The Lever as Instrument of Reason

Technological Constructions of Knowledge around 1800

Jocelyn Holland
Introduction

An Object and Its Positions: The Lever, the Fulcrum, and the Archimedean Point

I can circumnavigate myself, but I cannot get beyond myself.
I cannot find this Archimedean point.

Søren Kierkegaard

A stick, coupled with the will to power: levers have existed ever since early humans desired to increase their strength by instrumental means—since the advent of technology. At least, that is how one narrative goes. Another version of the same story suggests that the view of man as an originally “a-technical being,” may not be correct and that culture, including technology, is a part of human nature, not simply an extension of it. The Lever as Instrument of Reason is positioned at the intersection of these two perspectives. It shows how descriptions of the lever and its resting place—whether envisioned as an ordinary fulcrum or the idealized Archimedean point—are deeply entangled with descriptions of the human. In particular, we can observe this phenomenon in the eighteenth and early nineteenth centuries, in the work of such diverse thinkers as Immanuel Kant, Friedrich Schlegel, Friedrich Schelling, and Johann Herbart. Around this time, in contexts ranging from moral philosophy and Romantic poetics to Naturphilosophie and empirical psychology, the lever was used in such a way as to become deeply implicated in various cognitive activities, ranging from the act of making

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moral judgments (Kant), to the construction of concepts (Romanticism) and the emergence and suppression of thoughts (Herbart). Each of the case studies that informs The Lever as Instrument of Reason is designed to show how the lever was taken from the field of classical mechanics and deployed within various contexts associated with the human, even as the mechanical principles associated with it continued to play an influential role.

The Lever in Antiquity: Practical Use and Theoretical Reflection

In order to underscore how the intellectual work done with the lever around 1800 draws upon a tradition of mechanical thinking, even as it incorporates the lever into new contexts in unexpected ways, it helps to have an idea of the historical context within which discussions of the lever emerged. The purpose of this section and the next is therefore to highlight a few key moments in the history of the lever. Reflections about the lever in antiquity are often framed in terms of questions directed toward those objects that informed the landscape and seascape of daily life. It is appealing to imagine that ancient Greek and Roman philosophers looked to the fields and saw levers in the yokes of the oxen pulling the plows, that they looked at the oars and masts of their great sailing ships and saw levers that could be optimized for maximum efficiency, and that, in the marketplace, scales ensured the physical and economical balance of all transactions. These images need to be considered with a few caveats. Sylvia Berryman, in The Mechanical Hypothesis in Ancient Greek Natural Philosophy, warns against applying the term “mechanistic” to early Greek thought and plainly states that there was no discipline of mechanics before the fourth century BCE, nor were there “mechanical conceptions” of nature. Mark J. Schiefsky has noted that when the science of mechanics in antiquity did emerge, it encompassed two categories of knowledge, the one theoretical and the other practical, and he refers to the lever to illustrate how deeply intertwined they were. The law of the lever, he writes, was a “paradigm example of theoretical mechanical knowledge . . . stated and proved by Archimedes as a precise quantitative relationship between forces and weights.” At the same time “any practitioner who had made use of a lever would be familiar with the fact that it is easier to move a weight if it is placed closer to the fulcrum,” which makes the lever a “paradigm example of practitioner’s knowledge” as well. For Schiefsky, this means that as much as mechanical technology applies theoretical knowledge, it is also the case that “new technologies often preceded any theory that could explain them.”

One can observe further evidence of the close relationship between theoretical and practical knowledge in the Mechanical Problems, a well-known treatise on the lever dating from the third century BCE that has been attributed at various times to Aristotle and those in his school. Here, one finds a series of simple, yet fundamental questions: “Why do the men at the middle of the boat move the boat most? Is it because the oar is a lever? . . . Why does a steering oar, small as it is, and at the end of the boat have such force that with one little handle and the force of one man . . . it moves the great bulk of ships?” Questions such as these demonstrate not only the way in which commonly existing technologies can lead to intellectual inquiry, but also something that is unique to the lever itself: the frequency with which it can be discerned in various contexts. The lever, it seems, is embedded in how humans view the world, and once connections are established—for example, between a ship’s oars or mast and a lever—they can be invested with an explanatory power and take on a life of their own. For example, when Lucretius writes in Book IV of The Nature of Things that it should come to us as no surprise that the air we breathe as well as the soul of Virtual Vników Habicht (Berlin, Göttingen, Heidelberg: Springer Verlag, 1956), 35–36.

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5 Schiefsky, “Theory and Practice.”
6 Schiefsky, “Theory and Practice.”
9 E. J. Dijksterhuis sees in the Mechanical Problems the “seed of a general principle that will later play an important role in mechanics under the name of the principle of virtual displacements or with an older name that recalls its origin in the thought process sketched out above [in the Mechanical Problems, JH], the Principle of Virtual Velocities,” E. J. Dijksterhuis, Die Mechanisierung des Weltbildes, trans. Helga Habicht (Berlin, Göttingen, Heidelberg: Springer Verlag, 1956), 35–36.
an analogy to a ship at sea, but the underlying idea is connected to the mechanics of the lever:

The gentle breeze, so soft of substance, sets a great ship, great burden and all, to moving; whatever her speed, one hand controls her helm and one lone rudder alters her course at will; the sheave, the tackle, the windlass make light work, again and again, of shifting heavy weights.10

Attached to this passage from The Nature of Things one also finds a history of commentaries designed to drive the point home even more clearly, such as this one by Thomas Creech, dating from the eighteenth century:

This being premis’d, 'tis easy to understand, why a Sail, swell’d with wind, makes a Vessel move very swiftly, tho’ the Sail-yard be not far distant from the top of the Mast: for the Mast is, as the Lever; the Foot or Bottom of the Mast supplies the Place of the Pression or Rowler: and the Wind which fills the Sail, is as the Mover.11

Creech’s commentary, in particular, stands out for the concern with which he justifies the mechanics of Lucretius’s metaphor, with an eye to strengthening the initial comparison between breath and wind.

The examples cited above, as persuasive as they may be concerning the ways in which levers have historically become embedded within our observations of cultural phenomena, need to be considered alongside another idea that was widespread in early writing about levers and simple machines: that technology is fundamentally “unnatural.” The opening lines of the Mechanical Problems, for example, state that “one marvels at things that happen according to nature, to the extent the cause is unknown, and at things happening contrary to nature, done through art for the advantage of humanity.”12 After adding a quote from Antiphon, “we win through art where we are beaten through nature,” the anonymous author of the Mechanical Problems then introduces the lever as the most fundamental of instruments by which mankind “wins” against nature: “What a person cannot move without a lever is moved—even adding the weight of the lever—easily.”13 In more contemporary parlance, we say that a lever gives its user “mechanical advantage,” although we no longer perceive of this advantage as “unnatural.” Walter Roy Laird and Sophie Roux explain the origin of this perception in their introduction to Mechanics and Natural Philosophy before the Scientific Revolution. According to them, when a “machine moves a large weight with a small power,” it “produces an effect for human benefit” that was considered “not natural, for it violates the Aristotelian physical assumption that a moving power must be greater than the weight it moves.”14 Mechanical theory, with its assumption that a relatively weak individual can displace a load much heavier than himself or herself using the right tool for the job, seemed therefore to stand in an awkward relationship to Aristotelian “natural philosophy” which, up to the seventeenth century, was primarily a science concerned with motion and change (and in particular: natural changes such as generation and growth).15 As Schiefsky has shown, however, mechanical theories that developed after Aristotle, such as Heron of Alexandria’s, attempted to reconcile mechanical arts with nature. One of the ways in which this occurred was by arguing that the principle of the lever was common to other devices and itself related to natural principles. Heron’s original manuscript has been lost, but most historians of antiquity accept the validity of a lengthy passage from the Mathematical Syntaxis written by the third-century (CE) philosopher, Pappus of Alexandria. At stake is the question of whether there is a common principle underlying the five “simple machines” of antiquity, which Heron and Pappus refer to as “powers”: the lever, the wheel and axle, the pulley, the wedge, and the screw.

