities of knowledge transfer discussed here accorded with the political agenda of structural renewal of the Dutch economy via innovative SME. If not for regular support and expansion of teaching and research programmes, the polytechnics and universities did find incidental grants and longer-term subsidies for these new utility spots. This conjoined new political-epistemic actors to the university: both public ones, like the ministries of Economic Affairs and Social Affairs, provincial employment funds, and regional development agencies, and private parties, like chambers of commerce, banks and foreign companies. From transfer point to science park, the scientific institutes were able to persuade familiar and unfamiliar partners to provide financial injections for knowledge transfer on campus.

Four claims about knowledge transfer were central in this development from science shop to science park. First, that there existed two gaps. One 'technological gap' between continental Europe and the more entrepreneurial United States and Japan. And one 'innovation gap', between academic knowledge production and commercial production within Europe and the Netherlands. Second, that both these gaps could be bridged by providing the conditions for new, high-technology enterprises. Additionally, this would stimulate national economic growth and regional employment. Third, that the most important condition for the successful transfer of knowledge from institutes of scientific research to high-tech start-ups was physical and geographical proximity. Fourth, it was claimed that the proximity of industry and university would also benefit the latter; the increased exchange between science and practice would reboot and reorient the creativity of academic research.

This fourfold argument materialised into utility spots, actual physical buildings for knowledge exchange, from ABC to BTC and Bio Science Park. In these utility spots, we can thus read the changes taking place in global science and commerce, in national politics, as well as in local issues and university

697 Innovatie Adviesburo van der Meer & van Tilburg, *Spin-offs uit de Nederlandse kenniscentra*, 5–6.

698 'Top-industriëlen zijn het erover eens: Kleine bedrijven gaan het grote geld maken,' *De Telegraaf*, 22 January 1983.

organisation. The physical places of exchange discussed in this chapter were the root and representation of the new article on knowledge transfer in the 1985 Dutch Scientific Education Act. This article allotted transfer points and science parks an official place within university structures. It also expressed an epistemological shift: both in policy as in particular places of exchange, the circulation of scientific results was considered integral to the practice of academic knowledge production. Ultimately, it is this article that, twenty years later, was the condition for the emergence of valorisation policy. Therefore, we should understand the concept of the valorisation of scientific knowledge with reference to the spatial model of useful knowledge production embodied in science parks. Its main characteristics were geographical proximity between academic research and small high-tech companies in a controlled environment, sustained by public and private funding, management consultancies and local political compromises, to tap as much economic value from the university knowledge reservoir.

6. Conclusion.

History and Future of Utility Spots

In this dissertation, I have situated the usefulness of scientific research in the history of post-war science, in the geopolitics of the Atlantic world, and in concrete places for knowledge exchange. Focusing on utility spots instead of prominent scientists, dominant disciplines or powerful organisations has proved to be a fruitful way to highlight the intersection of political, societal, economic, cultural and scientific developments. In this concluding chapter, I pass by these different spots once more to reflect on (dis)continuities in the utility concept with respect to different political-economic regimes and geographic regions (6.1). An important conclusion from the historical narrative is the existence of a politics of proximity. For knowledge transfer—or the relations between science and society more generally—it matters where different actors in a network are situated. To refine the utility spot concept, I will elaborate the politics of proximity with respect to literature on the importance of trust and geography for successful innovation (6.2). Consecutively, I reflect on the implications of the applied spatio-historical approach for the study of science policy (6.3). Besides recollecting how spatial issues and solutions related to various policy decisions, I will also return to the valorisation concept. Viewed through the lens of utility spots, valorisation appears in relation to the currently paradigmatic spatial model of useful knowledge production: *the science park*. In the last part of the conclusion (6.4), I turn the historical-epistemological findings towards the future: what potential does this offer to organise research in alternative ways, in response to the criticisms raised about the valorisation concept? Ultimately, this leads to a reformulation of the utility spot definition and a call for alternative spatial imaginations of useful knowledge production.

6.1 Utility Spots in Post-War History of Science, Policy and Society

At the beginning of this dissertation, I introduced the utility spot in a dialectical fashion to cover the common ground between the *utility* and the *spatiality* of scientific research. More particularly, I proposed utility spot as *heuristic* concept to uncover this intersection in historical reconstructions of the policy and practice of publicly funded research. In section 1.7, I formulated a preliminary definition to enable the identification and interpretation of such spots in post-war history of science, policy and society:

> Utility spots consist of the spatial arrangements that facilitate and stimulate the political-epistemic interactions between heterogeneous actors, which actively shape the significance of research, with the public aim of creating and circulating useful scientific knowledge.

As I mentioned at the conclusion of the historiographical survey of post-war US science, the concept functions on an analytical level different from that of terms coined to characterise a specific, localised phenomenon. Instead, 'utility spot' stands for a methodological approach to study the history of science, universities and their societal meaning in space. As methodology, it implies both historical and philosophical hypotheses. Historically, it suggests not only that such spots existed but also that they played roles of importance in the organisation and legitimation of science, in the post-war period specifically. Philosophically, utility spots assume that there exists a relation between the spatial organisation of research, the network of actors involved, and the possible kinds of knowledge created. In the next three sections I will discuss both these philosophical and historical consequences to arrive at a more refined definition. First, I discuss the historical results from the spatial approach to utility.

My survey of spots has not aimed to be comprehensive, and I had to limit myself to discussing a handful of examples that exemplified diverse aspects of utility. Still, it seems warranted to claim that in the second half of the twentieth century there was a remarkable increase of hybrid spaces between academic research, extra-academic research, industry and society more generally. Such spaces both emerged from the bottom up and were purposively built and implemented from the top down. Abstractly, these two contexts of origin also represent two ideal-type reasons for existence of utility spots: either *in response to* increased interactions between different actors and practices in existing epistemic spaces, or *as stimulation of* new interactions between different actors and practices in a new epistemic space. A utility spot can therefore resemble both the *displacement* and the *establishment* of useful research. In the first analytical case, the study of utility spots not only is instructive for our understanding of the historically changing concept of utility, but also can highlight developments within the mother institution(s) and wider society. For example, the study of the Delft Technical-Physical Service highlighted the spatial frictions caused by 'sponsored research' within Dutch and European universities and polytechnics in the 1950s. The second analytic category of utility spots concerns places that are established from the top down to demand an increase in a specific type of interaction. The 1980s transfer points that aimed to stimulate contact between SME and university science are a case in point.

Most utility spots are of course not instances of either ideal type. Rather, in most cases a particular space is the result of existing relations between heterogeneous actors as well as of political, societal and economic arrangements that maintain or stimulate them. The science park type of utility spot is perhaps the most telling illustration. In the Leiden case, the science park allowed space for already occurring interactions between biochemists and entrepreneurs and was increasingly vindicated by investors as well as stimulated by local, regional and national political actors. There is no simple bottom-up or top-down causality to be uncovered. It was locally situated scientists who tapped ideas for new hybrid spaces for useful knowledge production from their international networks, which they then sold successfully to governments at different levels, so that they could structurally enable and stimulate the development. But the eventual realisation of such utility spots again relied heavily on local political-epistemic alliances. Many utility spots that I have identified in the post-war period are hybrid not only because of their situation in the liminal space between science and society, but also in the sense that they are the result of, and an active element in, political-economic, societal and scientific relations.

Utility spots are not just local nodes in a global network; the models of utility spots also circulate themselves. How this works out, emerged from the three historical reconstructions of utility spots in Europe and the Netherlands. The circulation of exemplary models from the US was indeed almost omnipresent in this period. But perfect imitation was rarely possible or even desired by European actors. As models, these utility spots are mutable mobiles: they change significantly because of the displacement. And, as particular place, they often turn out to be very 'regional', i.e. functional because of local circumstances and infrastructures that are difficult to understand and/or transfer. Also the circulation of circulation models thus takes place in both geographical and network space: it can change content, meaning and appeal in the process of displacement. Whenever a utility spot appears to travel, in the form of (published) personal experiences, consultancy reports, science policy meetings or floor plans, we need to be aware of the contextual aspects both of its origin and of its destination. Spatial models for useful knowledge production can thus function as a distorting mirror. From different angles, the mirror reflects different contexts, places and histories. For the case of the science park, for example, the mirror reflects intermittently the American geography of the military-industrial-academic complex, the changing appreciation of fundamental research in industry, the appeal of American entrepreneurial culture to Europeans, and the spatial politics in Dutch cities and provinces.

Although utility is typically associated with technological wonders and scientific breakthroughs, my study of utility spots demonstrated how it also shapes the humanities and the social sciences. The description of the historical origins of NIAS in discussions about a European university demonstrated that the same paradigmatic examples—like the industrial research laboratory—informed their organisation, image and appreciation. Two notable insights about the historicity of utility ensued. First of all, there is a geopolitical dimension to diverse meanings of utility. The (international) political forum on which utility spots are discussed imply, for example, economic, cultural, or military connotations of possible usefulness. In addition, these meanings have a geographical dimension, based on which countries are included in the discussion, from Atlantic or 'western' to European (with or without the UK)—and many more could be added. Second, the connection between concepts of utility and a particular spot, either existing or planned, is fluid. We have seen how the utility embodied by various virtual European universities fluctuated over time and resulted in a Dutch plan that progressively dropped most of these connotations. And although the finally established NIAS responded to all these concerns, and legitimised itself in terms of complementary utility, it was ultimately a reproduction of an isolated, rather than an open and interactive, ideal of knowledge production. Through the study of utility spots we thus learn that the imagination of a relation between research and usefulness can have counterintuitive effects.

