Hooke, Latour, and Extended Cognition

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In one of the longest examples in Latour's latest book, the author recounts a trek up Mont Aiguille.[1] This is a well-blazed trail; the climb can reasonably be completed in a day. It is perhaps noon, for Latour has been climbing for some time; it is late enough that he is slightly winded in the thin air of the Vercours Plateau. Every so often, he pulls a compass from his pocket, and subjects it to a curious gesture. He raises it to eye level, holds it quite still in his palm, and sights along a little notch in the lid; it is just as though he is scrutinizing a wafer before offering it to some unseen companion. Paused in his progress, he glances rapidly between a spot evidently in the far distance, and what is represented in the device. Having completed this little ritual, he puts the object aside, and checks what he has learned against a chart. It is this little ceremony, repeated so often that it gains the polish of habit, with which I want to begin. For Latour, as he himself notes, is in fact on two trips, and sighting along the compass works to stitch them together. He is making a slightly risky passage on a well-blazed trail, "outside," "in the fresh air," exposed to all the sublime views that make Mont Aiguille a popular site of adventure tourism. But he is also "inside," traversing "a continuous road paved with documents," and therefore negotiating a network "whose walls were so close together that [he] chose to lean on them every ten minutes or so." The challenge of the trek, as Latour tells it, becomes a challenge of coordinating these two journeys. The risky passage from trailhead to high plateau is in fact a chain of pauses, leaping backwards and forwards between chart, compass, landmarks, and chart again. Latour, therefore, is not alone. With him travel countless cartographers, tool-makers, and trail-blazers; they are condensed in the chart, the compass, and the trail. Nor is the trek the labor of a day; it comprehends the gradual perfection of maps, the manufacture of precision instruments, and the exhaustive exploration of the mountain itself. Latour's climb, as he puts it, is hardly his climb alone; it is the work of "three centuries" of collaboration.

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[1] Bruno Latour, *Inquiry into Modes of Existence: An Anthropology of the Moderns*, transl. Catherine Porter (Cambridge: Harvard University Press, 2013), 74-79.

Latour's problem is of course one of situation: the questions "where am I? and where am I going?" are hardly anywhere more pressing than on the steep slopes of the rock nicknamed "Mont Inaccessible." From finding the trailhead (his first challenge) to knowing that he has reached the top (not the last), his hike is a chain of navigational problems. And he solves this problem not once and for all, but by constantly, repeatedly linking the wilderness with a chart. He encounters, therefore, a version of a basic scenario that has been the recent subject of a great deal of scholarly attention; he is at the crux of the issues treated by the field of "situated" or "extended cognition," that program of research focusing upon the embeddedness of the mind in its environment during even the most normal cognitive operations.[2] Much of our thinking, according to this thesis, happens in exchanges between mind and its tools, in the cognitive ecologies in which we live. Referring to a chart is one operation that satisfies the criteria for a thought in the extended sense[3]; not only does map-making and map-checking mirror one folk model of cognitive processing (the "cognitive map"[4]), but our mental states themselves come to internalize a reliance upon information deliberately stored in the chart.[5] According to this argument, we do not build elaborate conceptual models and then set out on our adventure; the mind contains no such models. On the contrary, the mind develops repertoires for coordinating external media; it learns to rely, indeed to internalize, the technologies that it has inherited. A snapshot of a thought would therefore have to include not only a brain state, but also the body and its immediate environment, since thinking cannot be disentangled from motivated, bodily action. "There is," writes Andy Clark, in a study that has rapidly become a classic in the field, "a quite general difficulty in drawing a firm line between a user and a tool."[6] Latour, sighting down his compass to check the angle between landmarks, is clearly thinking with hands and eyes, inscriptions and instruments. Together, we might say, he, his tools, his notes, and Mont

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[2] Philip Robbins and Murat Aydede argue for "situated" as the most encompassing term, though "extended," for reasons that will become clear shortly, may be historically prior.
[3] Clark and David Chalmers, "The Extended Mind," *Analysis* 58 (1998): 10-23; Clark, *Supersizing the Mind* (2008), 78-106; Robert Rupert, "Memory, Natural Kinds, and Cognitive Extension; or, Martians Don't Remember, and Cognitive Science is Not about Cognition," *Review of Philosophy and Psychology* 4.1 (2013): 25-47.
[4] The term was introduced by Edward Tolman, "Cognitive Maps in Rats and Men," *Psychological Review* 55 (4): 189–208.
[5] Katherine Hayles reviews these issues in *How We Think* (2012) 87-96.
[6] Clark, *Being There: Putting Brain, Body, and World Together Again* (Cambridge: Bradford, 1998), 214. Drawing a firm line is *itself* something that requires a user and a tool—a point observed by (among others) Robert Hooke.

Aiguille form a cognitive ecology, a space of thinking in which the parts are in current, shifting interaction.

One thing missing from the study of extended cognition, so-called because it "extends" cognition outside the boundary of skin and skill, is a sense of its own history—not just of what situated thought might have looked like immediately before early experiments in robotics in the 1970's and '80's, but how the entanglements of technique with technology, thinking with note-taking, were theorized before the most recent wave of interest in cognition as an ecological property.[7] The standard cognitive model is, in the words of William Clancey, a "here-and-now… thing," interested in how we think *right now*, and not, on the contrary, how we got this way.[8] Situated accounts are hardly more attentive; Clancey's study itself is particularly historically aware because it reaches as far back as the radical empiricism of William James, but even rigorous and well-received studies like Alva Noë's *Action in Perception* offer a history of cognitive models of perception only to note that modern versions of the mind as an information processor are not historically inevitable.[9] Historicity is however built into cognition understood in its extended sense; elements of any thinking system evolve with reference to other elements in the system. This means that cognitive ecologies "have a history: how the parts have interacted in the past," writes William Clancey, "has changed the parts and what constitutes their system environment."[10] The question of how we arrived at this point in our cognitive history—or at this point in Latour's hike—demands therefore an answer formed from the technical media in which we find ourselves. An intellectual history of extended cognition, in other words, should take the form of a material history of technical media—that is, any medium which functions as a tool, or tool which functions as a medium.

