Utility spots: science policy, knowledge transfer and the politics of proximity

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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 cooperation 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 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.