This brings me to the historical result that utility spots function not only as places but also as plans. That is, already the idea of a potential place brings together diverse actors. We could observe this in the case of business technology centres in the 1980s, the European universities in the 1960s and the para-university institutes in the 1950s. I call this the political-epistemic effect of *virtual* utility spots (as opposed to mere *potential* spots, which would have real effects only once realised). Spatial planning and design are intrinsically speculative but also produce real effects by projecting a possible future. The perspective on spots as spatial imaginaries of the relations between science and society fits within the concept of relational space: 'to think of places as ongoing negations of possibilities', constituted in ongoing collective and individual imaginations.[699] Just like a physical building, a spatial imaginary of useful research can have political-epistemic effect on the socio-political network that supports the production and exchange of scientific knowledge. In the negotiation and imagination of these virtual places, similar bundles of relations and processes between scientific and societal actors arise that were imagined to be housed in the planned spot. The role of spatial imaginaries in science policy and broader culture is an important justification for the use of the utility spot concept: it is not *just another* approach to bring into view the many contexts of organised science, but it brings out a tangible trait of this period, namely, that many tend to think *spatially* about the appropriate relations within society. In this sense, it resonates with Michel Foucault's speculation that our current epoch is one of space, in the twentieth century more specifically defined by 'relations of proximity'.[700]

6.2 Utility Spots and the Politics of Proximity

As historical phenomenon and heuristic concept, utility spots are ambiguous. They are at once static and dynamic, as spots that harbour precisely the transfer, exchange and circulation of knowledge for the benefit of society. As 'relational space' they are the intersections of epistemic, social, political and cultural processes so that place becomes deeply intertwined with power, both in real processes and imagined relations. This applies to the places of knowledge production, and only more so to the

699 Massey, *For Space*; Claudia Matus and Susan Talburt, "Spatial Imaginaries: Universities, Internationalization, and Feminist Geographies," *Discourse: Studies in the Cultural Politics of Education* 30, no. 4 (2009): 517–18.

700 Michel Foucault, "Of Other Spaces," *Diacritics* 16, no. 1 (1986): 22–27.

sites geared at knowledge transfer. Relations of power make these places possible and effective, and the power effects they generate are intertwined with knowledge circulation. Situated in between demarcated zones of the scientific and the non-scientific (societal, economic, industrial), they are spaces of mediation where interests, languages and practices are translated in such a way that actors from different 'worlds' get to see, understand and act in a shared world. As mediation spaces these places have to generate trust on multiple levels. On the abstract level of policy, it is about trust in the institutions and communities that support the place. On the concrete level of knowledge exchange, it is more about trust in the reliability and usefulness of certain knowledge and experts, as well as the (scientific) potential of the concerns and problems which require solution.

Trust is tied up with proximity. Both are often considered central to processes of knowledge exchange, and it is not uncommon to think that trust increases as distance decreases. AnnaLee Saxenian, in her study of Silicon Valley and Route 128, states for example:

> Geographic proximity promotes the repeated interaction and mutual trust needed to sustain collaboration and to speed the continual recombination of technology and skill. When production is embedded in these regional social structures and institutions, firms compete by translating local knowledge and relationships into innovative products and services ...[701]

Also in historical studies of science, 'relationships of trust' inscribed in space are considered conditions for routine knowledge transfer and scientific sites are interpreted as 'locales for co-presence'.[702] Utility spots can thus be understood as places that mediate existing or stimulate new relationships of trust by creating locales that enable the co-presence of diverse actors. In the historical reconstructions, the importance of proximity expressed itself on (sometimes overlapping) regional and local scales. First, there was the concern about concentration or dispersion of scientific activities, and second the question about the appropriate and optimal distance between academic and extra-academic actors. These two issues together make up the 'politics of proximity'.

Both geographical concentration and dispersion of resources for scientific research were controversial topics in the debates about the organisation of research in Europe and the Netherlands. Concentration of research in national or transnational institutes was always seen by universities as posing a threat. Such plans were motivated by epistemic arguments about the benefits of centralising scientific activities: it would stimulate creativity and enable work on larger and more expensive instruments. But the academic establishment typically

701 Saxenian, *Regional Advantage*, 161.

702 David N. Livingstone, "The Spaces of Knowledge: Contributions towards a Historical Geography of Science," *Environment and Planning D: Society and Space* 13, no. 1 (1995): 20–21; Shapin, "Placing the View from Nowhere," 7–8.

feared that such places would become (perceived as) centres of excellence that hijacked precious scientific and technological manpower. Consequently, this would degrade universities from being *the* place for scientific research to mere teaching institutions. University rectors and representatives therefore preferred to organise a national research council, or a utility spot like the European University, in a 'decentralised' manner—meaning that (inter)nationally funded research would be housed in selected, existing academic institutions. If *concentration* was motivated by scientific concerns, and *decentralisation* often mirrored established academic interests, geographical *dispersion* of scientific activity related to political and societal concerns for regional economic development. As we have seen in the Dutch case, this could again be opposed by academic actors who preferred expansion of their own institutes, now motivated by the benefits of centralisation. These spatial models for the practical organisation of research—local concentration or geographical dispersion—intersected with institutional arguments about (de)centralisation. Because concentration and dispersion were employed differently as arguments in various situations, they always require situation in particular spatial and political-economic contexts.

Still, concentration and dispersion as analytical categories entail different epistemologies of research. Where concentration emphasizes the importance of intra-scientific interactions, dispersion puts more stress on the relations between scientific activities and broader social and economic contexts. Both, however, imply the importance of proximity. Concentrating research in particular places assumes that this brings actors from the same (or different) disciplinary cultures close together, that this increases activity and thereby heightens the quality of the results. Dispersing research to diverse regions, especially ones that lack scientific institutions, at the same time assumes that it makes a difference where research is located for the intensity of interactions with heterogeneous actors in society. In practice, a utility spot can also be a hybrid of concentration and dispersion, in the sense that such spots concentrate resources in one place to enable increased activity, but also locate themselves outside the university and in peripheral regions to specifically stimulate new types of interactions. The possibility of overlapping dispersion and concentration helps explain the appeal of the science park utility spot. Although it decentralises scientific activities, its proximity to the university makes it more a trait than a threat, because it simultaneously represents the logic of concentration, putting entrepreneurs and scientists together to boost creativity, and the logic of dispersion, promising increased local interactions and regional benefits.

Proximity as relevant political-epistemic category is thus presupposed in these debates about the geographical organisation of scientific research. Ultimately, this also plays out spatially at the local level, as we have seen in various historical cases described in this dissertation. The plan for para-university institutes for contract research, coined by the Kronig committee in 1963, is a good illustration. The concern for the appropriate character of university research originated in the lack of spatial separation between different types of research—both in orientation and funding. This was most tangible in spaces of the Delft polytechnic, but also turned out to apply to many natural scientific and medical laboratories at general universities. The 'architectural' solution of a para-university institute rearranged diffuse activities into separate but proximate spaces and redirected interactions with external parties through this in-between building, also to make professors aware of the difference between their 'vital and derivative' tasks. Proximity was a matter not so much of decreasing the distance between academic and industrial spheres as fully as possible, but rather of finding a spatial compromise between freedom and utility. In space, one thus finds the concrete, physical expression of abstract goals and categories of research. One professor expressed the appropriate relation between academic and extra-academic activities aptly, when he proposed that a new utility spot close to the university was preferably established at *cycling distance*.

The same applied, of course, for the non-academic organisations with which the university scientists collaborated. In the 1960s, TNO for example had a geographically different concept of proximity from that of most professors: rather than a location close to a university campus, it aspired to a location central within the Netherlands. They regarded the so-called 'techno-scientific atmosphere' of university towns as mere subjective factors, which would not enhance their contribution to the industrialisation of the Dutch economy. Industries with the most advanced research laboratories, like Philips and Shell, did not consider physical proximity the most important aspect of their relations to academic science either. Instead, they relied on a tightly knit social network and created similar 'atmospheres' in their labs. Special professorships and recent graduates circulated between the corporate laboratories, academic institutions and research organisations (especially the boards of ZWO and TNO), so that interests, results and organisational models were easily shared. The industrial focus on cultural affinity, rather than physical proximity changed around 1980 when corporate research was downsized and outsourced, and TNO was remodelled into a contract research organisation. Up to that point, physical proximity had mattered more *within* multinational, vertically integrated companies—between research, development and production—than *between* the company and external sources of knowledge, like the university. The science park model therefore resembles the ambiguous revival of the proximity argument at the beginning of a globalised and digital era, which both erased the primacy of place. Thus, science park enthusiast Witholt could present peripheral Groningen as a tapping point from an epistemically integrated globe.

The historical study of proximity relations in knowledge production could be a promising and fruitful direction for future research. Most historical studies of science that take note of it understand it merely in terms of 'co-presence' and physical distance. Recent social studies of science take proximity serious but limit the transfer of (tacit) knowledge and skills to the exchanges between scientists.[703] Although I have already provided thick descriptions of the meaning of proximity and its importance to concepts and places of utility, it would have to be developed more analytically in order to employ it as central category in future research. Recent social studies of the geography of innovation could be informative in this respect. They have pointed out that just physical or geographical proximity is not sufficient to explain the functioning of creative regions. The success of Silicon Valley, for example, is not based on spatial clustering of industries and science alone. Other relevant factors are the adaptive capacity in those firms, a culture of cooperation, creativity and entrepreneurship, and shared discourse, knowledge and practices between academic and industrial actors.[704]

To understand why knowledge exchange and cooperation do or do not take place between (economic) actors and organisations, economic geographer Ron Boschma has distinguished five dimensions of proximity: geographical, cognitive, organisational, social and institutional.[705] Cognitive proximity concerns the similarity of the knowledge base and is considered the most important condition for effective knowledge transfer; social proximity equals the overlap in personal networks of the various actors, which typically increases trust; organisational proximity describes the matter of belonging to the same (formal) 'groups', which does not create, but does lower the barriers for, interactions; institutional proximity denotes the degree to which formal and informal rules (including laws, norms and values) are shared.[706] Processes of innovation and knowledge transfer flourish when these different dimensions are in balance—both too much and too little proximity can be detrimental. More importantly, the diversification of proximity exposes the fact that geographical proximity, although perhaps theoretically sufficient in combination with a shared knowledge base, is not a sine qua non for knowledge transfer. Rather, increasing distances can be bridged when two organisations or actors are sufficiently proximate in the other dimensions.