And this history is in fact already being undertaken under a number of different names and with different beasts in view; among the best-known and most extensive of these is the work following in the footsteps of Bruno

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[7] See Michael Silberstein and Anthony Chemero, "Complexity and Extended Phenomenological-Cognitive Systems," *Topics in Cognitive Science* 4.1 (2012): 35-50; Tim van Gelder, "What Might Cognition be if Not Computation?" *Journal of Philosophy* 91 (1995): 345-81; William Clancey, *Situated Cognition: On Human Knowledge and Computer Representations* (New York: Cambridge University Press, 1997).

[8] Clancey, *Situated Cognition*, 225-26

[9] Clancey, "Scientific Antecedents of Situated Cognition," in Robbins and Eydede (eds.), *Cambridge Handbook of Situated Cognition* (New York: Cambridge University Press, 2009), 11-34; G. Picininni, "Computation without Representation," *Philosophical Studies* 137 (2008): 205-41.; Noë, *Action in Perception* (Boston: MIT, 2004), 40-48.

[10] Clancey "Scientific Antecedents," 14.

Latour, especially his work that most directly addresses the terrain of scientific practice. Latour's work has, from the start, preferred to address the tools and techniques of knowledge, rather than, say, mental techniques. He has not, he remarks, examined "scientists' brains" (he was, he adds, "forbidden access"). He has clung, on the contrary, "to the level of simple craftsmanship," offering an extended analysis of "the instruments" by which thought has historically been conducted.[11] It is for this reason that Latour's work is so promising in fleshing out the history of extended cognition; it is also why the links between his work and work in cognitive studies have not often been made. For, while the field of extended cognition has developed largely out of an interest in individual thinkers, extending models of thinking into the environment, Latour has quite explicitly expressed no special interest in individuals, preferring instead an exhaustive approach to the shifting networks that define and produce the present state of knowledge.[12] "Meaning productions," Latour has famously insisted, become "the only important thing to study."[13] Nevertheless, Latour remains invested in recovering the complicated histories of the world in which we only incidentally live, for, as thinking creatures, we dwell in ecological niches that are bequeathed to us by virtually limitless preceding generations.[14] Latour's work therefore provides one way of revisiting the history of the cognitive bed in which we find ourselves, though, of course, with barely a glance at the experience of being in that bed. "'Cognitive History,'" Latour elsewhere avers, "means exactly what we mean by 'science studies,' namely an obsessive attention to the material, historical, and practical conditions necessary for the discovery of new cognitive skills."[15]

Latour commonly remarks that the alternative history of science, which would develop as a history of technical media, should begin in the laboratory of Robert Boyle, especially as his work has been elegantly unpacked by Steven Shapin and Simon Schaffer in their seminal *Leviathan and the Air Pump*.[16] At one end of this history would be Latour, surrounded with a flurry

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[11] Latour, "Thinking with Hands and Eyes: Visualization and Cognition," *Knowledge and Society: Studies in the Sociology of Culture Past and Present* 6 (1986): 3-4.
[12] Latour, "On Actor-Network Theory: A Few Clarifications," *Social Welt* 74.4 (1996): 372-73.
[13] Ibid., 373.
[14] Bruno Latour, *Pandora's Hope: Essays on the Reality of Science Studies* (Cambridge: Harvard University Press, 1999), 185.
[15] Latour, "The Netz-Works of Greek Deductions," *Social Studies of Science* 38.3 (2008): 103.
[16] For instance, Latour, "Postmodern? No, simply A*Modern*! Steps towards and Anthropology of Science," *Studies in the History of the Philosophy of Science* 21.1 (1990): 145-71; *We Have Never Been Modern* (1993), 15-30; Latour, "Netz-Works," 104. See John Zmmito, *A Nice Derangement of Epistemes: Post-Positivism in the Study of Science from Quine to Latour*

of representations, taking a bearing in the mirror of a sighting compass; at the other would be Boyle's factotum and dogsbody, Robert Hooke, half man and half machine, surveyor, curator, and instrument-maker. Hooke would, in the ensuing years, become the surveyor most responsible for the layout of the City of London after the Great Fire, and a celebrated instrument-maker important in the history of such fields as navigation and cartography; he was responsible, among other things, for developing the first single-reflector surveying instrument. He was also the inaugural "keeper" of the Repository of the Royal Society, the first curator of the first museum with modern ambitions, and the place where Boyle's air-pump was stored when it was not in use. The Repository had been assembled as the critical resource for the renewal of natural philosophy sketched out by Francis Bacon. Just as, Bacon argued, human judgment works on and through arrangements of discrete ideas, so, too, the corporate project of natural philosophy was to proceed through the acquisition of vast natural histories, collections of objects such as the collection haltingly assembled by the Royal Society. The Repository marked an important turn in the new empirical project, which was as much a revolution in habits of thought as it was in the right ordering of the world. Henceforth, note Steven Shapin and Simon Schaffer, "if one wanted to produce authenticated experimental knowledge… one had to come to this space and to work in it with others."[17]

Bacon was however wrong however about the relationship between the work of intellection and the work of collection. As Bacon understood it, reason was a discrete faculty, floating free of its surroundings, operating on discrete little nuggets of information isolated from the world.[18] So, too, the Repository was to provide a field of facts for the investigation of natural historical questions; semi-professional, clean-handed "investigators" were to do the bulk of their work comparing examples assembled for them by others. But it turned out that many of the most powerful thinkers in the new empiricist project were the people most closely connected, on a day-to-day basis, with the stuff of the collection, the curators, keepers, and technicians who were continually among the objects of their concern. Boyle is often named as such an investigator, but first among this loose network of natural

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(Chicago: U of Chicago P, 2004), 176-80. Margaret C. Jacob, Margaret, "Latour's Version of the Seventeenth Century," in *A House Built on Sand: Exposing Postmodernist Myths About Science*, ed. Noretta Koertge (New York: Oxford University Press, 1998), 240-254.