In the Mathematical Syntaxis, Pappus cites Heron as an authority on the subject:

The five powers that move the weight are like the circles around a single centre, this is clear from the figures that we have drawn in the preceding chapters. But I think that their shape is nearer

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12 Anon., Mechanical Problems, 1.
13 Anon., Mechanical Problems, 1. Readers should be aware that the English translation, “against nature,” is not uniformly accepted. Sylvia Berryman has pointed out that “the phrase need not imply transgression against or opposition to, rather than merely going beyond, a given category” and that in “the particular case of Aristotle’s use of para phusin, there are reasons not to understand the Greek phrase to refer to phenomena opposed to or excluded from natural philosophy altogether” (Berryman, The Mechanical Hypothesis, 47).
to that of the balance than to the shape of the circle, because in
the beginning the first explanation of the circles came from the
balance. For here it was shown that the ratio of the weight hung
from the smaller arm to that hung from the greater arm is like the
ratio of the larger part of the balance to the smaller.\footnote{A. G. Drachmann, 
*The Mechanical Technology of Greek and Roman Antiquity* (Copenhagen: Munksgaard, 1983), 81. Also quoted in Schiefsky, “Theory and
Practice,” 31.}

As much as it is possible to observe circular motion in each of the
machines (an idea that can also be traced back to the *Mechanical
Problems*), Schiefsky argues that for Heron, at least, the “crucial
step” in linking the five powers is their connection to the balance (a
device that is essentially interchangeable with the lever, as each can
be constructed with a horizontal bar and a fulcrum point).\footnote{For
another historical point of reference, consider Leonardo da Vinci, who
“instead of the term lever (lieva), prefers balance—sometimes scale, which
for him does not necessarily have equal arms,” Raffaello Pissano and Danilo
Capocchi, *Tartaglia’s Science of Weights and Mechanics in the Sixteenth
Century* (Dordrecht: Springer, 2016), 3. Pissano and Capocchi also note
that Leonardo “avoids separate treatments of the lever, balance, wheel, and
axe... considering all of one type, as defined by the balance” (Pissano and Capocchi, *Tartaglia’s
Science of Weights and Mechanics*).}

These simple machines might seem to be “wondrous,” but they can still be
“integrated into the explanatory framework of natural philosophy”
such that the mechanical thinking of antiquity is “still part of a science
of nature.”\footnote{Schiefsky, “Theory and Practice,” 17.}

Of course, one needs to be careful not to think in terms of a linear
narrative when it comes to innovations in mechanical theory, given
the complicated history of manuscripts being lost or existing only in
various translations. The same holds true when philosophers who
appropriated mechanical ideas for their own thinking reached back
to various elements of antique mechanics that might not have figured
as prominently in contemporary scientific discourse. One could take,
for example, the notion that a lever (or balance) in equilibrium is
not just acting “against nature”—it is also acting against itself, such
that self-opposition is an innate structural feature of the lever in
equilibrium. This perspective of the lever, as a figure of self-contained
opposition, becomes clearer when visualized as balanced around a
fulcrum point, with weights on either side, such as in the following
illustration of mechanical scales, sometimes referred to as the “scales
of justice”.

\footnote{Hans Blumenberg has traced the notion of a “coincidence of
opposites” in Nicholas of Cusa’s philosophy to the discussion of the
lever in the *Mechanical Problems*, where the lever is derived from the
fundamental principle of the circle (the claim Heron later reverses), which
the author understood as embodying a tension of opposing directions.
Or, to provide another example, when Leibniz explains his principle
of sufficient reason, he does so with reference to Archimedes’s treatise,
*On the Equilibrium of Planes*. In that work, Archimedes’s first postulate
is that “equal weights at equal distances are in equilibrium, and equal
weights at unequal distances are not in equilibrium but incline towards
the weight which is at the greater distance.”\footnote{Although the mechanical
theories of equilibrium and the lever that informed Leibniz’s time had
become quite sophisticated, Leibniz reaches back to this first principle:

[Archimedes] takes as given that a balance will remain at rest
when everything is divided equally on both sides and one attaches

...considering all of one type, as defined by the balance” (Pissano and Capocchi, *Tartaglia’s
Science of Weights and Mechanics*).}

\footnote{Hans Blumenberg, “Neoplatonisn und Pseudoplatonisn in der Kosmologie
und Mechanik der frühen Neuzeit,” in *Asthetische und metaphorologische Schriften*,
ed. Anselm Haverkamp (Frankfurt: Suhrkamp, 2001), 320.}

\footnote{Archimedes, *The Works of Archimedes*, trans. Sir Thomas Heath (New York:
Cosimo, 1897; Reprint 2007), 89.}
equal weights to the ends of the lever arms. Then there is in this case no reason, why one side should sink before the other. Only through this principle, that a sufficient reason is necessary, why things behave one way or another, can the godhead be proven, as well as all further metaphysical propositions or natural theology, and even to an extent the physical principles independent of mathematics, the dynamic ones or principles of force.\footnote{I was not able to find a standardized English translation of this passage. Readers might find it useful to consult the German edition (which is a translation of Leibniz’ Latin): “Er [Archimedes, JH] nimmt als zugestanden, daß eine Waage in Ruhe bleiben wird, wenn zu beiden Seiten alles gleich verteil ist, und man an den Endpunkten der beiden Hebelarme gleiche Gewichte anbringt. Denn es gibt in diesem Falle keinen Grund, weshalb eine Seite eher als die andere sich herabsenken sollte. Einzig durch dieses Prinzip, daß es eines zureichenden Grundes bedarf, weshalb die Dinge sich eher so als anders verhalten, lassen sich die Gottheit und alle übrigen Sätze der Metaphysik oder natürlichen Theologie, ja in gewisser Weise auch die von der Mathematik unabhängigen physikalischen Prinzipien, d.h. die dynamischen oder die Kraftprinzipien beweisen,” Gottfried Leibniz, \textit{Hauptschriften zur Grundlegung der Philosophie}, part 1, vol. 3, ed. Ernst Cassirer, trans. Artur Buchenau (Hamburg: Felix Meiner, 1996), 85.}

Readers will note that Leibniz does not call the principle of sufficient reason a lever, nor does he content himself with a mere comparison. The result is neither a simple metaphor, constructed by a basic act of identification, nor a simile. Instead, one can discern two contexts, one philosophical and the other mechanical, whose relationship can be characterized by a reciprocal explanatory affinity. Leibniz’ lever serves as the illustration or model of a philosophical idea, one where he uses the lever for philosophical “advantage” in order to apply the idea much more broadly.