To connect the diversification of proximity to specific places of knowledge exchange, like utility spots, we could subsequently turn to studies of socio-technical transitions. The multi-dimensional concept of proximity has namely been

703 Koen Frenken, "Geography of Scientific Knowledge: A Proximity Approach," *Quantitative Science Studies* 1, no. 3 (2020): 1007–1016. It should be noted that Frenken's approach also differs in principle from mine: where he studies the diffusion of knowledge claims (sociology of scientific knowledge), I have focused on the historical, cultural and social conditions for such diffusion (sociology of science).

704 Saxenian, *Regional Advantage*; Kenney, *Understanding Silicon Valley*; Weiler, "Proximity and Affinity"; Lécuyer, *Making Silicon Valley*; Roger L. Geiger, "The Riddle of the Valley," *Minerva* 46, no. 1 (2008): 127–32.

705 Ron Boschma, "Proximity and Innovation: A Critical Assessment," *Regional Studies* 39, no. 1 (2005): 61–74.

706 Boschma; Ron Boschma, Pierre-Alexandre Balland, and Mathijs de Vaan, "The Formation of Economic Networks: A Proximity Approach," in *Regional Development and Proximity Relations*, ed. André Torre and Frédéric Wallet, New Horizons in Regional Science (Cheltenham, Northampton: Edward Elgar Publishing, 2014), 243–66.

embraced also by advocates of the Multi-Level Perspective approach (MLP), a heuristic device to study stability and change in socio-technical systems. MLP distinguishes between the levels of landscape, regime and niche which, although they ring spatially, are originally understood primarily in temporal terms: the sociotechnical *landscape* is the relatively stable, long-term context against which a transition takes place, the *regime* consists of established practices and rules, while the *niche* is a new, more unstable 'locus for radical innovations'.[707] To achieve 'spatially sensitive niche management', Rob Raven, Johan Schot and Frans Berkhout have related the relative temporality of socio-technical levels to levels of relative proximity.[708] Basically, they define a correlation between stability and proximity: the longer a network has developed, the 'closer' the different actors are—especially in cognitive, organisational and social terms. Niches, therefore, have the lowest level of proximity. This suggests that the prominence of the proximity argument in a debate about a particular new niche, or utility spot, is above all an expression of a lack of, an obstacle to, or friction in relations between diverse actors.

The MLP approach to innovation processes focuses on economic actors, while my emphasis has been mainly on scientific institutions and policy bodies. The concept of utility spot could, nevertheless, be perceived to function on the same analytical level as niche—and sometimes they overlap in particular places. Niches are, namely, understood as 'derived concepts': they exist *because of* a (perceived) lack or obstacle in existing structures or institutions (at the regime or landscape level). And niches are characterised as 'protected spaces' that provide 'the seeds for systemic change', by creating an environment and vision through which new actors can be enrolled, resources can be attracted and learning processes can occur.[709] Similarly, I have repeatedly situated the emergence of utility spots in contrast to existing institutional cultures, regulations or political economies, and described them as eccentric sites in which existing socio-material networks are reimagined and reshaped. The science park is a primary example of an overlap between niche and utility spot—while the fact that I was able to include NIAS in my discussion exemplifies the difference.

This association of the utility spot concept with multidimensional proximity and the MLP niche allows translation of my spatio-historical approach to the present. Yet, it also allows me to stress a historical point that MLP and the geography of innovation tend to overlook. From an abstract analytical viewpoint, MLP views proximity as an ahistorical category to explain historical change. The 'dynamic' conception of proximity, advocated by Boschma, does take into account that the *effect* of proximity in a network can change over time.[710] But, based on my historical exploration of utility spots, I would instead like to argue also for the historicization of proximity itself.

707 Frank W. Geels, "The Multi-Level Perspective on Sustainability Transitions: Responses to Seven Criticisms," *Environmental Innovation and Societal Transitions* 1, no. 1 (2011): 24–40.

708 Rob Raven, Johan Schot, and Frans Berkhout, "Space and Scale in Socio-Technical Transitions," *Environmental Innovation and Societal Transitions* 4 (2012): 70.

709 Geels, "The Multi-Level Perspective on Sustainability Transitions," 26–28.

710 Boschma, "Proximity and Innovation," 72.

For the relation between science and society, it would be relevant to study, at various sites and times, different types and meanings of proximity and their effects on the organisation and image of useful research.

6.3 Spatiality of Science Policy: The Case of Valorisation

Throughout the historical reconstructions of utility spots, it came to the fore that the abstract issues and concepts of the organisation of publicly funded scientific research often have very concrete spatial origins. And new science policy interventions usually have concrete spatial effects. The combination of these developments is what I called, at the end of chapter 3, the spatiality of science policy. Described in terms of MLP, one could say that utility spots can function as *niches* that have effects at the *regime* level—and the ensuing rules and regulations at regime level can stimulate the establishment of new niches (and so on). In the case of the TNO issue in the 1950s, for example, two concrete spaces that organised the interactions between academic and extra-academic actors were occasion for action at the university, interuniversity and ministerial levels. The science park, as well as the related utility spots of transfer point and academic business centre, also functioned as niches for new utility practices and policies. At the end of chapter 5, I already pointed in this direction. The knowledge transfer legislation of 1985 is, I argued, an example of how a utility spot can have structural effects (at the regime level). In this section, I jump a decade ahead in my historical narrative to flesh out this claim with respect to the policy concept of valorisation, by viewing it through the lens of utility spots. To do so, I return to its definition as it emerged after years of debate:

> Valorisation is the process of creating value from knowledge by making it suitable and/or available for economic and/or societal use and translating it into [competitive] products, services, processes and entrepreneurial activity.[711]

Presenting valorisation as 'process' is a way to steer away from a 'product' approach, in which the concept of useful knowledge becomes limited to artefacts, tools or patents that can be sold at a profit. In one attempt to clear up the meaning of valorisation, minister Van der Hoeven drew a list of concrete activities from an advisory report by policy consultant Dialogic. This contained processes such as the production of skilled workforce, contract research, cooperative research, publication of results, informal networks and science communication. This process approach seems to mirror a broader shift in the field of science studies from the study of the outcomes of scientific

711 van Drooge et al., *Waardevol.*

research—a finished theory, a completed book, a published article—towards the process of their coming about.[712] But at the same time it states that value is created only 'from knowledge', or the results of research, which reifies research into formalised scientific knowledge. This actually allows the imagination of two spatially separated activities: knowledge production and valorisation. This implies that stable, reliable, true knowledge and the process of becoming valuable to others, of being valorised, are distinct.

The three modalities of value creation consist of the alteration of knowledge to fit the interests of non-academic, external actors. By implication this means that these interests and actors are excluded from the chronologically primary research process. The three qualifications—available, suitable, translated—imply different interaction mechanisms between scientific and societal actors. 'Making available' suggests that it may be sufficient to share formalised knowledge with external parties, without modifying it for a different context of use. When interpreted as the spread of immutable mobiles in society, however, this consists of more work because the configuration of production would have to travel along. 'Making suitable' already suggests that the use of knowledge is a more localised phenomenon: research results need to be fitted to the particular situations, problems and questions of the actors who want to use it. That is, knowledge circulates as mutable mobile. Also the third modality of valorisation, the 'translation' of scientific knowledge into competitive products, services, processes and entrepreneurial activity, can be understood in terms of a mutable mobile. Translation suggests that knowledge, to be of use to others, has to be made *into* something else (either an artefact or activity) and in most cases *by* something or someone else: a translator, mediator or modulator. Viewed from a constructivist perspective, the modalities of availability, suitability and translation of knowledge appeared as (im)mutable mobiles. The reliability and utility of scientific knowledge then result from the same displacement (or translation) process: adapting general claims, specialised skills and theoretical understanding to a local, particular problem to mobilise the interests of others.

Lastly, there is the difference between value creation through economic or societal use. Obviously, societal could include economic, and sometimes society is reduced to the economy, but in the case of valorisation they are separated explicitly to mark off different goals for scientific research, basically in terms of either a profit or non-profit orientation. This does not necessarily map onto a disciplinary division. Also social sciences and humanities could play 'an important role in economic valorisation … for example with respect to the non-technological aspects of innovation … that are of importance for the successful introduction of new products and processes.'[713]

712 From this perspective, criticisms have been aired of scientometrics and bibliometrics because they reduce the complexity of scientific practice to easily calculable and comparable outcomes.

713 Minister and state-secretary of OCW to university boards, 'Valorisatie van onderzoek als taak van de universiteiten', 27 January 2005 (OWB/AI/04–57055).

In a way reminiscent of the 1960s discussions on the subservient, or complementary, utility of the humanities, these scholars were now mobilised to support the acceptance of new inventions into society. Or, if natural sciences transferred knowledge to entrepreneurs to develop products, the humanities and social sciences could transfer these products into wider society—transposing the controlled environment of the laboratory and the science park, onto the world out there.