[17] Steven Shapin and Simon Schaffer, *Leviathan and Air Pump: Hobbes, Boyle, and the Experimental Life* (Princeton: Princeton University Press, 1985), 39.

[18] Karl R. Wallace, *Francis Bacon on the Nature of Man* (Urbana: University of Illinois Press, 1968); Lisa Jardine, *Francis Bacon: Discovery and the Art of Discourse* (Cambridge: Cambridge University Press, 1974).

philosophers was Hooke—who virtually lived among the Royal Society's collection. What is more, the Repository was loaded not just with specimens, but with instruments; Boyle's air pump was in fact Hooke's, and it was Hooke who cared for it alongside such things as his many optical instruments, including the microscope which was the crucial technical medium of his best-known book.[19] Hooke was not only merely assigned to the Repository's care; he was also tasked with producing experiments on demand as investigators required them. For it was Hooke, not Boyle, who seems first to have coaxed a vacuum from nothing more than blown glass, vegetable gums, and machined brass; if Boyle was the man writing the pamphlets and assembling the groups of witnesses, it was Hooke who was toiling at the controls of the air pump, laboriously tinkering to get it to perform.[20]

So strongly was Hooke associated with the Repository that he set up his dwelling adjacent to the space in which the objects of the Repository were stored. Stephen Pumphrey goes so far as to call Hooke a "directed instrument," a part, rather than simply a keeper, of the Repository and its function,[21] but we may say with more accuracy that Hooke was an undirected instrument, who came increasingly to think in and through the material realm of natural philosophical concern. Put differently, as Steven Shapin notes, Hooke "worked where he lived," the Repository emerging as part of the texture of Hooke's everyday material, and therefore philosophical and intellectual experience.[22] So strongly did he identify with the Repository—so strongly did he internalize it—that pressed to offer a model of the intellect, what he proposed is clearly based, for its vocabulary and structure, on the place of his work. Hooke's mind, like his workplace and home, was a repository, complete with a workshop, instruments, and little specimens

[19] The best accounts of the remains "The Cabinet Institutionalized: The Royal Society's 'Repository' and its Background," in Oliver Impey and A MacGregor, *The Origins of Museums* (Oxford: Clarendon Press, 1985), 159-; Eileen Hooper-Greenhill, *Museums and the Shaping of Knowledge* (New York: Routledge, 1992), 145-66; Hunter, *Establishing the New Science*, 123-55.

[20] "The merit of constructing [the air-pump]," writes George Wilson, "should seem to be almost entirely Hooke's." George Wilson, *On the Early History of the Air-Pump in England* (Edinburgh, 1849), 6. See Terje Brundtland, "After Boyle and the Leviathan: the Second Generation of British Air Pumps," *Annals of Science* 68.1 (2011): 93-124.

[21] Stephen Pumphrey, "Hooke's Curatorship of Experiments," *History of Science* 29 (1991): 18. Jardine, "Hooke the Man: His Diary and His Health," in *London's Leonardo: the Life and Work of Robert Hooke*, ed. Jim Bennett, et. al. (Oxford: Oxford University Press, 2003), 163-206.

[22] See Steven Shapin, "Who Was Robert Hooke?" in *Robert Hooke: New Studies*, ed. M. Hunter and S. Schaffer (Woodbridge, Suffolk: The Boydell Press 1989), 254-62.

called "ideas."[23]

Like Latour, Hooke too has a soft spot for cartography, which likewise provides for him a pivotal example of how thinking is in the end a problem of coordinating technical media. Hooke poses what would become one of the commonplaces of empiricism when he suggests, in the Preface to his best-known work, that

> … the greatest part of mankind has so long wandred, because they rely'd upon the strength of human Reason alone, [but] have begun anew to correct all *Hypotheses* by sense, as Seamen do their *dead Reckonings* by *Coelestial Observations*.[24]

Hooke's comparison, like Latour's, leans on navigation to isolate the difference that technical media make, elaborating the difference between cognition understood merely to rely upon logically constructed mental models, and thinking that leans on, indeed routes itself through, technical means. And it reduces this problem—the general problem that the empiricist project is to repair—to an issue of situation. Dead reckoning is, for Hooke, like syllogistic reasoning because it turns the basic navigational problem—where are we, and where will we be?—into a logical operation local to the ship and its motion.[25] Dead reckoning depends entirely on the unaided powers of the single observer, who orients the world around himself; he builds a mental map of the world and navigates strictly using the relations that obtain in that map. He may rely on a few simple tools—a log-and-line, a sand-glass—but these mostly extend the idiothetic cues he already has, like the feel of the ship's leeway, or the feel of the wind on his cheeks. In contrast, Hooke proposes the "correction" of deductive reasoning through continual and complex technical exchanges with the environment, especially as that exchange is routed through the highly specialized tools

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[23] Hooke (writes Douwe Draaisma) "portrayed himself in his metaphors as a mechanistic thinker, an experimenter and an expert microscopist." Douwe Draaisma 56-58 ; Matthew Hunter, *Wicked Intelligence: Visual Art and the Science of Experiment in Restoration London* (Chicago: University of Chicago Press, 2013), 178-186; Sean R. Silver, *Reason's Materials* (Philadelphia: University of Pennsylvania Press, forthcoming); Susan Pearce and Kenneth Arnold, *The Collector's Voice* (Ashgate, 2000), 2.87-93.

