How the Romans conceived their roads: inner experience in the Anchoring of technological innovation

McAllister, J.W.; Flohr, M.; Mols, S.T.A.M.; Tieleman, T.L.

CHAPTER 2

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James W. McAllister

1 Invention, Innovation, and Anchoring

The distinction between 'invention', the production of a new idea, object or practice, and 'innovation', the successful adoption and diffusion of something new, originated with Joseph A. Schumpeter in his studies of entrepreneurship in the 1930s.[1] An important question since then has been what factors determine whether an invention leads to innovation. One promising answer focuses on how well and in what ways potential users comprehend the new idea. The concept of anchoring is meant to capture this requirement. An invention has a higher chance of leading to innovation if the experience of using it recalls—or is anchored in—something known and familiar.

Here we focus on anchoring of technology. A paradigmatic illustration in modern times is Thomas A. Edison's work around 1880 to transform a device, the incandescent filament lamp, into the electric lighting system that took over the world. Edison's appeal to design elements that recalled gas lighting facilitated acceptance of the innovation.[2]

Technology in ancient Rome is another good source of case studies. Rome made many engineering and manufacturing innovations, including the road network, bridges and aqueducts, sewers, baths, concrete, the *codex* or bound book, and glass manufacturing techniques.[3] Indeed, the Romans saw themselves more as systematisers of inventions made by other Mediterranean peoples than as inventors in their own right, if we are to believe Pliny the Elder in *Naturalis Historia*, a compendium of Roman knowledge and achievements (first century CE).[4] The study of Roman technology, therefore, turns the spotlight on anchoring.

1 Parayil 1991, 80–83; Fagerberg 2013, 6–10.
2 Hargadon and Douglas 2001.
3 Flohr 2016.
4 Romani Mistretta 2018, 131.

The concept of anchoring is still relatively underdeveloped, however. Ineke Sluiter, introducing the 'Anchoring Innovation' research agenda in classical studies, characterised the difference between invention and innovation as a 'human factor'. As Sluiter explained, 'Innovations may become acceptable, understandable, and desirable when relevant social groups can effectively integrate and accommodate them in their conceptual categories, values, beliefs and ambitions'.[5]

In this chapter, I offer a new philosophical account of the anchoring of technological innovations. This will draw on the work of Wilhelm Dilthey on natural and mental phenomena and how we apprehend them. I will support my account with evidence from Roman invention and innovation.

2 Dilthey on Inner and Outer Experience

Discussing the foundations of the *Naturwissenschaften* and *Geisteswissenschaften* in the 1890s, Dilthey took over a distinction formulated by Immanuel Kant between two categories of phenomena and the ways in which we apprehended them. *Naturerscheinungen* or natural phenomena, such as physical effects and processes, were grasped through sense perception, or what Kant called 'outer experience'. *Geistige Erscheinungen* or mental phenomena, which included human acts and artworks, were different. Their physical expressions were given in outer experience, but observers interpreted their meanings by linking them to what Kant called 'inner experience', or one's experience from within of one's own empirical-psychological states, including beliefs, intentions, and affects.

Dilthey elaborated on the ways in which we gained comprehension of phenomena of the two kinds. Since we were able to individuate natural phenomena purely by ostension in outer experience, according to Dilthey, picking out such a phenomenon did not depend on having achieved even a preliminary understanding of it. A scientific explanation of a phenomenon might come long after its discovery.

Things were otherwise for mental phenomena, Dilthey argued. Their meanings were partly constitutive of their identity, so it was impossible for us to individuate a mental phenomenon simply by ostension in outer experience: we needed first to grasp its meanings. When we individuated a mental phenomenon, therefore, it had already passed through inner experience. In that phase

5 Sluiter 2017, 21, 23.

we achieved an initial understanding of the phenomenon in common-sense terms. Subsequent scientific research might yield a more sophisticated comprehension of a mental phenomenon, of course; this had to maintain continuity with the initial common-sense understanding, however, or we would be unable to reidentify the phenomenon in experience.[6] As Dilthey wrote in 1894:

> The human sciences are distinguished from the natural sciences first of all in that the latter have for their object facts that are presented to consciousness as from outside—as phenomena and as given in isolation—while the objects of the former are given *originaliter* from within as real and as a living continuum or nexus. As a consequence there exists a system of nature for the physical and natural sciences only through inferential conclusions that supplement the data of experience by means of a combination of hypotheses. In the human sciences, by contrast, the continuum or nexus of psychic life is an original or basic given. Nature we explain, but psychic life we understand [Die Natur erklären wir, das Seelenleben verstehen wir].[7]

Let us consider a pair of illustrations. Take scientists studying a natural phenomenon, such as magnetism. They may individuate a magnetic effect in observational data, find it surprising, note that they lack an understanding of it, give it the status of explanandum, and subsequently strive to find a scientific explanation of it. This is a well-established empirical cycle in natural science. In his summary of Roman natural knowledge, for example, Pliny reported observational accounts of several notable magnetic phenomena while making clear that no explanation of them was available.[8]

Contrast this with a behaviour that Dilthey would classify as a mental phenomenon: gift-giving. What makes an object a gift is not any intrinsic properties of the object, but the intentions and meanings that giver and receiver ascribe to it. For this reason, ostension in observational data (as used to individuate natural phenomena) is incapable of identifying instances of gift-giving, distinguishing gifts of different types or demarcating gift-giving from other cases in which goods change hands. To do that, we need an initial common-sense understanding of the mental phenomenon of gift-giving, based largely on our own previous experiences of the phenomenon and what they meant to us.