Many critics of valorisation policy fear that it can lead to the commercialisation of academic research, and that this in turn has a limiting impact on the content and kind of knowledge produced. But whether the modalities of valorisation also affect the production of knowledge ultimately depends on the epistemological viewpoint one takes. The concept itself could be interpreted as allowing both separation and integration of research and knowledge transfer. And whether either of these also leads to societal *orientation* of the research-agenda (or the significance and form of research on a meta-level) is another aspect that could be understood either way. The enduring resistance against valorisation does not follow directly from its definition. To understand this, we need to turn to the spatial models of useful research on which it was based.

In November 2003, the Dutch Minister of Education, Culture and Science (OCW), Maria van der Hoeven, introduced valorisation in the agenda-setting Science Budget in response to the 'European paradox': an abundance of high-quality scientific knowledge, but too little utilisation.[714] By doing so, she followed the diagnosis set by the European Commission that the 'translation' of 'fundamental' research into economic activity trailed in comparison to the US. This observation was not new; rather, it had motivated European attempts at organising the exchange and interactions between science and society in the entire second half of the twentieth century. Applied to the Netherlands, Van der Hoeven observed that the universities indeed teemed with excellent science, but she did not agree that results were not transferred into society to a sufficient extent. To support the claim that Dutch university research was quite useful, she presented a notable source: a consultancy report about the appreciation by industrial managers of university knowledge transfer. Still, she introduced 'valorisation policy' to tinker with the interactions between academic research and society: 'valorisation is the transformation of research results into economic value.' What spatial model of useful knowledge production she had in mind was no secret:

> Effective collaboration with companies usually requires larger research groups that cooperate closely with companies. This is the basis of innovative clusters with a Silicon Valley character.[715]

714 "Wetenschapsbudget 2004. Focus op excellentie en meer waarde," Parliamentary Papers 2003–2004, 29 338 (1).

715 Ibid.

Furthermore, Van der Hoeven tied valorisation strongly to the knowledge transfer article in the Scientific Education Act, which had been introduced in 1985. In Dutch policy contexts, valorisation also related directly to the spatial models introduced in the 1980s. Valorisation first appeared at the National Genomics Initiative, which was established in 2000 to coordinate, and invest in, research at the intersection of health and genetics research.[716] This public coordination body was imagined to fit into a national 'knowledge infrastructure' between Dutch universities, public research institutes and biotech industries and as a 'pioneer' in the 'Europe of knowledge & innovation'. Part of the initiative was a specialised, and centralised, *valorisation office*, in cooperation with organisations, like BioPartner, that had experience with life sciences incubators on university campuses. The successor of the Academic Business Centre in Leiden was, for example, rebranded as BioPartner. Furthermore, valorisation support consisted of protection and exploitation of new findings and the stimulation of new knowledge-intensive industries. Importantly, the National Genomics Initiative distinguished valorisation from the societal orientation of its research, which would be studied 'empirically and normatively' by social scientists and humanities scholars.

The displacement of valorisation from a national coordination initiative in one specific field, to the entire realm of publicly funded research, caused controversy. Two aspects of the initial proposal for valorisation policy received most criticism, especially in combination: the limitation to economic value and the inclusion of the social sciences and humanities. In 2005, the minister explained in a letter to university boards what the 'economic and societal added value of social sciences and humanities for the knowledge society' consisted in.[717] She explicitly broadened the definition of valorisation, in response to parliamentary debate, to include also 'non-economic societal added value', so that it could explicitly apply to all academic fields. Valorisation included two types of activity, namely *orientation* of academic research to societal questions and industrial needs as well as concrete knowledge *transfer* practices. Whereas these had been institutionally separated in the Genomics Initiative, we have encountered in various utility spots this double-edged sword of transfer and orientation: the assumption that increased interactions with extra-academic actors do not lead only to useful applications in the short term, but also to a larger field of *possible* utility in the long term. Or to rephrase that in more philosophical terms, valorisation deals not only with the *content*, but also with the *form* or *significance* of research.[718]

As we have seen throughout this dissertation, all these valorisation activities already existed in the practice and legitimations of concrete and virtual utility spots at universities. Why, then, did valorisation remain controversial for a decade,

716 Nationaal Regie-Orgaan Genomics, *De Nationale Genomics Strategie: Strategisch Plan 2002–2006* (Den Haag: Nationaal Regie-Orgaan Genomics, 2002).

717 Minister and state-secretary of OCW to university boards, 'Valorisatie van onderzoek als taak van de universiteiten', 27 January 2005 (OWB/AI/04–57055).

718 Rouse, *Engaging Science*; Hacking, "Weapons Research"; Kitcher, *Science, Truth, and Democracy*.

and was it replaced by *impact* by 2019? My answer to this question is twofold: valorisation was historically tied up with specific spatial models of useful knowledge production that embodied a limited economic utility concept, and in this model there was no space (made) for social sciences and humanities, nor did they demand it. The controversy was thus rooted in the generalisation of one type of hybrid space on campus—the science park, and the associated transfer point and business centre—to the entire academic atmosphere. Today, Utrecht University is not joking when it dubs the entire Uithof, which houses most of its buildings for natural, medical and social sciences, a 'science park'.[719] This utility spot originally organised the relations between upcoming fields like biotechnology and small-scale high-tech business, but has become the overall norm by now. The science park as concrete reality and spatial imaginary of useful research also prohibits an easy alteration of a science policy concept, like valorisation or knowledge transfer. Conceptually, it might seem unproblematic to include societal value and the humanities, but this has no referent in the spatial organisation of epistemic and entrepreneurial practices at the science park. The historical connections between valorisation and science parks are on the one hand a demonstration of the spatiality of science policy, as well as an indication of the limitations that this produces. In the next and closing section, I argue that alternative spatial imaginaries might be powerful instruments to stretch the space for plural scientific practices on campus, in the city, on this globe.

6.4 Spatial Imaginaries of Useful Research

> Scientists know that, just as birds in an environment devoid of air would fall to the ground, their own practice would be impossible without what is simplified away when we represent … scientific research as indifferent to its social valorization.[720]

Place and usefulness matter to the practice of scientific research and thus to theories that aim to describe and explain the production of knowledge. In a frictionless world—one without material and social context, outside geographic, spatial and political-economic relations—scientific research cannot exist or function; it would fall to the ground. In this last section, I collect and reflect upon the conceptual implications of the spatio-historical approach to useful research by proposing a reformulated definition of utility spot.

In the introduction, I proposed to understand utility as meta-scientific concept that shaped the practice and politics of research. This allowed the historicisation of the utility concept by situating it in societal, physical and geographic space.

719 A. C. Flipse, "De opkomst van de universitaire campus in Nederland, 1945–2020," *Shells and Pebbles* (blog), June 18, 2020.

720 Isabelle Stengers, "The Need for a Public Understanding of Sciences," in *Topics and Trends in Current Science Education: 9th ESERA Conference Selected Contributions* (Dordrecht: Springer Science & Business Media, 2014), 26.

At different times, for different fields, and in different societies, the proclaimed, expected or demanded utility of scientific research has varied. This is, in itself, not a surprising outcome. But the study of utility spots in the second half of the twentieth century produced two additional insights that underlined the importance of utility as historical-epistemological category. First, one apparently stable concept of utility can change meaning and function. For example, the use of research to create new products and more profit, in order to support national industries, meant different things in the 1950s and the 1980s. In the Netherlands, the meaning of this type of utility co-evolved with its political-economic context—from a concern with industrialisation and catch-up with the US to a concern with industrial renewal in SME and globalisation. Utility spots like the science park and the transfer point, or in the US the UIRC and the TTO, provide a window on the entanglement of this changing meaning. Second, the different social and political consequences of the historicity of utility implies historical variations in the organisation of research. Ultimately, utility as historical category structures the practice of research, or to be more precise, the modal significance of research fields.

The main epistemological issue that inspired this study was whose values, goals and interests (can or should) inform the conduct and organisation of research. This relates to debates about the social construction of scientific knowledge, political philosophies of science and the epistemic justification of science policy. Taking utility and space seriously has not been, however, a move towards a relativism with respect to science. Indeed, my study namely has not attempted to reduce the content of research simply to the particularities of a spatial context. Rather, I have tried to make visible how spatial structures for research embody ideals of utility that affect the 'enacted narrative fields' or 'significance graphs' that shape the 'form' of research.[721] This epistemic function of utility spots follows from the fact that these structural arrangements enable or exclude particular kinds of social and political relations. These places are the result of a diverse set of social, cultural and political relations as well as values, and they stimulate explicitly the interaction of scientific practices with a plurality of other practices in the world. By inviting heterogeneous actors to contribute to the rewriting of the significance of past and present research, they shape what future research is considered possible, valuable and useful.[722]

In chapters 2 to 5, which reconstructed post-war organisation of research, I tied pronunciations of these philosophical questions to concrete and imaginary spatial arrangements for the conduct and exchange of research. In utility spots, epistemic distinctions and developments became manifest in architectural, geographic and geopolitical ways. Science

721 Rouse, *Engaging Science*; Kitcher, *Science, Truth, and Democracy*.

722 This could also be understood as an 'ecology of practices'. Isabelle Stengers, "An Ecology of Practices," *Cultural Studies Review* 11, no. 1 (2005): 183–96.

shops and transfer points, for example, positioned themselves as half-way houses between the university and (parts of) society, with the aim of reorienting academic research into more relevant directions, and the Technical-Physical Service in Delft allotted separated space to the orientation of research by external parties. The case of the European University plans showed how there is also a geopolitical side to the inclusion of actors and organisations in scientific research. At the Dutch science parks we saw, lastly, a shift in the geography of the political-epistemic alliances around useful research, with a stronger focus on local and regional actors in the production and circulation of scientific knowledge. These displacements and structures impinged on the significance of university science in general, which translated into policies and funding in support of particular types of research and topics.

