Valuation Studies

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Towards a Reformulation

Board of editors

The overall aim of this journal was to foster valuable conversations in the new transdisciplinary and emerging field of valuation studies. *Valuation Studies* has in this way been a successful experiment. The main testimony of this success is the twelve issues with articles, interviews, editorials we have published since 2013. As an editorial collective, we are proud about of what the journal has become. Yet, we also have the sense that we are ready to push the now ongoing conversations to take further steps.

We have, until now, taken valuation to denote *any social practice* where the value or values of something is established, assessed, negotiated, provoked, maintained, constructed and/or contested. Partially thanks to this journal and the many authors, reviewers, editors involved in this collective task, valuation practices are today an established object of inquiry in the social sciences and humanities. Given this, the current question for us is how this journal can continue to further the conversation.

We propose a transitioning the journal from focusing on the study of valuation practices to the study of valuation as a problem. Valuation stands as a crucial *problem* for the social sciences and the humanities today, in more than one way. Understanding the tensions, determinants, contexts and effects of valuation practices appears indeed as a decisive requirement for the understanding of how our world is constructed, transformed or shattered. An interdisciplinary approach is required in order to investigate the technical cultures, the political imaginaries, the historical processes, the methodological problems and the institutional settings that shape the ways in which things are valued, and to identify relevant shifts, controversies and struggles. Sociological, anthropological, cultural, political, semiotic,

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historiographic, legal, institutional, critical, organisational approaches to the study of valuation phenomena are needed in order to establish tractable, actionable interdisciplinary knowledge on valuation as a problem.

Valuation as a problem does not, certainly, exclude an attention to the practices of valuation. The problem of valuation is also the study of the problems of those who value and are subject of valuation. But, it implies also, to problematise further our own ways of approaching valuation. Our proposition is to push us, the editorial board, the authors, reviewers and readers to take new steps in our conversations about valuation. The revised focus will allow us to sustain and strengthen the journal as a platform for curated academic conversations on valuation.

These new steps further entails a shift in how we will manage submissions to the journal. From now on, content submissions will be made in response to broad open calls for contributions curated by the journal's editorial board, where we will always maintain a few thematic calls in parallel. This new format is to ensure focus and debate, while offering the space to address each call's purpose from many angles and in reference to various forms of evidence and demonstration. Papers already submitted will continued to be reviewed and assessed as previously and, once accepted, will be published on these pages. New submissions, however, will be received along the lines of the current new calls.

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Disobedient Things: The Deepwater Horizon Oil Spill and Accounting for Disaster

D.T. Cochrane

Abstract
Analysis of the Deepwater Horizon disaster and the accumulative decline of BP demonstrate both the analytical efficacy of the capital-as-power approach to value theory, and the irreducible role of objects in the process of accumulation. Rather than productivity per se, accumulation depends on (1) control of productivity, and (2) the evaluation of control. Capital-as-power focuses on capitalization as an expression of the evaluation by owners of their own power. In this article, I argue that the power of owners translated into capital values is power over both the human and non-human components of systems of production. Power is actualized through entities defined as cultural and political, as well as economic. Capitalization translates into the commensurable financial units of capital the irreducible social order—including objects—that bears on accumulation. The decline of BP's capital valuation in the wake of the disaster expressed the market's falling confidence in the expertise, experience and equipment that comprised the company's productive capacity.

Keywords: capital; value; accumulation; disaster; crisis; things

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Introduction

The Macondo well was difficult, but not exceptional. Equipment aboard the drilling vessel was misbehaving, but that was not, in and of itself, unusual. Drilling a deep-water well is a complicated undertaking, involving hundreds of workers and hundreds of millions of dollars of equipment, billions if you include the satellites required to maintain the rig's stationary position above the well. The workers are highly trained, highly skilled and well paid. Things can go wrong in an instance, but the workers know how to ensure the oil formation, the bedrock, the borehole, the drilling equipment and the vessel get along. Disobedience is expected, but when it occurs, it is swiftly contained thanks to an assemblage of documents, drills and devices (Law 1986). Unfortunately, the defiance of the Macondo well would exceed the expertise, experience and equipment of the drilling crew.