[24] Hooke, *Micrographia: Or Some Physiological Descriptions of Minute Bodies* (London: 1665), Preface.

[25] The similarity between dead reckoning and the syllogism helps account for its popular etymology; as Bowditch's *American Practical Navigator* notes, "dead reckoning" descends to us as the shortened form of "deduced reckoning," a reckoning that solves, in Hooke's words, a "geometric" problem with an "algebraic" method.

developed specifically for generating sightings. Unlike the dead reckoner, the celestial navigator coordinates a flurry of media—paper, quadrant, astrolabe, chart, logarithmic tables, and so on—to elicit a representation of himself in space. What is more, these media produce allothetic representations, including, for instance, the position of an indicator on a graduated dial, meant to capture the angle between the horizon and the sun. If the problem of dead reckoning is one of constructing accurate mental models, the problem of navigating by instrument is one of coordinating differently constrained representations—a problem, in the words of one team of researchers, of "sensor fusion."[26] It is partly because of the complexity of coordinating these multiple tools of thought that ships became, in the words of Peter Stallybrass and Ann Blair, "one of the main schools for the development of note taking."[27]

The virtue of the celestial navigator, like the virtue of the investigator in the Royal Society project, is that he is hardly a thinker at all, at least in the traditional sense. Better, perhaps, to think of him as what Edwin Hutchins calls the "lightly equipped" coordinator of technical media—or, in a bolder moment, a special kind of technical medium himself. Hooke provides two, sometimes conflicting accounts of the work of instruments in the natural historical project. In each, he refers to his own "weak abilities," which are amplified by such things as "Optical Glasses," barometric instruments, levers, wheels, books, and collections of other technical artifacts.[28] In the first version, it is the work of machines like the microscope "to correct" and "to clarify" senses which suffer as part of the general human condition after the Fall. In this account, an optical instrument like the microscope helps recover knowledge that would have been immediately available to Adam in his perfection before he was cast from the Edenic state of grace.[29] In this view, the world is full of facts waiting to be found and arranged; they are merely occluded by the poverty of our postlapsarian senses. In this account,

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[26] Alfredo Weitzenfeld, JM Fellous, B Barrera, G Tejera, "Allothetic and Idiothetic Sensor Fusion in Rat-inspired Robot Localization," in JJ Braun, ed., Multisensor, Multisource Information Fusion: Architectures, Algorithms, and Applications" (Proceedings of SPIE, 2012).

[27] Stallybrass and Blair, "Mediating Information: 1450-1800," in Clifford Siskin and William Warner, *This is Enlightenment* (Chicago: University of Chicago Press, 2010), 146.

[28] Hooke, "Preface" to *Micrographia*, np.

[29] The use of instruments—especially "optical glasses"—is "in respect of the Senses" for "supplying of their infirmities"; it is intended as a "universal cure of the mind," meant "to recover some degree of those former perfections… of the *Sense*, the *Memory*, and *Reason*." "Preface" to *Micrographia*, np. See also Joanna Piccioto, *Labors of Innocence in Early Modern England* (Cambridge: Harvard University Press, 2010); Sorana Corneanu, *Regimens of the Mind: Boyle, Locke, and the Early Modern Cultura Animi Tradition* (Chicago: University of Chicago Press, 2012).

technical media are, to quote the famous formula, the extensions of Man.[30] And so part of Hooke's project as curator of the Repository is, in his words, "making use of or employing these Means and Assistances of Human Nature for collecting … an exact Description of all sorts of Natural and Artificial Operations." Latour himself has traced this tendency to what has been called the descriptive impulse, the impulse to capture, in a mobile medium, something which (*mutatis mutandis*) appears exactly on paper as it does to the eye.[31] This helps account for the extraordinary level of detail in works like Hooke's best-known book, his *Micrographia*; the microscope helps produce what Hooke calls "an exact Description" of things as they are, participating in the painstaking emergence of what has come to be called objectivity.[32]

As Hooke begins developing this claim, he seems to insist that instruments merely create the conditions to be able to collect a world of knowledge that is, as it were, waiting to be discovered. But as the question evolves, it becomes clear that knowledge is situational, dependent upon the instruments in use. In the second account of the work of tools, Hooke insists, men develop "outward Instruments as are proper for their particular works," not least in the pursuit of knowledge about nature.[33] This is not merely to "enlarge and [to] strengthen" the natural operation of powers we already have; it implies additionally the development of new techniques shaped to new tools, and new habits of thought which anticipate that shaping. In this case, mediated representations are bound up in thinking as an evolving process. Take for instance what Matthew Hunter calls Hooke's "material models."[34] *Micographia* contains a wealth of images, many appearing alongside or above or below images of technical precision, which look nothing like anything that could be seen with the eye. Pictures such as, for instance, a geometric rendering of atoms in crystals, "are data from Hooke's modeling enterprise"; they are not representations of anything that could be seen in the world. They are, on the contrary, episodes in the unspooling of Hooke's thought, as he grappled with things beyond the ken of the eye. It is necessary for the investigator "to design and draw very well, thereby," Hooke