\textbf{Aspects of the Lever in Renaissance Mechanics}

When gaining a perspective of the history of the lever prior to the eighteenth century, it is also important to acknowledge the fact that the lever, however intuitive its mechanical properties might seem to be, is not necessarily a stable object from an epistemological point of view. The fact that central questions connected to levers were debated well into the Enlightenment suggests that they were not only instruments to be integrated within larger physical and conceptual models: under certain circumstances, they could also acquire the characteristics of “epistemic things” (Rheinberger) in their own right. One of the key questions troubling Renaissance philosophers had to do with whether or not the mechanical principle of the lever should be understood as the basis for the other simple machines. As mentioned above, the opinion of Pappus of Alexandria was that one can find in the lever a unifying principle or “common denominator” that would connect it to other simple machines, such as the wedge or the pulley.\footnote{Domenico Bertoloni Meli, \textit{Thinking with Objects. The Transformation of Mechanics in the Seventeenth Century} (Baltimore: Johns Hopkins University Press, 2006), 27.} This idea gained some traction in the Renaissance, most notably through the work of Guidobaldo dal Monte. Domenico Meli relates how dal Monte helped popularize the work of Archimedes and Pappus of Alexandria and how, in the preface of his \textit{Mechanicorum liber (Book of Mechanics)} from 1577, he vowed to describe the properties underlying the balance “in order that my whole work might be more easily built up from its foundation to its very top.”\footnote{Dal Monte quoted in Meli, \textit{Thinking with Objects}, 24.}

Another important text from Renaissance mechanics was the \textit{Discourses Concerning Two New Sciences of Galileo Galilei}. The “two sciences” of the title are statics (the science of bodies in resting equilibrium, which relies upon the law of the lever) and the science of motion. In their commentary of Galileo’s \textit{Discourses}, Arkady Plotnitsky and David Reed emphasize that these sciences “are as much technological as they are natural,” and that means both “pure” and “applied” sciences of statics and motion.\footnote{Arkady Plotnitsky and David Reed, “Discourse, Mathematics, Demonstration, and Science in Galileo’s \textit{Discourses Concerning Two New Sciences},” in \textit{Configurations 9.1} (2001): 40.} Their reading also underscores the way in which Galileo’s thinking about the lever relies upon a translation of the physical object into geometric terms. The lever “provides a geometric configuration or figure . . . that interprets or realizes the mathematical concept of ratio in the measurement of moments of heavy bodies.”\footnote{Arkady Plotnitsky and David Reed, “Discourse, Mathematics, Demonstration,” 52. See also Pissano and Capecchi, who note that “In \textit{Le mecaniche} Galileo introduced a concept and a term, that of moment (momento), that will be of great fortune and adopted, at least in Italy, until the early nineteenth century” (Pissano and Capecchi, \textit{Tartaglia’s Science of Weight and Mechanics}, 175).} The point of view of the character Salviati demonstrates the way in which a “geometric representation of a physical object can be used to make a mathematical argument,” a point of view that Galileo affirms using the lever.\footnote{Plotnitsky and Reed, “Discourse, Mathematics, Demonstration, and Science,” 53.} The lever thus becomes paradigmatic for an act of translation between laws associated with natural phenomena and their geometric representations, which enable us to visualize the concepts at hand. Benvenuto has also described the
particular position of the field of statics as existing "between physical research and pure mathematics." He reminds us that, historically, the principles of statics have two attributes: they are "propositions with empirical relevance" and "theorems of a deductive system whose axioms were so immediate as to require no specific confirmation," like the intuition that accompanies the observation of a lever or balance with equal weights equidistance from the fulcrum. The following chapters contain numerous examples of how this basic idea associated with the lever—its ability to translate between the empirical and the theoretical—is retained when the lever is imported from classical mechanics into other areas of thought.

For all that dal Monte and Galileo worked to secure the lever's position, however, other philosophers and mathematicians were equally invested in its "dethronement." Descartes wrote that "it is a ridiculous thing to want to use the law of the lever for the pulley, as Guidobaldo convinced himself he should do," and readers of Descartes, such the French mathematician Pierre Varignon, took up the cause for a "more abstract principle" underlying the simple machines of the inclined plane, pulley, and screw. Benvenuto describes the problem as a tension between "power" and "act": either "to focus one's attention on power" or "to concentrate on the actual motion of the mobile body." He reminds us that the quest undertaken by Pierre Varignon and others to define more general mechanical principles that did not privilege a particular instrument led to the adoption of the principle of virtual velocities formulated by Jacob Bernoulli in a letter to Pierre Varignon dating from January 26, 1717. In the Nouvelle mécanique (New mechanics), Varignon refers to the contents of the letter when he writes that Bernoulli, "after having defined there what he meant by the word energy . . . declared to me that in every equilibrium of forces whatsoever, in whatever way they are applied to one another, either indirectly or directly, the sum of positive energies will be equal to the sum of negative energies, taken positively." Varignon's definition of virtual velocities is taken directly from Bernoulli's letter:

Given several forces acting in various directions that hold in equilibrium a point, a line, a surface or a body, let us imagine applying to the whole system of these forces a slight movement, either parallel to itself in any one direction or around any one fixed point. It is easy to see that, because of this movement, each of the forces will go forward or backward in its own direction, unless the direction of the slight movement is perpendicular to one of the forces . . . [These] advances and withdrawals are what I call virtual velocity.

Although the details of the debates that centered around the principle of virtual velocity and the related notion of virtual work go beyond the scope of the present study, one point of interest here is that the state of equilibrium is conceived of without any reference to a lever, whether as a physical body or a geometrical representation. The most important question is not what the implications are for the history of mechanics, but rather, and more narrowly, how the advent of the principle of virtual velocities changes the way in which the mechanical "object" of the lever as well as the mechanical law associated with it are conceived of and used in philosophical arguments. In his discussion of Vincenzo Riccati's "universal principle of statics," Benvenuto describes how for Riccati the "law of the lever" itself was "only an instrument, useful in research" but which "lacks intrinsic value as a foundation because it is only a consequence of the general principle." An analogous turn of phrase is used to describe Lagrange's work on the mechanical pulley (or "poliplaste"), when Benvenuto writes that that Lagrange "freed this object from its material existence and turns it into a pure instrument of thought" in the Mécanique analytique (Analytical Mechanics).

It would seem, then, that the question of lever's "usefulness,"—regardless of whether it is understood as a mechanical or geometric object—is perhaps not as straightforward as one would think. I argue that what is described above as a lack—whereby the law of the lever becomes "only" an instrument, once it is dethroned as a fundamental principle for the field of statics—ultimately becomes a gain for other areas of scientific research. One of the most striking things about the

28 Benvenuto, An Introduction, 14.
29 Benvenuto, An Introduction, 67.
30 See Meli, Thinking with Objects, 303. For Meli, it is significant that Varignon's critique of dal Monte occurs in conjunction with the publication of the Principia Mathematica: he sees a connection between Newton's rejection of visual analogies between projected and orbiting bodies and Dal Monte's quest for a "more abstract principle" (Meli, Thinking with Objects).
31 Benvenuto, History of Structural Mechanics, 67–68.
32 Quoted in Benvenuto, History of Structural Mechanics, 89.
33 Quoted in Benvenuto, History of Structural Mechanics, 89.
34 Quoted in Benvenuto, History of Structural Mechanics, 94.
35 Quoted in Benvenuto, History of Structural Mechanics, 95.
law of the lever is the degree to which it could be deployed across vast scales. The same age that brought us the most intricate automata, such as the mechanical musicians constructed by the Droz brothers, whose near microscopic levers required the use of a clockmaker’s loupe in order to see, also witnessed the lever used to describe laws of planetary motion. These innovations are connected by the workings of the lever, which astronomers such as Borelli and Kepler used to draft their blueprints of the heavens. The fact that the lever and its mechanical laws become topics of interest for other fields however—such as philosophy, literature, and psychology—raises a new range of questions. To what degree are these areas of thought changed by the introduction of mechanical concepts? And, conversely, what happens to the lever when it is adapted into these unfamiliar environments?