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6 Bransen 2001, 16167–16168.

7 Dilthey [1894] 2010, 119.

8 Healy 1999, 155–158.

This requirement holds both for participants in the practice of gift-giving and for scholars in human sciences studying this mental phenomenon. For example, the Romans distinguished gifts of two types, *dona* and *munera*. *Dona* included spontaneous gifts, such as those given at the beginning of a relationship, while *munera* were gifts considered socially obligatory, such as customary gifts on the occasion of festivals and recompense for services for which payment was not appropriate.[9] Before any scientific research project into Roman gift-giving can get under way, we must have an intuitive understanding of these social categories and their meanings to be able to distinguish instances of *donum* and *munus* in historical records.

The contrast between the ways in which natural and mental phenomena are individuated suggests that, whereas it is possible to encounter a natural phenomenon that no-one has observed previously, there are no completely novel mental phenomena to discover: we have seen all mental phenomena before, in one form or another. We identify a thing as a particular mental phenomenon largely on the basis of that prior acquaintance.

I suggest that Dilthey's account of natural and mental phenomena and their individuation offers a plausible way to underpin the concept of anchoring of technological innovations. The distinction between invention and innovation maps onto that between outer and inner experience, I hypothesise. On this view, the outcome of an act of invention is a natural phenomenon that we apprehend purely in outer experience. For this reason, an invention may strike viewers as irreducible to familiar categories. A successful innovation, by contrast, holds meaning for us and is apprehended partly via inner experience. This explains why a successful innovation will strike users as familiar in some respects: they are already acquainted with the mental phenomenon of which it partially consists. Anchoring, on this suggestion, involves turning a technology from a purely natural phenomenon into at least partly a mental phenomenon.

3 Inventions in Outer Experience

To show how this account helps us understand anchoring in technological innovation, let us trace the roles of outer and inner experience in the perception and reception of Roman inventions and innovations. I will contrast invention in this section with innovation in the next.

9 Hyland 2009, 25–28.

Hero of Alexandria, who lived in Roman Egypt in the first century CE, designed and manufactured many automata, which he described in his treatises, *Pneumatica* and *Automata*.[10] These automata were mechanical animations that appeared to move spontaneously: some depicted recognisable everyday or mythological scenes, such as a singing bird or Hercules' shooting an arrow at a dragon.[11] They were intended as wonders in temple rituals and theatre performances, evoking in viewers an experience of *thauma*, or astonishment and awe.[12] Hero's automata were powered by various component mechanisms, like the aeolipile ('ball of Aeolus'), a brass vessel fitted with transverse nozzles that spun on its axis when water inside was heated into steam.[13]

Crucial to the effectiveness of such wonders was that their movements should seem unexpected and inexplicable. Hero emphasised the importance of keeping the workings of his automata out of sight, withholding any sense of understanding or familiarity from the audience so as to heighten the effect of surprise and mystery. For example, Hero wrote that he made his automata too small to conceal a human operator, so as to deprive spectators of even that suggestion of intelligibility.[14] Hero, in other words, studiously avoided providing any anchoring for his automata: any semblance of familiarity to the viewer would have diminished their impact as spectacles.[15]

On this point, I depart from the interpretation that Michiel Meeusen offers later in this volume. Meeusen argues that mythology was an important resource for anchoring Roman technological applications. He gives Hero as an example: in Meeusen's view, Hero's depiction of familiar mythological characters and scenes in his automata was a way of providing anchoring for them, thus facilitating their acceptance and adoption.[16] I suggest that these visual references to the familiar cannot be regarded as anchoring, however, for two reasons. First, anchoring of an innovation usually hinges on recognisability of the means that are used to produce a new effect, not on recognisability of the effect. Anchoring of infrangible glass, for example, consists in the fact that, while it demonstrates a new property (infrangibility), it does so by means that appear familiar (it resembles ordinary glass). Second, anchoring is a demystifying technique that negates *thauma*. By contrast, it was important to Hero that the way in which his automata produced their effects remained obscure and enigmatic, in order

10 Murphy 1995; Sherwood et al. 2020, 76–82.
11 Steadman 2021, 111–131.
12 Tybjerg 2003; Berryman 2009, 50–53; Lightfoot 2021, 208–214.
13 Keyser 1992; Sherwood et al. 2020, 39–40.
14 Murphy 1995, 15.
15 Bosak-Schroeder 2016, 127–128.
16 Meeusen 2025.

to heighten their effectiveness as temple and theatre wonders. That is why his designs refrained from offering any clues to their functioning. In other words, Hero deliberately withheld anchoring from his automata. In turn, this helps explain why his automata and their mechanical components never caught on as innovations. The aeolipile, for example, clearly never progressed from invention to innovation: this application of steam power remained a one-off gadget, as G.E.R. Lloyd noted, leading to no further technical developments.[17]

In Dilthey's terminology, Hero's temple and theatre wonders, and more particularly components like the aeolipile, were good examples of natural phenomenon. They appeared to the observer in outer experience as surprising spectacles awaiting explanation. By contrast, they did not show up in inner experience: Hero's contemporaries had no pre-existing or common-sense understanding of these phenomena by which they could make sense of them.