What does the spatial and historical situation of utility as meta-scientific concept mean for theories of scientific practice? In the introduction, I alluded to the diverse set of concepts that have popped up in the last two to three decades in attempts to conceptualise scientific research: mode-2 knowledge production, responsible research and innovation (RRI), technoscience, post-normal science, triple helix and so on. Without exception, these concepts de- and prescribed blurred boundaries between formerly strictly distinguished actors and emphasized the networked, interlinked or ecological nature of scientific research. My exploration into various utility spots has been partly informed by these approaches, in the sense that I have been aware of the diverse relations that made such a place possible. At some points, theories of scientific practice again leaked back into the organisation of useful research: NIAS understood itself in relation to Kuhnian paradigms and sociological studies of the industrial laboratory, while the knowledge transfer clause in the Scientific Education Act was legitimised with reference to contemporary science studies that understood it as an integral part of research. Taking a step back, many of these concepts are themselves based on very specific spatial models of useful knowledge production—ones that blur boundaries between formerly heterogeneous actors.

There is a political risk implied by too strong interrelations between research concepts and dominant spatial imaginaries of useful knowledge: such a connection tends to legitimise current practices uncritically and might lead to a lack of awareness of alternatives. This applies both to images of isolated academic research and for the maligned 'commodification of scientific research' at the science park. But instead of opposing this 'naturalistic tendency' in science studies with a normative philosophical approach about 'good science', as Hans Radder proposes, I have advanced above all a critical empirical method to map shifting political-epistemic coalitions

723 Hans Radder, "The Commodification of Academic Research," in *The Commodification of Academic Research: Science and the Modern University* (Pittsburgh, PA: University of Pittsburgh Press, 2010), 2.

and utility concepts in specific spatial settings.[723] Both the exclusion and inclusion of non-academic actors, as well as the drawing and blurring of purified boundaries between science and society, can come to the fore as relevant factors in the organisation of research and thus the shaping of possible knowledges. Further work could explore in more detail the feedback loops between places, policies and theories of useful knowledge production and exchange.

From my critical empirical approach to the spatiality and utility of scientific research, it follows that no two sites of scientific research are the same, even when imitation is purposively attempted. In a stronger sense, I advocate spatial pluralism and heterogeneity in the organisation of useful scientific practices; some places should dare to become or remain different. Alternative organisation of the relations around scientific research, to transform the significance and possible knowledge of specific fields, requires new spatial imaginaries. A main result of this dissertation is that in science, society and politics alike, virtual utility spots are productive: they bring together diverse actors to imagine what new kinds of knowledge are possible, where these should be organised and in what way. Just like spatial models, abstractions of real places, travelled the world, concrete abstractions of virtual places, or utopias, should be proposed to proceed towards alternative forms of knowledge productions. Actually, spatial imaginaries can be considered to lie at the root of science policy: the main progenitor of the utility of modern science, Francis Bacon, also produced the 'first report on science policy … written as a fable'.[724] His utopian novel *New Atlantis*, of 1627, describes a group of European explorers who, by coincidence, arrive at an 'undiscovered' island where they disembark in the city of Bensalem to learn about the scientifically advanced society. The visitors are especially awed by the island's most powerful institution, the House of Solomon, which resembled Bacon's ideal of science: a highly organised, scientific community that cooperatively produced new phenomena and control over nature, so as to produce 'things of use and practice for man's life'.[725]

New Atlantis relates to the history of utility spots in two ways. Firstly, Bacon's philosophy of science policy, forcefully summarised as utopia, arguably informed the organisation as well as the ethos of modern science, starting with the Royal Society of London. Secondly, many scientists as well as historical and philosophical analysts of science in the last four centuries have reinterpreted and referred to this spatial model. On that level, the historical hermeneutics of *New Atlantis* allows one to follow changing appreciations of Solomon's House as utility spot. This works especially well, because many use the spatial model in comparison with their

724 Kitcher, *Science, Truth, and Democracy*, 137–46.

725 Francis Bacon, *New Atlantis and The Great Instauration* (Wheeling, IL: Harlan Davidson, 1989).

contemporary situation: in relation to the military use of science, for example with the use of the atomic bombs in the 1940s or the criticism of the military-industrial complex in the 1970s, Bacon's utopia was a premonition of the shortcomings of the social responsibility of a science without public safeguards;[726] or in the golden age of basic research in the 1960s it represented the isolation of the college, the autonomy of the scholars and the lack of attention for knowledge transfer.[727] Later scholars who historicised *New Atlantis* as well as its interpreters found space for criticism of the imperialist, elitist or capitalist assumptions in this spatial model of knowledge production.[728] In its own times and to this day, *New Atlantis* has functioned as spatial imaginary of useful scientific research.

The elitist imagination of *New Atlantis* isolated scholars from a society that appeared to have extensive, and grounded, trust in their utility and responsibility. This is an image that has repeatedly appeared also in twentieth-century organisation of science and has as often been challenged by niche-like utility spots. Ultimately, we should wonder not only who are, and should be, involved in the practice of research, but also who we want to imagine what spatial alternatives for significant science might exist. Do we leave this to elite think-tanks, policy officers, and university governors, as in the first decades after the Second World War, or to local business communities, entrepreneurial professors and management consultants, as was more typical from the 1980s onwards? Following Bacon, utopian fiction might be an inspiring resource to re-think knowledge production beyond a mere extrapolation, and thereby legitimation, of the present. As my spatio-historical approach to utility highlighted also the importance of virtual proposals for the place of scientific research in society, I would like to propose (speculative) science fiction as a potential field for further study. This art form namely produces 'new environments that arouse wonder', in which geographical and architectural aspects self-evidently receive elaboration. The unnaturalistic portrayal of worlds and knowledges produces *cognitive estrangement* which opens a space for reflection and critical thought.[729] These fictional utility spots could prove to be rich resources for both future speculations and historical understanding, as these works of art both express the concerns of their times and stretch the boundaries of the possible. Ultimately, science fiction can arouse in the reader an experience of the historical contingency of present science and society, as well as its geographical relations.

To make such future inquiries and speculations possible, I present an updated definition of the utility spot concept that includes the central theoretical and empirical findings that I have presented in this dissertation:

726 Robert P. Adams, "The Social Responsibilities of Science in Utopia, New Atlantis and After," *Journal of the History of Ideas*, 10, no. 3 (1949): 374–398. Judah Bierman, "New Atlantis Revisited," *Studies in the Literary Imagination* 4, no. 1 (1971): 121–41.

727 Judah Bierman, "Science and Society in the New Atlantis and Other Renaissance Utopias," *Publications of the Modern Language Association of America*, 1963, 492–500.

728 Denise Albanese, "The New Atlantis and the Uses of Utopia," *ELH* 57, no. 3 (1990): 503–528; Attie, "Selling Science."

729 James Kneale and Rob Kitchin, *Lost in Space: Geographies of Science Fiction* (London: Continuum, 2002); Matthew W. Wilson, "Cyborg Geographies: Towards Hybrid Epistemologies." *Gender, Place and Culture* 16, no. 5 (2009): 499–516.

> Utility spots consist of **actual and virtual** spatial arrangements that facilitate and stimulate the political-epistemic interactions between heterogeneous actors, which actively shape the significance of research, with the public aim of creating and circulating useful scientific knowledge. They **emerge at the intersection** of international ideals, national policy and local contingencies, where they **function as distorting mirrors** that reflect current problems and provide speculative solutions.

The power of place and fiction intersect in spatial imaginaries of the science-society relationship. Both policy plans and science fiction offer a window on historical varieties of the organisation of useful research, but only the latter also provide the speculative potential to imagine the world otherwise.

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Summary

How we think about and act on the *usefulness* of scientific research has epistemological and political implications: what knowledge consists of, how it comes about and to what ends. In this dissertation, I situate the usefulness of scientific research in concrete places for knowledge exchange. The exchange of knowledge within and between environments is shaped by many spatial factors: from architectural designs, physical proximity and material infrastructures to city planning, regional development and geopolitics. And not only knowledge travels: also spatial models for research organisation circulate. Focusing on 'utility spots' instead of prominent scientists, dominant disciplines or powerful organisations is proposed as a fruitful way to highlight the intersection of political, societal, economic, cultural and scientific developments. This allows me to relate different utility concepts to the histories of science, universities, science policy, and the geopolitics of the Atlantic world in the second half of the twentieth century.

Chapter 1, 'Introduction. Situating Science Policy in Space', posits the central question answered in this dissertation: in which ways do spatial models of knowledge production shape and reproduce the concepts and politics of the utility of scientific research in the late-modern Western world? This question was incited by a recent controversy in Dutch science policy over value creation from academic knowledge production, or 'valorisation'. To better understand the limits and potential of such science policy concepts I use the spatial lens of the utility spot and situate, for example, valorisation in concrete places and times. I propose utility spot therefore as *heuristic* concept to uncover the intersection between *utility* and *spatiality* in historical reconstructions of the policy and practice of publicly funded research.

This spatio-historical approach to utility is the result of a critical synthesis of four strands of literature. Taking my cue from studies on the historicity of meta-scientific concepts (such as objectivity) and non-modern epistemologies of useful research (such as technoscience), I situate utility as a historical-epistemological category that shapes research practice. In addition, I stress the importance of place also for practices of knowledge exchange between academic and societal space, based on perspectives from historical geographies of scientific research and social studies of the circulation of scientific knowledge. To enable the identification and interpretation of utility spots in post-war history of science, policy and society I use a preliminary definition, which I will iteratively apply and refine in concrete (historical) cases throughout this dissertation:

> Utility spots consist of the spatial arrangements that facilitate and stimulate the political-epistemic interactions between heterogeneous actors, which actively shape the significance of research, with the public aim of creating and circulating useful scientific knowledge.