What a Lever Can Be

One of the challenges an investigation into the lever poses is how to navigate between the vagaries of historical example—the ways in which levers have been deployed as models in extra-mechanical discourses—and those contemporary theoretical perspectives that may be useful for making connections between the historical roles levers play in various contexts. It is one thing to analyze the mechanical laws associated with the lever in the writings of Galileo or Varignon, for example, but quite something else to describe a lever when it is being used heuristically in a different theoretical context altogether, as shown in the case of Leibniz and his definition of “sufficient reason,” or, Benvenuto’s assessment of the lever as “useful in research” for the mechanical theorists of the Renaissance. To give just a brief example of how varied the metaphorical terrain can be, one could take the historical example of Pierre Massuet, who prefers to speak of levers in terms of êtres de raison (beings of reason) in his Elements of Modern Philosophy (1752), whereas the psychologist Johann Herbart chooses Gedankending (thought-thing), a term popularized by Idealist philosophy that takes on its own idiosyncratic meaning in Herbart’s writings. What kind of descriptive or theoretical language would be most appropriate for navigating between the lever as being and thing, a creature of reason and thought? One can contrast those examples against the work of the historian of science Domenico Meli or the philosopher Hans Blumenberg. Meli refers to the lever as a philosophical and mathematical instrument and, more descriptively, as a “tool of investigation.” He also taps into the notion of the lever as an innately translatable object when he describes “creative and fertile applications of the lever” that could be both “conceptual and mathematical.” Hans Blumenberg, for his part, puts his finger on the ineffable quality of the lever when he describes a kind of “hybrid space” within which the lever functions. With reference to one of Galileo’s dialogues, Blumenberg comments that the simplicity of devices (Geräte) such as the lever and balance is such that they approach the “pure conditions” required for mathematical representation. The common factor among them—which Blumenberg refers to as highly “artificial” (perhaps with reference to the suggestion found in the Mechanical Problems that they operate “against nature,”)—is that something small moves something big. These objects, he suggests, occupy a hybrid space between mathematics and physics: the objects involved are physical, and the method of describing them is mathematical. This theoretical description of a “hybrid space” will prove useful when, in later chapters, it comes time to analyze the ways in which levers as “thought-things” are being mobilized, and to what end.

Another fruitful axis of comparison that connects historical descriptions of the lever to more contemporary theoretical language centers around analogies between the lever and the human body. As noted in the opening paragraph, the boundary conditions between the human and the technical are open to debate, and nowhere is this more the case than in those instances in which the lever itself is anthropomorphized and in which the human body itself is associated with the lever. With regard to the former, one could take as a historical example Jacob Leupold’s Theatrum Machinarum Generale. Leupold refers to the longer arm of the lever as the “head” and the shorter arm as the “tongue.” In other words, the lever, that most primitive of instruments, is described as a monument to the human faculties of thought and language. The notion of the “body” of the lever appears

37 “Several scholars, including Kepler, Descartes, Borelli, and Leibniz, used the lever in their accounts of circular and orbital motion” (Meli, Thinking with Objects, 312).
40 Meli, Thinking with Objects, 234.
41 Meli, Thinking with Objects, 312.
42 Hans Blumenberg, Genesis der kopernikanischen Welt (Frankfurt am Main: Suhrkamp, 1975), 484–85.
43 Jacob Leupold, Theatrum Machinarum Generale, Schauplatz des Grundes mechanischer Wissenschaften (Leipzig: Christoph Zunckel, 1724), 8.
in various contexts. In specialized levers, such as ones that were specifically used for "loading" and "packing," the relationship of head and tongue might be reversed. Thus, in Krünit's Oekonomisch-technologische Encyclopädie, "the short round part" is the head and the "longer part" is the tongue, a state of affairs that comes complete with a piece of mechanical wisdom almost proverbial in its tone: "Therefore, the larger the head of the lever is, the more capacity one has to master a burden." Even though the dominant association of the lever and the human body is usually one where levers are part of the human body (i.e., when we understand our arms or legs as levers), this second understanding, whereby the lever itself is understood in terms of the human body and as an illustration of ars superat naturam, has an important role to play in my study. Readers should keep this perspective of the lever as body in mind when they come to the second chapter, because it will help contextualize German Romanticism's more radical claims that the lever—and its fulcrum point—are equated with the ego.

I would also like to make it clear from the beginning that this inquiry into the theoretical use of levers in the eighteenth and nineteenth centuries outside of classical mechanics is neither focused on modernity's fascination with automata, nor is it concerned with the technologies and discourses on prosthetics that developed in the wake of increasingly devastating acts of warfare. That is well-traveled terrain—there are numerous writings on automata and prosthetics to which interested readers can refer. Instead, I focus on a historical tendency to understand certain aspects of being human, such as making judgments, thinking, or organizing concepts, in terms of the activity of the lever. To frame this problem and provide an example from a contemporary theoretical perspective familiar to most readers, Jacques Derrida's 1990 essay "Mochlos, ou le conflit des facultés" (Mochlos, or the conflict of the faculties), is a useful point of reference.

Though Derrida is not the first name that comes to mind when thinking about the theoretical discussions that incorporate mechanical terms, mochlos is the Greek word for lever and Derrida refers to it directly in the last paragraphs of his essay. The main thrust of his argument has to do not with mechanics but with a different kind of positioning and leveraging: the responsibility of the academic with regard to the university. Eventually, however, he calls out for "a new university law" based on the existing, "traditional law" that will "provide, on its own foundational soil, a support for leaping to another place." Derrida continues:

We might say that the difficulty will consist, as always, in determining the best lever, what the Greeks would call the best mochlos. A mochlos could be a wooden beam, a lever for displacing a boat, a wedge for opening or closing a door, something, in short, to lean on for forcing and displacing. When one asks how to be oriented in history, morality or politics, the most serious discords and decisions have to do less often with ends, it seems to me, than with levers.

In this passage, Derrida makes an analogy between the endpoints of the lever and the political ideologies of "left" and "right," but—after a detour through Heidegger—it is the lever of the body, articulated through a quotation from Kant's Conflict of the Faculties, that claims the final word of the essay:

The fact that Prussian infantrymen are trained to start out with the left foot confirms, rather than refutes, this assertion [i.e., the assertion that the right foot has the advantage over the left J.H.; for they put this foot in front, as on a hypomochlion, in order to use the right side for the impetus of the attack, which they execute with the right foot against the left.

Derrida—and Kant—go beyond a simple alignment of man and simple machine, of human and lever, in order to implicate the human body within acts that are at the same time physical and concerned with foundations and structures of law and power. The lever, as understood here, is not contained within the human body, where joints are usually understood as the fulcrum points for arms and legs. Instead, the body as (total) lever seeks its fulcrum point at the interface of the human with its environment. Through the complete overlapping of the physical interface of body and ground and the theoretical interface of human ideologies, we are reminded of Blumenberg's notion of a "hybrid space" that levers have historically inhabited, and that more contemporary

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45 One of the few studies devoted almost entirely to the eighteenth century is Alison Muri's, The Enlightenment Cyber (Toronto: Toronto University Press, 2011).


47 Derrida, "Mochlos."

reflections on the lever seem to do as well. Derrida’s comments on the fulcrum point, or hypomochlion, also remind us that for as long as there have been theoretical reflections about levers, philosophers have also pondered the notion of the lever’s resting place. The history of the lever—in particular, its history as thought-thing—cannot be separated from the history of the Archimedean point. The following section will sketch out the historical parameters of this idealized point, which has actively participated in expanding the borders of knowledge and sovereignty in the modern era.