[30] Marshall McLuhan, *Understanding Media: The Extensions of Man* (1964).
[31] Latour, "Visualization and Cognition," 9-10. The term is indebted to Svetlana Alpers, *The Art of Describing: Dutch Art in the Seventeenth Century* (Chicago: University of Chicago Press, 1983).
[32] The argument of Lorraine Daston and Peter Galison, *Objectivity* (New York: Zone Books, 2007), 55-114.
[33] Hooke, "Preface" to *Micrographia*, np.
[34] Matthew Hunter, "Hooke's Material Models," in *Beyond Mimesis and Convention: Representation in Art and Science* ed. R. Frigg and Hunter (Springer, 2010), 207.

argues, "to express his own Ideas the better to himself, to enable him to examine them and ratiocinate upon them himself."[35] As someone like Richard Feynmann would have recognized, such images are not a *record* of Hooke's work, not its outcome or superficial accessory; they *are* the work.[36]

So Hooke is, on the one hand, committed to an essentialist theory of cognition, in which instruments are mere accessories to a mind, while, on the other, he is fully embedded in the mangle of practice, developing knowledge across and through a stable of instruments customized to the task. In the first case, the investigator comes to the task with his own faculties, which stand apart and merely deploy tools as he sees fit; in the other, he arrives as a special kind of medium, ready to coordinate the tools that make thinking possible. The surest way, Hooke remarks, "to inform the Intellect with a Notion of [a] thing," and "by degrees to find out its Nature," is what he calls "a comparative Act of the Understanding from all the various Informations 'tis capable of receiving." Correct thought, in this "comparative Act," is what emerges from an "exercise" that "begins with the Hands and Eyes," is "continued by the *Reason*," and "comes about to the Hands and Eyes again." Here, as elsewhere, Hooke articulates his twin commitments: at once to a notion of reason as a faculty discrete from the materials on which it works, while, at the same time, noticing that the work of reason depends on instruments and experiments. This "continual passage round from one Faculty to another" poises the work of the mechanic as the work of the understanding, "adding… as it were… artificial Organs to the natural."[37] It pairs the "Faculty" of reason with the "Faculty" of mechanical know-how. Likewise, it begins to point to the importance of the combination of efforts among people—as the development of such "artificial Organs" is the accretive, progressive work of many techniques and technicians, inventors and inventions, with a history developing parallel with the discoveries they make possible.

This "continual passage" is what Hooke elsewhere, discovering a proleptic echo of extended cognition, calls "excogitation," and it provides therefore one possible site of origins for thinking about cognition as a

[35] Hooke, "A General Scheme, or Idea of the Present State of Natural Philosophy," in *Posthumous Works*, ed. Richard Waller (London, 1705), 20. Drawing has come to be one of the paradigmatic examples in the case for embedded cognition generally. For instance, C van Leeuwen, I Verstijnen, & P Hekkert, "Common Unconscious Dynamics Underlie Uncommon Conscious Effects: A Case Study in the Interaction of Perception and Creation" in J. Jordan, ed. *Modeling Consciousness across the Disciplines* (Lanham: U Press of America, 1999): 179-218.
[36] See Andy Clark, discussing Richard Feynmann's papers. *Supersizing the Mind: Embodiment, Action, and Cognitive Extension* (Oxford: Oxford University Press, 2008), xxv.
[37] Hooke, "Preface" to *Micrographia*, np.

technical process. Excogitation is thought with a mechanical or action-oriented purpose, the "comparative act" whereby the intellect, in approaching the "knowledge of a thing," devises "observations and experiments" in order to elicit "informations." It relies, on the one hand, on impressions received "more immediately by the Senses," and those received "more mediately by various other Observations or Experiments."[38] Ideas are immediate—which is to say idiothetic—or "mediated," which is to say developed in consultation with technical media. The "continual passage" means to capture not merely the simple development of a tool for a physical task; the excogitative process is the co-development of an instrument with a set of procedures to answer a question or set of questions. It is, likewise, the corresponding adaptation of the mind to the instruments it puts to use—hence, "excogitation" as a centrifugal mode of thought, thought as directed through and actively anticipating the range of its instantly available technical media. In Latour's terms, Hooke's "continual passage" is in fact a "chain" of such "passages" between technical media, a series of leaps between dissimilar representative forms coordinated by a technician.[39]

Just around the time of *Micrographia*, the term "excogitation" enjoyed a sudden and strange flowering with a circle of Royal Society thinkers, so much so that it suggests a broader shift in the history of intellection, a twist in ways of thinking about thinking. John Evelyn, for instance, remarked in a letter to his friend and patron—in the same year that Hooke published the *Micrographia*—that "Dr. *Wilkins*, Sir Wm *Pettit*, and Mr. *Hooke*" were all three living together at Durdans, "excogitating new rigging of ships, new chariots… &c. so as I know not of such another happy conversation of Virtuosi in England." Evelyn was one of the founders of the Royal Society, who had imagined this sort of collaborative work in advancing technical know-how as its core mission; these three or four men, driven into a country estate by a London outbreak of the Plague, probably represented to Evelyn the sort of "happy conversation" he had imagined in the first flush of excitement over the project.[40] Theirs was a communal reframing of the laws of nature as technical problems, the kind of thing that could be pursued through practical experiments in technical learning. It is no coincidence that 1665 ended up being a productive year for all three men; Hooke published his best-known

[38] Hooke, "the Method of Improving Natural Philosophy," in *Posthumous Works*, ed. Waller (London, 1705), 9.
[39] Edwin Hutchins, *Cognition in the Wild* (Boston: Bradford Books, 1996), 287-315; Rumelhart et al., "External Representation and Formal Reasoning," (1986);
[40] See Michael Cyril William Hunter, *Establishing the New Science: the experience of the early Royal Society* (1989), 1-44.

work—the *Micrographia*—while Petty penned the rudiments of a new theory of economic value and Wilkens developed his *Essay towards a Real Character*. Similarly, and perhaps suggesting the importance of this collaborative summer, "excogitation" remained part of the working vocabulary of all three men, each of whom used it to denote the routing of intellectual problems through material experiments.[41] To recall Hooke's phrasing, excogitation is the "exercise" that "begins with the Hands and Eyes," is "continued by the *Reason*," and "comes about to the Hands and Eyes again."