Chapter 2, 'Utility Spots in the United States: Architecture, Location and Circulation', describes the scholarship on specific places of knowledge production that have functioned as paradigms of useful research in the US between 1945 and 1990, from Bell laboratories to RadLabs and Silicon Valley. Special attention goes to the origins (and the immense economic success) of this last area and the role of the Stanford industrial park model more specifically. Historians of US science have extensively studied the political-economic, social and cultural conditions that made possible the emergence of such industrial parks around academic institutions. Based on this scholarship, I situate the rise of 'science parks' in a longer lineage of utility spots in the post-war US. It is in this period, namely, that a great variety of utility spots proliferated at, or close to, American universities.

From this historiographical survey I draw additional aspects of the utility spot concept. *Architecture* concerns spatial separations between different types of research (e.g. in terms of funding, classification or goal) that typically also mediate a political-epistemic boundary between 'academic' and 'useful' research. This is closely related to the *location* of useful research, which symbolically says a lot about what relations are considered desirable at that spot. This can be interpreted at a small scale, in terms of a relation between *proximity* and collaboration, and at a larger scale, as the participation in a political-economic *geography*. When a successful spatial model of useful knowledge production is put into *circulation*, local complexities tend to get abstracted into clear-cut *geometries* with the promise of reproducing such highly situated success elsewhere. The spatiality of useful research is thus very specific to the context in which it emerges, and the political-epistemic alliances on which it relies. In subsequent chapters, I combine these aspects to produce tangible histories of utility spots as the products of local conditions, regional environment, national political economy and international geopolitics. In addition, I emphasize that similar attention for local complexity should be applied at the receiving end of hegemonic spatial models of useful knowledge production.

Chapter 3, 'The Spatiality of Science Policy. Para-University Institutes for Sponsored Research, 1954–1963', focuses on the spatial origins of a science policy debate *avant la lettre* about the character of university research in the 1950s in the Netherlands. It concerned the acceptability of and criteria for the funding of research in universities and polytechnics by 'extra-academic' bodies, like the Nederlandse Organisatie voor Toegepast-Natuurwetenschappelijk Onderzoek (Dutch organisation for applied natural science research, TNO) and industry, especially Philips N.V. Such questions arose in various hybrid contexts, of which I discuss two: The Technisch Physische Dienst TNO-TH (Technical Physical Service), a hybrid place for cooperative and contract research at the Technical Physics department of the Delft polytechnic, and the Gezondheidsorganisatie TNO (Health Organisation TNO), a coordinating body for Dutch medical research who proposed to establish an extra-academic Medical Physical Institute. The issues in these, perhaps exceptional, utility spots were corroborated by a high-ranking science policy officer through a national questionnaire: many university laboratories in the natural, medical and engineering fields turned out to be hybrid amalgams of long- and short-term, pure and applied, free and sponsored research. This could cause friction on the lab floor, where different researchers served diverse purposes with varying remunerations, but was especially problematic in boardrooms, where policymakers, professors, trustees and industrialists tried to bring order to this messy reality.

This chapter uncovers how these developments informed an inter-university advisory report about sponsored research at academic institutes (the Kronig report) and a high-level policy discussion about the geographic decentralisation of TNO, both of which have not been covered in Dutch histories of universities or science policy. These discussions about the character and appropriate place of academic research demonstrate that, among historical actors, there existed a spatial understanding of the relation between utility and independence: use-oriented and cooperative research was imagined into para-university institutes to safeguard the university as house of fundamental research and these in-between places were stimulated because of their expected contribution to the development of regional economies. Ultimately, this chapter highlights how concrete hybrid spaces of exchange and cooperation were the spatial origins for abstract policy issues and contemplative debates about the value of research.

Chapter 4, 'The Geopolitics of European Universities and Advanced Institutes for Humanities, 1955–1975', takes a 'geopolitical' perspective on usefulness by portraying the first (conflicting) plans for a European University by international policy bodies such as the European Economic Community (EEC), the European Atomic Energy Community (Euratom), the Western European Union (WEU), and the North Atlantic Treaty Organisation (NATO). Each plan had to grapple with political-epistemic concerns about the appropriate geographical scope, involvement of the US and the tension between the political and intellectual costs and benefits of concentration. By looking at plans for new institutes of exchange outside existing university structures, this chapter takes serious *virtual* utility spots. Such spatial plans each embodied different world views—both in terms of geographical scope and in terms of utility concepts—depending on the politics of the overarching international organisation that proposed them. Even though the desired relations between knowledge production, transfer, and societal use were not always (or almost never) realised in a concrete spot, the process of imagination and speculation is productive in itself: it ties together heterogeneous actors from policy, science and society.

This chapter also demonstrates that the utility spot perspective extends beyond natural sciences and engineering to include also social sciences and the humanities. It turns out that the history of the Netherlands Institute for Advanced Study in the Humanities and Social Sciences (NIAS) can be tied to the geopolitics of the European University. As place, the institute partly corresponded to the emerging humanities research policy, which stimulated both disciplinary and interdisciplinary endeavours in comparison with the natural sciences. But, it also diverged from it because in the end, it did not seriously embody the 'complementary utility' of humanities research—that is, cultural transfer of relevant values to support reflection on the rapid societal changes sparked by technological developments. American examples of Princeton and Stanford provided the contours for the initial plans for NIAS, just like spatial models from across the Atlantic directed the plans for the European University. Spots travel, as stories but also quite literally as floor plans, and always require adaptation to local interests and possibilities.

Chapter 5, 'The Spatial Politics of Knowledge Transfer. From Science Shop to Science Park, 1970–1985', describes a shift in key concepts to denote the utility of research in Dutch science policy from 'societal relevance' to 'knowledge transfer' and 'innovation'. The chapter makes this shift tangible in terms of various utility spots that were imagined and built in the late twentieth century: science shops, transfer points, technological business centres and science parks. For Leiden University, I look at the conflicting succession of all of these spots, in comparison with science shops at other Dutch universities, a transfer point at the Eindhoven polytechnic, a business technology centre in Twente and a 'national experiment' with a science park at the university of Groningen. This allows me to bring out the spatial politics of knowledge transfer, which for example consisted in an intra-academic conflict in the debate on transfer points between 'progressives' and 'pragmatists', who took diverging political-economic stances—roughly social-democrat or neoliberal—towards the utility of research. At the same time, university governors and entrepreneurial (biotech) professors actively fostered new political-epistemic alliances to direct new sources of funding to the campus. Especially the science park vision was effective in persuading municipalities, business communities, regional development funds, ministries, banks, and foreign companies to provide financial injections for knowledge transfer on campus. Based on a proximity argument—that physical and geographical proximity between university and industry would benefit both the regional economy and academic creativity—actual physical buildings for knowledge exchange were established.

From the analysis of science parks in the 1980s I conclude that we can read in these utility spots the changes taking place in global science and commerce, in national and local politics, as well as in university organisation. The spots engaged in commercial knowledge transfer were often modelled on American ideals, Silicon Valley and the science park in specific. These models circulated in policy memoranda, advisory reports and personal experiences between universities, polytechnics and regional business communities in the Netherlands and wider Europe. What is more, the utility spots discussed in this chapter were the root and representation of a new article on knowledge transfer in the 1985 Dutch Scientific Education Act. This act also expressed an epistemological shift: both in policy as in particular places of exchange, the circulation of scientific results was considered integral to the practice of academic knowledge production. Ultimately, it is this article that, twenty years later, was the condition for the emergence of Dutch valorisation policy. Valorisation, in turn, was modelled after the science park, the paradigmatic model of useful knowledge production that still dominates our spatial imagination today.

In this dissertation I propose and develop the *utility spot* concept as spatio-historical approach to the epistemology of useful scientific research. The preliminary definition that I started with, grounded in theory and historiography, has been iteratively sharpened through the analysis of primary sources on such spots. In Chapter 6, 'Conclusion. History and Future of Utility Spots', I set forth a refined definition of utility spots:

> **Actual and virtual** spatial arrangements that facilitate and stimulate the political-epistemic interactions between heterogeneous actors, which actively shape the significance of research, with the public aim of creating and circulating useful scientific knowledge. They **emerge at the intersection** of international ideals, national policy and local contingencies, where they **function as distorting mirrors** that reflect current problems and provide speculative solutions.

This could guide further research into previous, current and future organisation of scientific research with societal value. I suggest two specific two directions. One is the historical study of the politics of proximity (in multiple dimensions) at various utility spots. The other is an exploration of science fiction as potential rich resource of alternative spatial imaginaries of valuable scientific research.

Summary (in Dutch)

Het denken over en het organiseren van het *nut* van wetenschappelijk onderzoek heeft epistemologische en politieke implicaties: waar kennis uit bestaat, hoe het tot stand komt en met welk doel. In dit proefschrift situeer ik het nut van wetenschappelijk onderzoek in concrete plekken voor kennisuitwisseling. Vele ruimtelijke factoren geven vorm aan de uitwisseling van kennis binnen en tussen milieus: van architecturale ontwerpen, fysieke nabijheid en materiële infrastructuren tot stadsplanning, regionale ontwikkeling en geopolitiek. En het is niet alleen de kennis zelf die zich verplaatst; ook ruimtelijke modellen voor de organisatie van onderzoek circuleren. In dit proefschrift stel ik dat het zinvol en vruchtbaar is om het onderzoek naar het nut van wetenschap niet op vooraanstaande wetenschappers, dominante disciplines of invloedrijke organisaties te richten, maar de aandacht te verleggen naar *plekken* van nut, wat ik 'utility spots' noem. Het bestuderen van de totstandkoming, werking en circulatie van zulke plekken—zoals het *science park*—brengt de concrete vervlechting in kaart van politieke, maatschappelijke, economische, culturele en wetenschappelijke ontwikkelingen. Daarnaast stelt deze benadering mij in staat om verschillende 'nuttigheid' begrippen in verband te brengen met de geschiedenissen van wetenschap, universiteiten, wetenschapsbeleid en Atlantische geopolitiek in de tweede helft van de twintigste eeuw.