Where to Put Your Lever: The Archimedean Point
The above pages have provided a brief overview of the lever’s practical and theoretical importance in antiquity and the Renaissance and emphasized the lever’s extreme. I have also introduced a few of the fundamental ideas associated with the lever, such as its connection to the body and the “hybrid” space it occupies between mathematics and physics, each of which will be elaborated in greater detail in the course of the following chapters. The question has also arisen of how, precisely, to refer to the lever in the context of this study. Clearly, its instrumental value should not be underestimated. After all, the lever responds to fundamental philosophical questions and has demonstrated its potential to be the instrument of knowledge-building par excellence. The lever does not usually appear in isolation, however. It is part of a larger conceptual “apparatus” that includes the mechanical moment, the state of equilibrium, and of course the fulcrum point (also known as the hypomochlion, literally that which “rests beneath” the lever). The lever’s conceptual apparatus also includes an idealized version of the fulcrum known as the Archimedean point, which is traditionally associated with an extreme demonstration of the lever’s mechanical advantage—the ability to displace the world itself. The Archimedean point provides the most intuitive example of how the lever is useful beyond the field of mechanics. This section will outline a few of the most prominent moments in the history of this special point as well as its connection to those aspects of the lever noted above.

If the history of the lever could be said to have a mantra, it would probably be this: give me a firm point, and I will move the world, an English equivalent of the famous dos mot pou sto associated with Archimedes. To this day, these words continue to refer back to an original scene which likely has never taken place. Still, if there is a foundational moment to

49 Plutarch, recounting the life of the Roman general Marcellus, allows for a digression in order to relate a few anecdotes from the life of Archimedes, whose own life is inseparable from the history of mechanics. In the face of a
from the Renaissance through the nineteenth century that challenged its practicality, ultimately leading to disavowals that a so-called Archimedean point can even exist. This irritation occurs at the same time as the position of the self with regard to its philosophical endeavors is increasingly called into question in the wake of Cartesian philosophy.

Bruno Latour describes Archimedes’s lifting of a ship as perhaps “the oldest public scientific experiment,” one that played an important role in the relations between rulers and scientists. His analysis describes four “reversals of forces”: that a single person could theoretically move the world; that the power of a mathematical demonstration is greater than all other contrary ... evidence”; that a simple, well-designed piece of machinery can change the face of the earth; that a “little bit of abstract reasoning” can be even more valuable than actual achievements; and lastly, that a powerful tale such as this one has a staying power despite historical evidence to the contrary. Michel Authier argues along similar lines as Latour, focusing on the engagement of science and politics in this story. He also makes an important connection to another (lost) text by Archimedes titled Grains of Sand. In this text, Archimedes calculated how many grains it would take to fill the volume of the universe. The question in this context is also how to manipulate the largest quantity (in this case, through imagining a number greater than the one which existed at the time in Greek thought, the “myriad of myriads” or 100,000,000). There is a trajectory here that crosses orders of magnitude in space, from grain of sand, to ship, to world, to universe.

If it is clear that the history of the Archimedean point is inextricably linked to that of the lever, it should be equally evident that this history is much more than a simple fiction, or anecdote. As much as it is defined by the repetition of words that were never spoken in the first place and by the search for a fulcrum point that never quite materializes, it has gained status over time by being coupled with one of the definitive problems of modernity: the quest for a firm base of knowledge. In modernity, this quest evolves into a bifurcated narrative, where attempts to define a firm point upon which to ground one’s knowledge and build a philosophical system are coupled with growing skepticism toward the self-same project. From a distance, all Archimedean points might appear more or less the same, but a closer look reveals that each is situated in a particular intellectual landscape. One of the most dramatic changes in terrain occurs when the point ceases to be external to the agent wielding the lever and instead is conceived of as an “interiorized” hypothetical point. Descartes is a special case in this regard. On the one hand, the interiorization of the point is implicit, because what is at stake is the certainty of knowledge: “Archimedes claimed, that if only he had a point that was firm and immovable, he would move the whole earth, and great things are likewise to be hoped, if I can find just one little thing that is certain and unshakeable.” The metaphorical language of the Meditations is not quite aligned with the philosophical language, however. When Descartes refers to his own situation, he describes himself in “a deep whirlpool” with purchase neither below nor above as he seeks just one certain thing.

The Lever, the Archimedean Point, and the Construction of Knowledge

Like the lever, the Archimedean point enjoys an amazing degree of discursive mobility. Both are implicated in those contexts when what is at stake is the grounding of knowledge. In modernity, this quest evolves as a bifurcated narrative, where attempts to define a firm point upon which to ground one’s knowledge and build a philosophical system are coupled with growing skepticism toward the self-same project. From a distance, all Archimedean points might appear more or less the same, but a closer look reveals that each is situated in a particular intellectual landscape. One of the most dramatic changes in terrain occurs when the point ceases to be external to the agent wielding the lever and instead is conceived of as an “interiorized” hypothetical point. Descartes is a special case in this regard. On the one hand, the interiorization of the point is implicit, because what is at stake is the certainty of knowledge: “Archimedes claimed, that if only he had a point that was firm and immovable, he would move the whole earth, and great things are likewise to be hoped, if I can find just one little thing that is certain and unshakeable.” The metaphorical language of the Meditations is not quite aligned with the philosophical language, however. When Descartes refers to his own situation, he describes himself in “a deep whirlpool” with purchase neither below nor above as he seeks just one certain thing.

56 Adam Weishaupt, Über die Kantischen Anschauungen und Erscheinungen (Nürnberg: Gratia, 1788), 91.
58 Descartes, Meditations on First Philosophy.
Philosophical skepticism with regard to the certain thing Descartes seeks and believes to find in the cogito—as well as with regard to the Archimedean point—takes many different forms. On the one hand, there are those critics who try to prove mathematically that such a point is either impossible or so unrealistic to attain as to be completely unfeasible. Consider, for example, Alexandre Savérian’s entry on the lever (le levier) from his Dictionnaire universel de mathématique et de physique (Universal Dictionary of Mathematics and Physics) from 1754. After a few admiring words about the mechanical advantage associated with the lever, he gets down to the business of calculating just how long a lever one would need to move the earth: “I think one will see with pleasure the determination of this length”:

The force of a man who presses on a body is estimated to be 100 pounds, and the weight of the earth 39984700118074464789750 pounds. Let us place this weight at the end of a lever at the distance of 2000 leagues from the point of contact [i.e., the fulcrum point]. The person or power would have to be at a distance of 3997847001180744647897500 from the point of contact in order to lift the earth. Lifting it a mile, the pressure traverses a distance of 666307833530107441316 leagues & ¼.

Savérian neglects to explain how he comes up with the “weight” of the world—he would have to answer the question: in whose gravitational field is this weight being calculated? Ultimately, the value of his calculation lies in the pleasure it provides to the imagination—the experimental scenario he describes is remarkably short on logistical detail as well as other, more theoretical concerns. In comparison to Savérian, the French literary figure Edouard Charton seems more cognizant of these problems. Charton, whose lever is conceptualized with somewhat different dimensions in mind, has calculated that “it would take three thousand years in order to move the earth the millionth part of a millimeter” and that one would need to increase the lever arm somewhat in order to take into account “the force of attraction that tends to pull the earth toward the sun.” Then there are those, such as Andrew Motte, whose attention is more focused on the potential limits of the materials involved: “An Engine framed for that Purpose [i.e., to displace the earth, J.H.] would operate so very slowly, that not only Archimedes, but the Earth itself, would come to an End, before the Effect would be in the least sensible.”