Hooke here anticipates language happened upon roughly three hundred years later by Bruno Latour—whose early essay "Visualizaton and Cognition: Thinking with Eyes and Hands" forms one of the clearest statements of the thesis of extended cognition in his body of work. It is also here that Latour starts the chain of thinking which will end with his reflections on Mont Aiguille. He is interested in the way that thinking may be described as the propagation of representations across media; the essay follows, in Latour's words, the "transformations of rats and chemicals into paper," thinking as a continual negotiation between a tools, tool users, and paper records. Instead of admiring "intellectual feats" as though they involved "high theories or differences in logic," he focused on the "activity of paper writing" and the use of precision instruments, especially those instruments and documents produce and fix images in order to render them comparable with others.[42] And, extending a pattern inaugurated by Hooke, Latour leans on navigation for his pivotal example. Consider the charts gathered in the 1780's by Lapérouse while retracing the last voyage of James Cook; this voyage, Latour argues, represents an exemplary episode in the history of cognition. What separates Lapérouse from the people he encountered on the Pacific Rim is not some fundamental difference in brain structure or some mystical leap in cognitive capacities inside the skin and skull. What separates Lapérouse from the Chinese, Latour insists, is a set of material habits depending upon the manipulation, the *handling*, of paper and pen.[43] Mercator projection, the chronometer, the transit and the sextant, not

[41] See Henry Power, *Experimental Philosophy* (London, 1663); "excogitation" is a synonym for a mechanical experiment. William Lilly ("Christian Astrology," 1647) means by "excogitation" the design of mechanical solutions to ideal problems. William Petty elsewhere "excogitates" the work of the hand in transforming wool into cloth. The task of "describing" even the most "small… common, and cheap" manufactures requires a length of prose evidently out of proportion with the manual working of the shuttle and the loom. This is what he calls "excogitation." Petty, "Of Making Cloth with Sheeps Wool."

[42] Latour, "Visualization and Cognition." 3-4.

[43] This argument is explicitly posed in another text well-known to Latour: Edwin Hutchins's *Culture and Inference: A Trobriand Case Study* (Boston: Harvard University Press, 1980).

to mention the log book, rulers, compasses, and reliable ink: it was these media, which Lapérouse did not invent, but which were inherited from others, that made the expedition meaningful. Indeed, if navigational thinking had not been about the propagation of representations across media, if it hadn't in other words been excogitative, Lapérouse's discoveries would have been lost with his expedition. It was only a few paper inscriptions, shipped home on a merchant vessel and incorporated permanently into the modern sea-chart, that survived the loss of the navigator's ship and all hands at sea.

Latour coins a term; these inscriptions are what he calls "immutable mobiles." "Immutable mobiles" are sometimes descriptive, sometimes abstract, but always poised between a representation and an idea. They are "immutable" because they are relatively permanent; they are "mobile" because they may be superimposed upon, compared with, or transferred to other media. They mark the centrifugal tendency of thought, and the term therefore has over the course of his career marked the places where Latour treats cognition as environmentally situated, often quite literally. When he coins the term, it is to describe Lapérouse's charts of the South Pacific. When it turns up again, Latour notes Tycho Brahe's systematic mapping of the night sky. In a review of Edward Hutchins, whose fieldwork was on the bridge of an American warship, Latour discusses the immutable mobile as what makes it possible to express one's position in space as an "x" on a nautical chart. And when the term has last come up, in *An Inquiry into Modes of Existence*, it refers to Latour's mapchecking during his hike up Mont Aiguille.[44] We may in other words say that Latour has himself, over the course of a career, incorporated or internalized a technical innovation; what begins as a category or tool for thought, developed in Brahe's observatory or Laperouse's charthouse, becomes part of the texture of a twenty-first century outing.

In pursuing the immutable mobile over a career, in other words, Latour has repeatedly plucked out the single document—the map—that most strikingly summarizes a history of situation as an extended technical achievement. In each example, the chart makes possible a certain kind of orientation by linking an individual to a network. For, on the one hand, the map isolates the very terrain of situated or extended cognition, making explicit the central problem of how we know, in a meaningful way that can be communicated to others and to ourselves, where we are and where we are going. While, on the other, the map is itself a remarkable technical

[44] "Immutable Mobile" appears first in his "Thinking through Hands and Eyes" (1984), again in *Science in Action* (1990), in a 1996 review of Edwin Hutchins's landmark study *Cognition in the Wild*, and, finally, nearly unchanged in his 2013 *Inquiry into Modes of Existence*.

achievement, containing more knowledge than any one navigator could possibly have comprehended alone. It signals therefore the ghostly presence of past navigators and mathematicians, tool-makers and shipwrights, who have handed along the technologies and techniques that make plotting a position in space possible.[45] Looked at in this way, individuals, if they are being honest with themselves, are revealed as merely the "lightly equipped" coordinators of artifacts that make cognition possible; people are in other words the sites where techniques and technologies are made to mesh. "Intelligence," Edwin Hutchins has argued in an important essay co-authored with Nick Flor, "is manifested at the systems level, as opposed to the individual cognitive level."[46] This, then, is how Latour's hike is the work of ages—beginning not on some twenty-first century morning, but, on the contrary, in an eighteenth-century charthouse, a seventeenth-century laboratory, a sixteenth-century observatory, and so on.