Summarising, Hero's automata and mechanisms such as the aeolipile were novel natural phenomena that had no presence in viewers' inner experience. This meant that they could count on no familiarity. This, in turn, heightened their effectiveness—anchoring them would have been counterproductive. They emphatically remained inventions rather than innovations.

4 Innovation: Inner Experience

The role of common-sense understanding is otherwise for what Dilthey termed mental phenomena. The meanings of a mental phenomenon are central to its identity, so we cannot individuate such a phenomenon without relying on a preliminary, common-sense understanding of it. We gain this in inner experience, in which our beliefs, intentions, and affects come into play.

My contention is that successful Roman technological innovations amounted partly to such mental phenomena. Let us take roads as an example. Whereas the first paved roads in the Italian peninsula were Etruscan, the Romans made the *via publica* into a widely adopted innovation. Starting with the Appian Way linking Rome to Capua in the fourth century BCE, the network reached an extension of 120,000 kilometres by the late empire.[18]

Why did this innovation catch on so well in the Roman world? Saying that military commanders, administrators, and traders found roads useful does not fully answer this question, for not all useful inventions catch on. There were, I suggest, pre-existing intellectual conditions that made roads available to

17 Lloyd 1973, 106.
18 Chevallier 1997, 306.

Dilthey's inner experience. This meant that Romans already had, so to speak, an understanding of roads when they first saw them.

This prior understanding was rooted in the Roman notion of space. Pietro Janni, Kai Brodersen, and others have distinguished two conceptualisations of space: in terms of lines that pass through it, and in terms of areas that fill it.[19] They have argued that the former was more prominent than the latter in ancient—and especially in Roman—spatial cognition. Romans seem to have conceptualised space primarily by means of one-dimensional lines or routes traversing it. This is a hodological conception of space (from the Greek, *hodos*, road or path).

Evidence that the Romans held this conception comes from two main sources: aids to travellers and descriptions of the geography of a region. First, the Romans summarised practical geographical knowledge primarily in itineraries, ordered lists of places defining a route.[20] One example is the *Itinerarium Antonini*, a third-century CE guide for travellers that listed over 2000 places and their distances along over 225 routes across the empire. Scholars continue to debate the extent to which Romans made maps and even how broadly we should construe the category 'map' in the Roman world.[21] Nevertheless, it seems that the Romans made few cartographic representations of landscape of the sort that we take for granted today, and did not use these for travel.[22]

The hodological view of space is prominent in Roman geographical writing too. At the opening of *De Bello Gallico*, for instance, Julius Caesar gave an overview of the geography of Gaul. Caesar did not describe the spatial relationship of areas to one another, as a modern writer might. Instead, he listed the natural routes through Gaul consisting of the rivers Garonne, Marne, Seine, Rhone, and Rhine, and explained how they led to the territories of the *Belgae*, *Aquitani*, and *Galli*.[23] In a similar way, Pliny followed coastlines and rivers to structure the geographical survey of the known world in his *Naturalis Historia*.[24]

It is easy to see how this might have helped the innovation of roads catch on in the Roman world. Built roads were an embodiment of the itineraries in terms of which the Romans conceptualised space.[25] The identity of the phenomenon 'road' for Romans was determined partly by meanings attributed to it, namely its congruence with the hodological conception of space. Roads

19 Janni 1984; Brodersen 2003.
20 Salway 2007.
21 Riggsby 2019, 172–201.
22 Whittaker 2004, 63–87; Cioffi 2016.
23 Bertrand 1997; Krebs 2018, 96–102.
24 Murphy 2004, 133–148.
25 Kolb 2007; Carlà-Uhink 2022.

for the Romans were therefore, in Dilthey's terminology, not solely a natural phenomenon, but partly a mental phenomenon too: a Roman encountering a road for the first time would have recognised it from inner experience. This amounts to anchoring the technology in something familiar to its users, and distinguishes the road network as innovation from the aeolipile as invention.

5 Conclusions

Interpreting the anchoring of technological innovation in terms of Dilthey's inner and outer experience convincingly reconstructs, I believe, the human factor at the heart of this notion. Naturally, the proposal calls for further development and scrutiny. To begin with, we should look at philosophical traditions since Dilthey that, taking everyday life as the basis of experience, have developed the concept of inner experience in new ways. In the phenomenology of Edmund Husserl, for example, the *Lebenswelt* (lifeworld) was the domain of common sense or daily life, given to and taken for granted in our immediate experience prior to scientific knowledge.[26] Second, the proposal should be articulated and tested by reference to further examples of invention, innovation, and anchoring from both ancient Rome and other epochs. I necessarily postpone that work to future occasions.

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26 Smith 1995.

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