Most philosophers and mathematicians did not take Archimedes quite so literally. More in the tradition of Descartes, they used the Archimedean point as the fixed and certain point of an epistemology directed toward the reliability of knowledge itself, even if this goes against the Archimedean tradition. Schelling summarizes the problem succinctly, without pointing to a solution, with his observation that “Archimedes demands a firm point beyond the world. To want to find it theoretically (that means, in the world itself) is absurd.” By the same token, there is a well-documented history of disagreement with Schelling’s statement. One could instead refer to German Romanticism’s own appropriation of the Archimedean point as essential to the process of observing one’s thoughts and the manifold relations of the self. A fragment from Novalis’s General Brouillon connects Archimedes’s proverbial call for a fixed point to the formation of an “independent organ” of observation, one which would witness not only the phenomena of nature per se, but also the formations, changes, and mixtures of thoughts and images that are inspired by them. The early German Romantics imagine the fixed point as a paradoxical organ of observation capable of assessing and encompassing change, internal to and yet independent of the subject.

After 1800, philosophers return to the question of what service the failed project of the Archimedean point might be, time and again, and with increasing urgency. We have Niklas Luhmann to thank for putting

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his finger on a problem already present in German Romanticism’s statements on the point: that of self-implication. For Luhmann, even the most powerful articulations of the subject as Archimedean point cannot escape a logic of recursion that prohibits any possible perspective external to the system within which a subject is defined: like Kierkegaard, he can circumnavigate himself without moving in any way beyond himself. In Luhmann’s writing, the modern loss of an Archimedean point requires a fundamental rethinking both of epistemology and of sociology. When asked if sociology could offer an Archimedean point from where to describe all of society, he responded that today it is no longer possible to imagine such an outside for the observation of the whole, sociology being no exception.64

In order to illustrate how a critical approach to the Archimedean point can be theoretically productive, I would like to mention just one example discussed by Hans Blumenberg in Care Crosses the River. This work unfolds as a series of short prose pieces, philosophical meditations unframed by either a preface or an afterword, leaving the reader to navigate the flotsam of section titles running the gamut from “Maritime Emergencies” to “Fundamental Differences.” The latter section contains two references to the Archimedean point in the context of the science of knowledge, in essays titled “The Building Site” and “On Board.” In each case, the point is embedded within a broader concern of epistemological certainty and uncertainty. Blumenberg frames “The Building Site” in terms of a philosophical interest in the question of foundations. The question, to what degree a proposed building site’s suitability for the raising of architectural structures can serve as a topos for philosophical thinking, can be traced from the first extensions of the Cartesian into the twentieth century. The extension of the Cartesian cogito into space (and, implicitly, the positing of the cogito as the Archimedean firm point) as well as the philosophical systems of idealism are indebted to this conceit, but in the early twentieth century such figurative relations are increasingly called into question. Blumenberg cites the philosophical debates of the Vienna Circle. His chief example is Moritz Schlick’s essay, “Über das Fundament der Erkenntnis” (On the Foundation of Knowledge) from 1934, which is one of the last attempts to fight the proverbial tide by (re-)establishing the firm ground of knowledge, even though this very insistence also brands the project as intellectually conservative. Schlick’s work was, according to Blumenberg, behind the times for its insistence on “groundwork” when other more appropriate metaphors are available to describe structures of knowledge. What are the alternatives? “Net” is a possibility, according to Blumenberg, although its full potential will only be exploited years later. Otto Neurath’s revival of the encyclopedia is offered as a more viable alternative mode of collecting knowledge. The reference here is to the “Unity of Science” movement and the International Encyclopedia of Unified Sciences, a series of monographs that eventually included both Neurath’s Foundations of the Social Sciences and Thomas Kuhn’s Structure of Scientific Revolutions. Blumenberg also writes about the “institution” of the encyclopedia in the context of the twentieth century more generally in a passage from The Legitimacy of the Modern Age where he refers to it with regard to the problem of how to speak about science without, on some level, also performing science:

While we know more about the world than we ever did before, this “we” does not by any means mean “I.” The “we” of this statement confronts the “I” only in the form of institutions—of encyclopedias, academies, universities. These represent higher-level agencies [Übersubjekte] that administer knowledge about reality in space and time and organize its growth.65

One could, perhaps, understand these Übersubjekte as the captains of what Thomas Kuhn refers to as “Archimedean platforms” in the sense that they are collectives of historically situated agencies who respond “in space and time” to conditions on the ground, were it not for Neurath’s bleak assessment of science in its individual and institutional manifestations with which Blumenberg concludes the “The Building Site.” Channeling Neurath, Blumenberg comments: “The condition of Archimedes, which had understandably already appeared to Neurath as unrealizable, also meant the theoretical unattainable: ‘We do not have a stable point from which we could turn the earth upside down: and, in the same way, we have no absolutely solid ground upon which we could erect the sciences.’”66 With reference to the IX International Congress of Philosophy in Paris of 1937, Blumenberg also quotes Neurath as saying, “We have no absolute foundation from which we can proceed. . . . Science in all its aspects is always under discussion.


Everything flows." With these words, the problem addressed in Blumenberg's essay receives its clearest statement: in the end, one is pulled back into the Heraclitan floodwaters. As it turns out, however, the question of what ground one establishes a theoretical basis of knowledge is still relevant. Blumenberg's decision to conclude the essay with the quotation is itself a silent declaration. The lack of a closing frame in his essay is tantamount to the relinquishing of narrative purchase. By allowing the quotation to speak for itself, Blumenberg leaves it an open question, to what extent the further qualification or leveraging of this sentiment is possible.

The Lever and Its Point: Constructing a Conceptual Apparatus

Although the case studies that inform The Lever as Instrument of Reason are situated historically in the decades before and after 1800, the above reflection on the Archimedean point should show that there are broader questions to be addressed, both concerning the relationship of the lever and its resting place to the construction of knowledge, and to the difficulties involved in positioning the lever relative to ourselves. Questions such as these demand an approach to the study of the mechanical lever and its fulcrum point that differ from the concerns and methodology of a traditional history of science. The distinction Joseph Vogl makes in the introduction to his Poetologien des Wissens [poetologies of knowledge], with reference to Foucault, is worth echoing today due to the pervasiveness of often conservative disciplinary biases: "A history of knowledge is not a history of science" because it remains critical of claims made in the name of scientific rationality and traditional narratives of the history of early modern knowledge.

I would like to underscore the fact that the following chapters, though attuned to particular contexts in which the individual authors were working, do not purport to write a history of science, nor have they been written using a conventional historical methodology. It is rather my belief that an interdisciplinary project such as this one, which studies examples from philosophical, literary, and psychological texts, needs a more flexible approach. To be sure, disciplinary distinctions are not simply to be ignored, but neither should they be prohibitive. Christian Kassung's study of the pendulum is a good point of reference in several regards. In The Pendulum. A History of Knowledge, he constructs a model or conceptual apparatus whose fundamental elements are comprised of the terms circle, pendulum, and number, because "they mark the gravitational center of that knowledge that emerges in the pendulum in the most varied forms." For Kassung, the replacement of a history of science with a history of knowledge is an important step because the kind of work he wishes to accomplish requires, as he explains, a "de-teleologisation" (Entteleologisierung) of historical genealogies of knowledge in favor of "focusing on the concrete materiality and practice of the construction of knowledge." Kassung is more interested in a material history of the pendulum and its connection to symbolic order than I am to a material history of the lever, but to some degree his argument is still transferable to my project. The levers in question do not have to "work" in a positive scientific sense to be of theoretical interest (and value) for the discourses in which they participate.