For all that taking a bearing on a sighting compass involves a personal habit, it is also an acquired discipline. This is what it looks like: Latour stands quite still, with the compass in the palm of his hand; he flips up a mirror, hinged at the back of the compass, and marked with a vertical hairline. He aligns the top of the hairline with the landmark viewed in the background, making sure that the hairline also passes through the jewel bearing of the compass. He links, in a material way, Mont Aiguille ("Mount Needle") with compass needle. With his free hand, he twists a graduated ring, lining up its zero-mark with the north pole of the compass needle; in the reflection, he is able to take a bearing, represented where the sighting line seems to pass through the graduated ring. The mirror is the critical thing, here; the mirror transfers, internal to itself, a sighted landmark to magnetic north, registering as a mathematical figure the difference. In the lingo, it "reduces" a complex situational problem to a single number; this number is what can then be returned to a chart, as part of Latour's efforts not to lose himself on a mountainside.

I mention this at length because it was Hooke who seems first to have thought to introduce a mirror into navigational instrument. Either while at Durdans, in that magical year with Petty and Wilkins, or in the year or two following, Hooke developed the first prototype reflective instrument which would become, after a century of refinements and improvements, what

[45] Hutchins, *Cognition in the Wild*, 108-16.
[46] Flor and Hutchins, "Analyzing Distributed Cognition in Software Teams: A Case Study of Team Programming during Perfective Software Maintenance," in J. Koenemann-Belliveau (et al), eds., *Proceedings of the Fourth Annual Workshop on Empirical Studies of Programmers* (Norwood, Ablex Publishers, 1991), 37.

remains one of the critical devices in celestial navigation; this was a forerunner of the sextant, and Hooke's innovation was to introduce a reflector.[47] Prior to Hooke, mariners interested in determining the height of the sun might have recourse to an astrolabe; in its simplest form, this is two arms attached at a pivot, one of which is pointed at the horizon, and the other at the sun. It was a difficult device to employ on a heaving deck at sea—for the navigator was tasked with looking, simultaneously, at the celestial object and the horizon. Hooke's instrument does this work internally, using a mirror to split the field of view thereby offering, in one glance, the horizon and a semisphere of the sun. It makes mobile, in other words, the original immutable, performing a little trick that mariners still call "bringing the sun down to the horizon." What is taken away from this primitive octant, the final risky leap it authorizes, is a single number recorded on a graduated arm, indicating the angle between horizon, eye, and sun. This number is the single thing taken away from the sighting, an entry in an effort to solve a problem of situation, and useful precisely because of its difference from a verisimilar representation.

The instrument was itself only possible because Hooke had already undergone an interior revolution, developing an instrument to perform what he had already learned to do through a mental trick. And so, by way of conclusion, I would like to end with a final episode, this one from Hooke's *Micrographia*—literally, "tiny writing," but principally meant as writing about the miniscule. The critical problem in this book is one of *coordination*, which begins, right at the start, with the problem of transferring what Hooke sees with the eye to what we see on the page. And he accomplishes this challenge in what will become a repeated pattern—with a further level of mediation, though in this case, the medium is himself: "Having rectifi'd the *Microscope*, to see the desir'd Object through it very distinctly," Hooke writes,

> at the same time that I look upon the Object through the Glass with one eye, I look upon other Objects at the same distance with my other bare eye; by which means I am able, by the help of a *Ruler* divided into inches and small parts… to cast, as it were, the magnifi'd appearance of the Object upon the Ruler, and thereby exactly to measure the Diameter it appears of through

[47] Charles H. Cotter *The Mariner's Sextant and the Royal Society; Notes and Records of the Royal Society of London*, Vol. 33, No. 1 (Aug., 1978), pp. 23-36; See also Maurice Daumas, *Scientific Instruments of the Seventeenth and Eighteenth Centuries and Their Makers*, transl. Mary Holbrook (London: Portman, 1989); GB Magnaghi, *Relfective Instruments* (Milan, 1875).

the Glass.[48]

Hooke presents here a solution to the problem of transferring representations across media, from the objective field of the microscope to the scale of the page; the standardized measurement of the ruler, "cast, as it were," over the object as it appears magnified to the eye provides the first step in the transfer between microscope as medium and book as medium.[49] With octant, so it is with microscope, except that in the first case, Hooke expects the instrument to bear the cognitive load of translation that he, previously, performed internally.[50] The individuated mind, in this sense, is a special form of technical medium, which gathers together many coordinating functions; it carries techniques mastered with one technology into new contexts. Hooke's technical innovation, in other words, was made possible because he thought of thinking as a technical operation, and vice versa; this is what he called excogitation. Hooke in other words presents himself as a solution to a problem with instruments, rather than the other way around. Hooke starts to look, in some important respects, like a technical object—a man adroitly called by Steven Pumphrey an "instrument."

[48] Hooke, "Preface" to *Micrographia*, np.
[49] Michael John Gorman goes so far as to suggest that Hooke used the "double-vision" trick "to *draw* the extraordinary plates of the *Micrographia*." Michael John Gorman, "Projecting in Early-Modern Europe," *Inside the Camera Obscura—Optics and Art under the Spell of the Projected Image* (Max Planck Institute, 2007), 41.
[50] Freidrich Kittler, in *Optical Media* (2002), argues that it was not until the 19th century that human agents—however lightly equipped—were to be removed from communication and information relays.