In hoofdstuk 1 introduceer ik de centrale onderzoeksvraag: hoe vormen en weerspiegelen ruimtelijke modellen van kennisproductie de concepten en politiek van *nuttig* wetenschappelijk onderzoek in de laat-moderne Westerse wereld? Deze vraag ontleent haar oorsprong aan een recente controverse in Nederlands wetenshapsbeleid over 'valorisatie', dat wil zeggen waardecreatie uit wetenschappelijke kennis. Om (de weerstand tegen) zulke wetenschapsbeleidsbegrippen beter te begrijpen, pas ik de ruimtelijke lens van de *utility spot* toe en situeer ik, bijvoorbeeld, valorisatie in concrete plekken en periodes. *Utility spot* introduceer ik daarom met name als heuristisch begrip om de overlap tussen nuttigheid en ruimtelijkheid te kunnen belichten in historische reconstructies van het beleid en de praktijk van publiek gefinancierd onderzoek.

Deze ruimtelijk-historische benadering op het nut van onderzoek verbindt op kritische wijze aspecten uit vier onderzoeksvelden. Enerzijds begrijp ik nut als een historisch-epistemologische categorie die de wetenschapspraktijk mede vormgeeft. Hiermee verhoud ik me tot wetenschapshistorische studies die de veranderlijkheid van metawetenschappelijke concepten beschrijven (zoals objectiviteit) en recente kennistheorie die niet-wetenschappelijke waarden en actoren als integraal onderdeel van de wetenschapspraktijk zien. Anderzijds benadruk ik het belang van plaats voor praktijken van kennisuitwisseling tussen academische en maatschappelijke sferen, waarbij ik me baseer op perspectieven uit de historische geografie van wetenschappelijk onderzoek en sociale studies van de circulatie van wetenschappelijke kennis. Aan het eind van het methodologische hoofdstuk poneer ik een voorlopige definitie van *utility spot* om de identificatie en interpretatie van specifieke gevallen in de naoorlogse geschiedenis van wetenschap, beleid en maatschappij mogelijk te maken. Doorheen het proefschrift pas ik het concept toe en aan op basis van de historische analyses.

> Utility spots bestaan uit de ruimtelijke configuraties die politiek-epistemische interacties tussen heterogene actoren faciliteren en stimuleren, de significantie van onderzoek actief vormen en het publieke doel nastreven om nuttige wetenschappelijke kennis voort te brengen en te verspreiden.

Hoofdstuk 2 past deze ruimtelijke lens toe op de bestaande Noord-Amerikaanse geschiedschrijving van de naoorlogse wetenschap. Ik beschrijf een serie specifieke plekken van kennisproductie en -uitwisseling die tussen 1945 en 1990 in de Verenigde Staten als schoolvoorbeelden van nuttig onderzoek golden, zoals de Bell laboratoria, RadLabs en Silicon Valley. Bijzondere aandacht gaat uit naar de oorsprong (en het grote economische succes) van dit laatste gebied en de modelrol die het Stanford industriepark daarbinnen speelt. Amerikaanse wetenschapshistorici hebben de politiek-economische, sociale en culturele mogelijkheidsvoorwaarden uitvoerig in kaart gebracht die tot de opkomst en wisselende prestaties van industrieparken rondom academische instituten hebben geleid. Het *science park* situeer ik in een langere geschiedenis van diverse *utility spots* rondom universiteiten in de naoorlogse VS zodat het opdoemt als symbool van de verschuivende politiek-economische verhoudingen in de jaren 1980.

Uit dit historiografische overzicht destilleer ik aanvullende aspecten van het *utility spot* begrip. In termen van architectuur neemt de politiek-epistemische grens tussen 'academisch' en 'nuttig' onderzoek de vorm van ruimtelijke afscheidingen tussen verschillende types onderzoek (op basis van financiering, classificatie of doel). Dit is verweven met de *locatie* van nuttig onderzoek, omdat specifieke plekken in symbolische zin reeds impliceren welke relaties wenselijk zijn. Dit geldt zowel op een kleine schaal, in termen van *nabijheid* en samenwerking, en op een grotere schaal, als onderdeel van een politiek-economische *geografie*. Zodra men een succesvol ruimtelijk model van kennisproductie in *circulatie* brengt, worden lokale complexiteiten geregeld geabstraheerd tot vereenvoudigde *geometrisch*e schema's. Deze dragen de belofte dat het succes van de ene plek elders nagebootst kan worden. Keer op keer blijkt echter dat de ruimtelijke organisatie van nuttig onderzoek zeer specifiek is voor de oorspronkelijke context en afhankelijk is van lokale politiek-epistemische allianties. In de hierop volgende historische hoofdstukken voeg ik deze aspecten samen om tastbare geschiedenissen van *utility spots* te schrijven als het product van lokale condities, regionale omgeving, nationale politieke economie en internationale geopolitiek. Daarbij benadruk ik dat we evenveel aandacht moeten besteden aan de lokale complexiteit van de 'ontvangers' van heersende ruimtelijke modellen van nuttige kennisproductie.

In hoofdstuk 3 richt ik mij op de ruimtelijke oorsprong van een wetenschapsbeleid debat *avant la lettre* over het karakter van universitair onderzoek in de Nederlandse jaren 1950. Dit betrof in het bijzonder de wenselijkheid van en criteria voor het subsidiëren van wetenschappelijk onderzoek in universiteiten en technische hogescholen door 'buiten-academische' organisaties, zoals de Nederlandse Organisatie voor Toegepast-Natuurwetenschappelijk Onderzoek (TNO) en de industrie, Philips NV in het bijzonder. Deze kwesties hadden hun oorsprong in enkele hybride ruimtes, waarvan ik er twee bespreek: de Technisch Physische Dienst TNO-TH, een klein laboratorium op de afdeling Technische Natuurkunde van de Technische Hogeschool Delft waar coöperatief en contractonderzoek werd uitgevoerd, en de Gezondheidsorganisatie TNO, een coördinerend lichaam voor Nederlands medisch onderzoek dat de oprichting van een buiten-academisch Medisch Fysisch Instituut overwoog. De vragen die in deze, enigszins uitzonderlijke, *utility spots* opkwamen werden door het Ministerie voor Onderwijs, Kultuur en Wetenschappen uitgezet in een landelijke vragenlijst: vele universitaire laboratoria in de medische, technische en natuurwetenschappen bleken amalgamen van lange en korte termijn, zuiver en toegepast, vrij en contractonderzoek. Deze mengvormen veroorzaakten soms wrijving op de werkvloer, waar verschillende onderzoekers uiteenlopende belangen dienden met evenzeer uiteenlopende vergoedingen. Meer nog was het een probleem in de bestuurskamer, waar beleidsmakers, curatoren, hoogleraren en industriëlen orde in de chaotische realiteit hoopten te scheppen.

Dit hoofdstuk belicht hoe lokale, ruimtelijke spanningen leidden tot een interuniversitair adviesrapport over contractonderzoek binnen de academische muren (het Kronig rapport) en hoe dit vervolgens een rol speelde in een beleidsdiscussie over TNO's geografische decentralisatie. Beiden voorvallen zijn tot op heden niet besproken in de Nederlandse geschiedschrijving van universiteiten of wetenschapsbeleid. Deze twee discussies over het karakter en de plek van universitair onderzoek tonen juist dat er ook onder historische actoren een ruimtelijk begrip bestond van de relatie tussen nut en onafhankelijkheid: men stelde 'para-universitaire instituten' voor om gebruiksgericht en coöperatief onderzoek in te huizen en zo tegelijkertijd de universiteit te vrijwaren als plaats voor fundamenteel onderzoek en de regionale economie te stimuleren met nuttige onderzoeksprojecten. Doorheen het hoofdstuk komt naar voren dat concrete ruimtes voor uitwisseling en samenwerking tussen heterogene actoren de aanleiding waren voor abstracte beleidskwesties en contemplatieve debatten over de waarde van onderzoek.

Hoofdstuk 4 plaatst nuttigheid in een geopolitiek perspectief door de uiteenlopende plannen voor een Europese Universiteit te portretteren. Deze, soms conflicterende, plannen ontstonden tussen 1955 en 1965 bij verscheidene internationale politieke organisaties, zoals de Europese Economische Gemeenschap (EEG), de Europese Gemeenschap voor Atoomenergie (Euratom), de West-Europese Unie (WEU) en de Noord-Atlantische Verdragsorganisatie (NAVO). Steeds leidde dit tot geopolitieke beslommeringen zoals de juiste geografische reikwijdte, de betrokkenheid van de VS en de spanning tussen de intellectuele en politieke kosten en opbrengsten van grensoverschrijdende concentratie van onderzoek. In dit hoofdstuk neem ik virtuele *utility spots* serieus door vooral te kijken naar plannen voor nieuwe plekken gericht op kennisuitwisseling en samenwerking buiten bestaande academische structuren. Ieder ruimtelijk plan belichaamde andere wereldbeelden, zowel in termen van geografische oriëntatie als in termen van nuttigheidsbegrippen, die in lijn lagen met de overkoepelende politieke organisaties die er de aanzet toe deden. De beoogde relaties tussen kennisproductie, overdracht en maatschappelijk gebruik materialiseerden lang niet altijd, of bijna nooit, in een concrete plek. Maar het proces van verbeelding en speculatie was in die gevallen zelf reeds productief door heterogene actoren uit beleid, wetenschap en de samenleving bij elkaar te brengen en in een visie te verbinden.