By remaining attuned to the function of the lever in various contexts, to the linguistic environment in which it is embedded, and to the theoretical concerns that cause its appearance in the first place, it is possible to observe surprising points of overlap between thinkers usually thought to have little in common. The eighteenth-century German philosopher Georg Lichtenberg once wrote, in the notes of his Waste Books, that "among all heuristic lifting devices [Hebezeugen], none is more fearsome than that which I have called paradigms." This study responds to Lichtenberg's idea by studying the ability of the specific lifting device known as the lever to function more generally as a model of thought. In this concluding section of the introduction, I will provide some background to justify my decision to focus on the eighteenth and early nineteenth centuries, outline my approach and specify which questions in particular this study will address, as well as give an overview of the four chapters that comprise the case studies of this project.

As we have seen, the lever is both a very simple object, a tool used since ancient times for the most primitive of tasks of lifting and balancing, and one whose mechanical law was foundational to the field of statics through the Renaissance. I have also provided evidence of the lever's ability to cross physical scale and to prove itself relevant to

67 Blumenberg, Care Crosses the River.
70 Kassung, Das Pendel, 23. Kassung gives the example of two pendula associated with Jean Bernard Foucault: the first, found in his own house; the second, the famous "Foucault pendulum" that demonstrates the rotation of the earth. Kassung suggests that only the second is considered successful in a positivistic sense, but both are interesting for a history of knowledge: "An apparatus, which has never functioned, can become the central Aussagesystem of an archaeology of knowledge" (Kassung, Das Pendel).
both terrestrial and celestial mechanics. Not one of these phenomena, however, suffices to explain why, in the years around 1800, there is a proliferation of levers outside of traditional scientific contexts. Jean de Groot, in an essay on "Motion and Energy," has noted that "what is remarkable about the long history of ancient mechanics is that a few basic principles . . . remained central even as mechanics moved away from theoretical formulations," and he cites "Archimedes's law of the lever" as a prime example for how "there is something basic about kinematic principles that keeps them freshly appearing in the history of science." 72

As of yet, though, no one has investigated the parallel observation that the same phenomenon holds true in areas of inquiry that, at first glance, have nothing to do with classical mechanics. Why, for example, is it advantageous for Kant, in his 1763 essay on negative magnitudes, to use the lever and the concept of equilibrium to explain the process of making moral judgments? Why do the early German Romantic writers Friedrich Schlegel and Friedrich von Hardenberg (Novalis) rely so much upon the fulcrum and the lever to model their understanding of the subject, as well as use it as a tool for constructing relationships between concepts? Even were one to consider the broader historical backdrop and argue that both the rise of mechanics as a science and the emergence of a "mechanical philosophy" (however disputed the definition of this historical phenomenon might be) 73 have a role to play, these developments cannot explain the widespread desire to translate the lever into new contexts and use it as an instrument for working through problems that seem to have little connection to mechanics. Such a tendency is even more surprising at a time when organic tropes and modes of explanation were rapidly gaining in popularity, as is the case with German Romanticism and Naturphilosophie. 74

Although the research underlying The Lever as Instrument of Reason takes as its point of departure the surprising discovery of the lever's transdisciplinary rise in popularity around 1800, what connects the individual chapters and gives coherence to the work as a whole are further insights into what functions the lever performs. Even as the lever translates knowledge and mobilizes new ideas among the most diverse disciplines, these acts of translation participate in a common concern to use the lever to model certain problems connected with cognition, intellectual activity, and the ego. In order to see how this is the case, it is important to note that when the lever and the mechanics associated with it are imported into areas of thought as diverse as Kant's precritical writings, Idealist philosophy, German Romanticism, Naturphilosophie, and empirical psychology, it is no longer simply being used as a metaphor of convenience or rhetorical effect. To be sure, there are numerous "levers of reason" scattered throughout the Enlightenment, just as one can find multiple references to levers of religion and the state. Most of these are just the illustration of a basic idea: the augmentation of human agency. In The Lever as Instrument of Reason, however, I show that in this time period the lever is also being used in more sophisticated (and interesting) ways that share some affinity with Hans Blumenberg's concept of the "absolute metaphor." Such metaphors, he writes, have a "conceptually irredeemable expressive function." 75

Glossing a passage from Kant's Critique of Judgment, Blumenberg finds an understanding of metaphor that points to his notion of an absolute metaphor, where metaphor "is clearly characterized as a model invested with a pragmatic function" and is "a principle not of the theoretical determination of what an object is in itself, but the practical determination of what the idea of it ought to be for us and for the purposive use of it." 76 Such metaphors cannot be reduced to a single concept or antecedent image but rather serve as models. One example, which will be discussed in greater detail in the next chapter, is Hegel's definition of Aufhebung (sublation). It is often forgotten that Hegel's explanation of this concept in the Science of Logic (1812-16) relies directly on the theory associated with the lever (Hebel) and the mechanical moment. Rather than using the lever metaphorically (one will not find any references to a "lever of sublation" in Hegel's writing), he uses the lever and the mechanical theory associated with it to model the challenge that a philosophical definition and description of Aufhebung presents.

One of the difficulties in writing about the lever lies in the fact that it is by no means a stable entity. Over time, philosophers and mathematicians found the law of the lever, which describes it in a state of static equilibrium, intuitively obvious yet difficult to prove. The

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73 For a historical overview, see J. A. Bennett's essay, "The Mechanics' Philosophy and the Mechanical Philosophy," History of Science xxiv (1986). Bennett suggests that greater attention be paid to the historical context of mechanical philosophy (i.e., that it was "not solely an intellectual construction"), and that one should also consider to a greater degree contributions made by the "practical mathematical sciences" (Bennett, "The Mechanics' Philosophy," 24).

74 One can refer to my book, German Romanticism and Science: The Procreative Poetics of Goethe, Novalis, and Ritter (New York: Routledge, 2009) for further information about this historical trend.


76 Blumenberg, Paradigms for a Metaphorology, 10.
initial attempts by Archimedes and Aristotle were disputed and revised by influential thinkers through the Enlightenment (including Descartes, de la Hire, Lagrange, and others). They argued about how to provide a mathematically and philosophically sound basis for the seemingly self-evident laws describing the lever and, eventually, whether it should even be seen as the “foundation and pillar” of mechanics. Those discussions, which emerged within the context of a widespread critique of the teleological explanations central to Aristotle’s natural philosophy, lasted through the end of the eighteenth century and have been described by Benvenuto, Meli, and others. These studies have inspired me to understand the lever as both historically unstable and yet, by the same token, uniquely adaptable, and my readings of Kant, Schlegel, Schelling, and Herbart are attuned to these nuances. I wish to show that the lever has had more influential role to play in the history of knowledge than has usually been recognized. Another important exception can be found in the work of M. Norton Wise and Crosbie Smith, who refer extensively to the lever and balance in their work on the history of economics. The context is an argument about the “rediscovery” of time. In a series of essays gathered under the heading of “Work and Waste,” they argue that in the course of a “transformation of natural philosophy in the 1840s,” “temporality now entered in an invasive way into the explanation of natural systems” and that “time was rediscovered.” In the years prior (their argument refers to the French Enlightenment and British scientific culture through the 1830s), before the “rediscovery” of time, they suggest, it was the balance that “served as a model of scientific rationality.” They refer to the historical use of the balance to explain “ecologies of nature” in contexts ranging from the solar system to geology, chemistry, biology, and political economy as something that provided an “explanatory strategy” in various ways. My work on the lever can be seen as a fine-tuning of this perspective, because it discusses numerous examples where time does, in fact, figure into the picture in ways that Wise and Smith might not have anticipated.