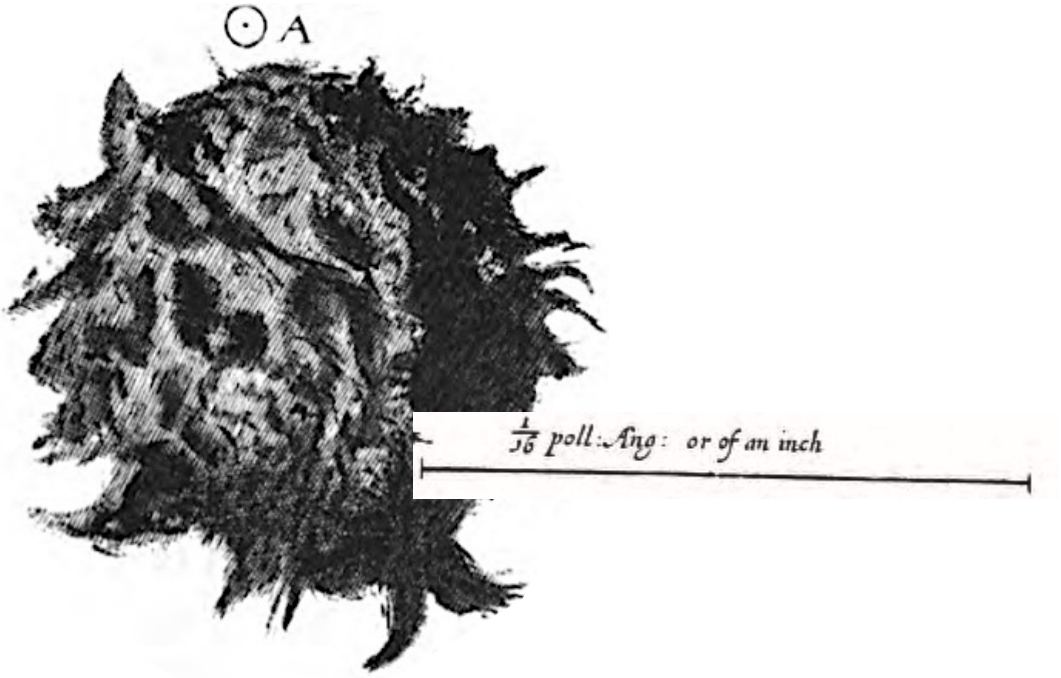

Exhibit 1. Robert Hooke, "a *point* commonly so call'd."
Micrographia (London, 1665), Plate 2.

We are offered a period at massive magnification; it floats like a dark sun, haloed with solar flares, alongside the horizon of a scale. To be quite clear, the scale is intended for the edge of a razor drawn beneath it, but we may nevertheless be invited to allow our eyes to swim, as it were, to superimpose the images, one upon another. Or, in any case, we are invited to do the same with the razor's edge, superimposing scale with likeness. We, like Hooke, in this case become merely the clever technicians providing cognitive solutions to a coordination problem. Hooke in other words presents himself—or us—as a solution to a problem with instruments, rather than the other way around.

When Latour takes up his compass, then, he is offering himself as the solution to a coordination problem, linking up the two journeys upon which he has embarked. There is the physical exertion of an ascent, with a narrow plateau as its object; there is the chain of references, from the trailhead on a map to the point that marks the peak, the marker placed there the very same year that Columbus set out for India. For a moment, Latour stands perfectly still; only the compass moves, for Latour has become a technical object in a chain of reference which exceeds his situation. Perhaps, then, we should say that Latour is the way that the compass converts a waypoint into an angle, or

the means whereby a chart visits the places it represents, for the very success of such an enterprise, of finding one's way to a goal, depends upon losing oneself in a network of objects.

This enchaining is what Latour calls a "mode of existence"—and it may in fact be the original of these modes. Latour's claims half his title from Gilbert Simondon, whose inquiry into *The Modes of Existence of Technical Objects* includes, but is not limited to, things like sextants or sighting compasses.[51] Among Simondon's most important insights is the way that technical objects develop inside networked ensembles; technical objects begin as mere crippled things, that can only exist in the right ecology, but they evolve towards self-sufficient, quasi-"natural" entities, as they become "individuated."[52] The chart, for example, begins as a mere sketch or drawing; it must refer to numerous other objects outside itself: a log, a narrative, sketches of coastlines, and so forth. As it develops over time, however, the map increasingly gathers these extraneous functions to itself, internalizing them. It "becomes independent of the laboratory with which it is initially associated," Simondon writes, "and incorporates it into itself dynamically in the performance of its functions."[53]

But individuation is not limited merely to technical media in a network of such media; it extends, as well, to the people who learn to think through them. Simondon is quite clear about this: in the mechanistic view, "the fundamental operation of the simple machine is analogous to the functioning of logical thoughts."[54] Like the linkages or enchaining of coordinated machines, the technician comes to see himself as "analogous;" he recognizes reason as a mechanical process equivalent, to take Simondon's example, to the concatenation of links into a chain. Perhaps it is best, then, to say in that "Reason" arises as a progressively developed internalization, the effect of organizing cognition according to the tasks in which it engages. Objectivity, in this sense, is what emerges out of the long, agonizing process of becoming a technical instrument.

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[51] Latour's remarks on the "cost-free displacements" between "*res extensa*" and "*res cogitans*" in the *Inquiry* (112) echo strikingly similar passages in Simondon's work. See "Technical Mentality," transl. Arne De Boever, *Parrhesia* 7 (2009):18.

[52] Gilbert Simondon's thesis in *L'individu et sa génèse physico-biologique* (Presses Universitaires de France, 1964).

[53] Simondon, *On the Mode of Existence of Technical Objects*, transl. Ninian Mellamphy (University of Western Ontario, 1980), 48.

[54] Simondon, "Technical Mentality," 17.