Daarnaast beargumenteert dit hoofdstuk dat het *utility spot* begrip niet alleen relevant is voor ons begrip van het nut en de organisatie van natuurwetenschappen maar ook van de sociale en geesteswetenschappen. Dit demonstreer ik door de geschiedenis van het

Netherlands Institute for Advanced Study in the Humanities and Social Sciences (NIAS) aan de geopolitiek van de Europese Universiteit te knopen. Enerzijds bood het instituut als plek apart van de universiteiten ruimte aan nieuwe disciplinaire en interdisciplinaire initiatieven in deze wetenschapsgebieden. Dit kwam overeen met de inzet van het opkomende sociaal en geesteswetenschappelijk onderzoeksbeleid, dat zich expliciet aan de organisatiestructuren van de natuurwetenschappen spiegelde. Maar NIAS week hier ook van af, want er werd niet daadwerkelijk ruimte gemaakt voor het 'complementaire nut' van onderzoek in de sociale en geesteswetenschappen—dat wil zeggen, de culturele overdracht van relevante waarden ten dienste van broodnodige reflectie op de razendsnelle maatschappelijke veranderingen die technologische ontwikkelingen in gang hadden gezet. Amerikaanse voorbeelden uit Princeton en Stanford boden de contouren voor de eerste schetsen van NIAS, zoals andere Amerikaanse ruimtelijke modellen ook al tot inspiratie dienden voor de Europese Universiteit. *Utility spots* reizen, als verhalen maar ook vrij letterlijk als bouwtekening, en arriveren alleen als zij aan lokale belangen en mogelijkheden worden aangepast.

Hoofdstuk 5 beschrijft een verschuiving in Nederlands wetenschapsbeleid waar het nuttigheidsbegrip eerst in termen van 'maatschappelijke relevantie' geduid werd en later vooral in termen van 'kennisoverdracht' en 'innovatie'. Deze verschuiving maak ik tastbaar met een rits verbeelde en gebouwde *utility spots* uit de periode 1970–1985: wetenschapswinkels, transferpunten, academische bedrijvencentra en, tot slot, wetenschapsparken. De ruimtelijke politiek van kennisoverdracht komt naar voren in achtereenvolgens de opkomst en ondergang van wetenschapswinkels aan verschillende Nederlandse universiteiten, het eerste transferpunt bij de Technische Hogeschool Eindhoven, een *business technology center* bij de Technische Hogeschool Twente en het Zernike Science Park van de Rijksuniversiteit Groningen. Doorheen het hoofdstuk volg ik ieder van deze ontwikkelingen bij wijze van vergelijking ook binnen de Universiteit Leiden. De ruimtelijke politiek bestaat onder andere in een intra-academisch conflict over het transferpunt tussen 'progressieven' en 'pragmatisten', die uiteenlopende politiek-economische standpunten innamen over het nut van onderzoek, grofweg van sociaaldemocratisch tot neoliberaal. Ondertussen bouwden universiteitsbestuurders en ondernemende (biotechnologie) hoogleraren actief nieuwe allianties op in hun zoektocht naar aanvullende geldstromen. Met name het *science park* droombeeld bleek effectief om gemeente, bedrijfsleven, regionale ontwikkelingsmaatschappijen, ministeries, banken en internationale firma's te verleiden tot financiële injecties in kennisoverdracht op de campus. Onder verwijzing naar het nabijheidsargument—kleine fysieke en geografische afstand tussen universiteit en industrie zou zowel de regionale economie als de academische creativiteit bevorderen—verrezen er daadwerkelijk gebouwen voor kennisuitwisseling op de campus.

Uit de analyse van de komst van *science parks* naar Nederland in de jaren 1980 trek ik de conclusie dat deze plekken de verknoping representeren van veranderingen in wereldwijde wetenschap en handel, in nationale en lokale politiek, en in universitaire organisatie. Deze plaatsen met een oriëntatie op commerciële kennisoverdracht waren vaak minstens retorisch gemodelleerd naar Amerikaanse voorbeelden, Silicon Valley en het industriepark in het bijzonder. Deze modellen circuleerden in beleidsstukken, adviesrapporten en persoonlijke ervaringen tussen universiteiten, technische hogescholen en het regionale bedrijfsleven zowel in Nederland, van oost naar west, als in heel Europa. Belangrijker nog is dat deze *utility spots* de oorsprong en representatie waren van een nieuw wetsartikel over kennisoverdracht in de Nederlandse Wet op het wetenschappelijk onderwijs uit 1985. Dit artikel schreef aan academische instellingen ook de taak van kennisoverdracht toe en was twintig jaar later de mogelijkheidsvoorwaarde voor de opkomst van het valorisatiebeleid. Als beleidsconcept is valorisatie op haar beurt een reflectie van het *science park*, het toonaangevende model voor nuttige kennisproductie dat nog altijd de ruimtelijke verbeelding domineert.

In dit proefschift poneer en ontwikkel ik het concept *utility spot* als ruimtelijk-historische benadering op de epistemologie van nuttig wetenschappelijk onderzoek. Een voorlopige definitie ontwikkelde ik in relatie tot theorie en historiografie en scherp ik na uitvoerige analyse van primaire bronnen verder aan. In hoofdstuk zes besluit ik daarom met een verfijnde definitie van *utility spots*:

> **Werkelijke en virtuele** ruimtelijke configuraties die politiek-epistemische interacties tussen heterogene actoren faciliteren en stimuleren, de significantie van onderzoek actief vormen en het publieke doel nastreven om nuttige wetenschappelijke kennis voort te brengen en te verspreiden. Zij **ontstaan op het snijvlak** van internationale idealen, nationaal beleid en lokale contingenties, en zij **functioneren als lachspiegel**s die zowel bestaande problemen reflecteren als speculatieve vergezichten bieden.

Dit maakt verder onderzoek mogelijk naar eerdere, huidige en toekomstige organisatiemodellen van wetenschappelijk onderzoek met maatschappelijke waarde. Ik stel daartoe twee specifieke richtingen voor. De historische analyse van de politiek van nabijheid (in meervoudige dimensies) bij verschillende *utility spots* is ook relevant voor het heden. En ik suggereer dat science fiction een rijke inspiratiebron kan zijn voor alternatieve ruimtelijke verbeeldingen van waardevol wetenschappelijk onderzoek.

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Two interdisciplinary meeting places were particularly inspiring. In the Soeterbeeck convent in Ravenstein I had the privilege to enjoy the company of many passionate science studies PhD candidates and scholars at the WTMC workshops and summer schools. The earnest and open attitude of the training school coordinators, Bernike Pasveer and Govert Valkenburg, and its director, Sally Wyatt, was essential, as were the early morning runs along the Maas and the numerous table tennis competitions. At the University College London Department of Science and Technology Studies on Gordon Square it was very stimulating to participate in the cohabitation of history, philosophy and sociology scholars. Thanks to Chiara Ambrosio and Erman Sözüdoğru, I felt instantly at home.

On the margins of academia, two places played an important role. This project began to unfold at the Rathenau Institute in The Hague, as intern to Stefan de Jong and Leonie van Drooge. You remained caring custodians and I am thrilled we are again working together. Also the joyful collaborations with Patricia Faasse on the history of science policy, and with Laurens Hessels on impact evaluation, originated here. At a later stage

I regained the motivation to persist in my doctoral studies at the Royal Netherlands Institute in Rome (KNIR). Frits van Oostrom, with some help of the 'Feestclub' (you know who you are!), created an ideal atmosphere for reflecting on academic life.

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Curriculum Vitae

Jorrit Smit was born on November 9, 1988 in Arnhem, the Netherlands. In 2011, he completed the interdisciplinary bachelor programme Bèta-Gamma at the Universiteit van Amsterdam (UvA), where he majored in physical chemistry. During his bachelor Jorrit was elected to the faculty student council which he served as chairman. In 2011, he obtained a Thomas More scholarship for an additional year of philosophy study at KU Leuven. Between 2012 and 2015, Jorrit followed the History and Philosophy of Science research master at Utrecht University. As part of this programme he spent a semester abroad at the History Department of the University of California, Los Angeles (UCLA) and conducted an internship at the Rathenau Institute, a science policy think tank in The Hague. He obtained his MSc degree *cum laude* with a thesis on the societal value of Ernst Cohen's physical chemistry in the early twentieth century.

In 2015, Jorrit obtained a grant in the PhDs in the Humanities funding scheme of the Dutch Research Council (NWO). At the Institute for Philosophy of Leiden University he set out to study the history and philosophy of science policies that aim to stimulate the societal value of scientific research. During this PhD trajectory, he was a visiting scholar at the Science and Technology Studies department at University College London (UCL) and PhD-representative in the board of the national graduate school in science studies (WTMC). He also commenced editorial activities at public philosophy magazine *Wijsgerig Perspectief* and history of science blog *Shells and Pebbles* that continue to this day.

As of September 2020, Jorrit is a postdoctoral researcher in the project Evaluating Societal Impact at Erasmus University Rotterdam. Results of his research have appeared in *Studium, Science and Public Policy* and *Research Evaluation*, as well as in edited volumes published at Routledge and Verloren.