In The Lever as Instrument of Reason, I also challenge the teleologically based assumption that human history can be defined by the invention of increasingly better tools, an argument that requires both a rethinking of the relationship between tool and agency and a revision of the anthropological model of the tool, which understands it as a substitute limb, in favor of an alternative where the body and tool are one. It is in this collapse that one can also observe the intersection of the two cultural histories, of the lever and the Archimedean point, that inform my project. Just as Blumenberg has argued that our failure to achieve the Archimedean point—the firm ground of knowledge—is unavoidable when one attempts to construct a theory of science from within a scientific mode of thinking, an analogous collapse occurs when the human and lever are one—when it is no longer possible to separate agency and instrumentality. The Lever as Instrument of Reason argues that the potential loss of “firm ground” from which to position oneself as agent is surprisingly productive, resulting in significant, if widely varying, philosophical gain.

Overview of the Chapters
Chapter One, “The Balance of Life / Quantifying Kant,” focuses on the precritical essay, “An Attempt to Introduce the Concept of Negative Magnitudes into Philosophy” (1763). This might seem like a peculiar choice, given that the essay, at first glance, does not seem to have much to do with mechanics at all. Kant devotes most of the argument to distinguishing between different modes of negation in mathematical terms, using the mathematician Abraham Kästner as a reference point, before turning to the case of psychology (Seelenlehre). As it turns out, the lever has an essential role to play as the concretization and, I argue, fundamental embodiment of “real contradiction” (i.e., one that does not posit a logical impossibility) and active “rest” when in a state of equilibrium. The lever is also what connects the disparate bodies of Kant’s essay: from the Spartan mother torn between pride and devastation, to the learned man whose apparent stillness belies

77 Benvenuto, History of Structural Mechanics, 76.
78 Descartes, Galileo, and Newton “began to criticize the idea that teleological explanations were appropriate for understanding nature, and advocated in their place explanations that privileged mechanical causation.” See Peter Dear, The Intelligibility of Nature. How Science Makes Sense of the World (Chicago and London: University of Chicago Press, 2006), 16.
81 They define three aspects, whereby the first identified "an opposition of two forces, labelled 'natural,' 'constant,' or 'regular,' which would produce an eternal, timeless stability in the natural state of the system" and the second "distinguished regular variations, or periodic 'oscillations,' controlled by the constant natural forces, from irregular variations or 'fluctuations,' produced by forces called 'disturbing' or 'accidental'" (Wise and Smith, "Work and Waste (II)," 391). The third invoked analytic tools (such as variational calculus and statistical averaging) for locating the "optimum" (natural or average) state of a particular system (Wise and Smith, "Work and Waste (II)").
an active mind. With reference to these and other examples, this first chapter offers an eighteenth-century case for the lever’s use to model certain aspects of the human psyche, an idea that will return, vastly reconfigured, in Early Romanticism’s thought experiments. Schelling and Eschenmayer’s Naturphilosophie, and Herbart’s neuro-mechanics. Equally integral to this chapter and the project as a whole is the way in which the lever and, more generally, the concept of equilibrium mediate between material and abstract domains.

Chapter Two, “The Levers of German Romanticism,” shifts the focus of the lever as a model of the human from processes of thinking and judgment to constructions of the self. Part of the continued interest in Romantic theory and literature today can be attributed to its ability to undermine the stereotypes that have populated research agendas since the nineteenth century. Familiar descriptions of Romanticism as the cult of irrationality, as pure nostalgia for a hypothetical golden age, and as a purveyor of idealized femininity have, with time, been exposed to more critical treatment. The most recent scholarship has taken up Romanticism’s manifold relationships to scientific thinking, once thought of as beyond its scope. Perhaps the last of Romanticism’s unchallenged concepts is that of organicism. The “organic” has left its mark on almost every aspect of early Romantic thought, from the tropes of its literary works to its aesthetics and its subject theory, and it is a concept that, at first glance, would seem to have little to do with the mechanical. In this chapter, I argue the contrary position and show that, in fact, the lever is deeply ingrained in early Romantic thinking, where its theory serves as a heuristic tool to model relationships between concepts, to describe processes of generation of both the individual and the universe, and, more generally, as a way of addressing potential contradictions of philosophical thinking through the logic of sublation embodied by the lever in equilibrium. The analyses of this chapter are far removed from the mechanical automata of later Romanticism. My study approaches the problem of a “mechanical” human from a very different angle: the second part of the chapter addresses the relation of the lever to early Romantic concepts of the subject to show that it no longer serves as an instrument for the augmentation of human agency in the spirit of Archimedes. Instead, it comes to stand in for the agent itself, such that the subject position and fulcrum point are one.

Chapter Three, “The Contested God of Naturphilosophie,” reveals how Friedrich Schelling and Carl Eschenmayer remove the lever from purely mechanical contexts and use it as a model for both the self and the emergence of self-consciousness. For Eschenmayer, the mechanical lever is a way to make physical and psychological phenomena “more visible” (anschaulicher) and he constructs diagrams to make his case. He provides a theoretical basis that enables us to understand how Schelling uses the concept of equilibrium as a bridge between the material and nonmaterial and the lever as a model for the basis for self-consciousness. This chapter also exposes the lever’s surprising role in a heated debate that erupts between Schelling and Eschenmayer around Schelling’s 1809 essay, Philosophical Investigations into the Essence of Human Freedom. As much as this debate is about God’s relationship to the concepts of “ground” [Grund] and “non-ground” [nongrund] it is, surprisingly, just as much about the status of the lever. Although Schelling’s position is that the usefulness of the lever and its mechanical theory is “dead” from a nature-philosophical perspective, Eschenmayer counters with its apotheosis as the “god” of the philosophy of nature.

The final chapter of the book, “From Naturphilosophie to a Mechanically Minded Psychology,” confirms that, despite Schelling’s prediction, the lever’s demise is far from certain. Its resurrection takes place in the field of psychology, as witnessed by the central role it plays in what Matthew Bell has called “the two best-known psychological products of Idealism”: Eschenmayer’s Psychology in Three Parts (1817) and J. F. Herbart’s Text Book for Psychology (1816). These two works go in very different directions: in Eschenmayer’s case, through further thinking about Schelling’s psychology of the absolute, and in Herbart’s, through the application of mathematics to psychology. Herbart, best known for his pedagogical theories, has an avid interest in what he calls the “statics and mechanics of the mind” where the role of the lever is, in his opinion, too obvious to ignore. I show how Herbart uses the lever to develop one of the first mathematically rigorous models of the human mind: a model where the emergence and suppression of thoughts and our cognitive states were understood as quantifiable.

In the letter from Friedrich Heinrich Jacobi to Princess Adelheid Amalie Gallitzin quoted as the epigraph to this study, one finds embedded the most prominent themes of the following pages, including the lever’s connection to consciousness and thinking and, above all, the way in which it “appears to be everywhere the first.” For Jacobi, it is a contemplation that generates a degree of discomfort that derives, perhaps, from the awareness that the lever is, simply put, an unavoidable component of our worldview. Readers should not be surprised if, after perusing the following pages, they too are left with a heightened awareness of the myriad lever effects that inform our daily activities. It remains a personal decision whether such contemplations inspire unease or simply greater admiration for the way the simplest of mechanical objects remains so fundamental to our existence.