The name of the well—Macondo—came from the ill-fated town of Gabriel Garcia Marquez's *One Hundred Years of Solitude*. It now seems prescient because of what happened at 21.45 on April 20, 2010. Opening up the Macondo well was the Deepwater Horizon. The name of the vessel is now ubiquitous, invoking the deaths of 11 men, massive environmental degradation in the Gulf of Mexico and the near demise of BP, one of a handful of giant oil corporations.

Among the outcomes of the Deepwater Horizon disaster was a massive decline in the market capitalization of BP, the majority owner of the Macondo well (Figure 1). This decline emerged from calculative translations by market participants. Buyers and sellers of BP's shares observed and evaluated the qualitative events surrounding the disaster. That evaluation translated them into the quantities of finance. According to the capital-as-power theory of value (CasP), the decline of BP—assessed relative to the broader universe of corporations—constitutes an evaluation of a loss of power by the company. The originators of CasP, Jonathan Nitzan and Shimshon Bichler (2009), have defined power as "confidence in obedience" (17). That means a loss of power occurs with a reduction in confidence or an increase of disobedience. Evaluations get translated into the commensurable values of finance through capitalization, which is the defining "inscription device" (Latour 1987) of capitalism. Within the CasP framework, because those values are meaningful relative to other values, capitalists pursue *differential accumulation*. The concept will be described more fully below. However, for now it suffices to note that what capitalists seek is not simply a return on investment but a return on investment that outperforms the returns of the broad market.

In this article, I argue that things have to be included in our understanding of obedience and, in the case of the Deepwater Horizon disaster and the changing evaluation of BP by market participants, things were among the disobedient entities. This analysis offers an

affirmative response to Marion Fourcade's (2011) call for a "full-blown sociology of economic valuation," contingent on a broad, transdisciplinary understanding of sociology. It seeks to bring together insights from capital-as-power about the meaning of the financial practices that comprise capital accumulation with insights from actor–network theory (ANT) about the emergent qualities of human-thing assemblages. What is the relationship between the quantities and qualities of accumulation? In other words, *what is the relationship between values and that which is evaluated*?

Things enlisted in the drilling of the Macondo well operated outside their expected behavior, both individually and collectively. This transgression triggered a cascade of emergent responses with a plethora of qualitative impacts, including the deaths of 11 men, the worst marine oil spill in history, widespread public outrage, numerous lawsuits and regulatory changes. These complex, irreducible events were evaluated by market participants giving them quantitative sense.

As long as political economy defines value in terms of human labor or human desire it accedes to the bifurcation of humans and things that many sociologists, particularly in science and technology studies (STS), have argued against (Miller 1997; Latour 2005; Slater and Barry 2005; Pinch 2008; Swedberg and Pinch 2008). Conversely, Nitzan and Bichler's analytical method transcends the bifurcation as it assumes ongoing evaluation of human-thing assemblages that bear on the fortunes of capitalized entities. The practices of price construction attempt to account for anything that might affect expected earnings with no differentiation between "social" or "natural" causes.

The role of things in the formation and functioning of society was a motivating concern of STS (Callon and Latour 1981; Knorr-Cetina 1981; Latour and Woolgar 1985; Woolgar 1985; Callon 1986; Law 1986; Latour 1987). This has influenced a line of research examining how things shape finance (Knorr-Cetina and Bruegger 2000, 2002; MacKenzie 2006, 2008; Muniesa 2008; Preda 2008). Description and analysis of valuation processes has been one tangent of that research (Fourcade 2011; Muniesa 2011; Muniesa et al. 2017). With my analysis of the Deepwater Horizon disaster and the accumulatory decline of BP, I intend to demonstrate both the analytical efficacy of the CasP approach to value theory, as well as the irreducible role of things in the process of accumulation.

In the founding editorial of *Valuation Studies*, Claes-Fredrik Helgesson and Fabian Muniesa (2013) confront the question of objectivity. Sociologists have almost universally—and rightly—rejected the objectivity of capital values, in the sense that these values do not express some underlying reality. However, Helgesson and Muniesa, following Lorraine Daston and Peter Galison (2010), note that what matters is the process of objectification, which "makes valuation solid

or weak, meaningful or flawed, useful or useless in particular situations" (7). Capitalization is the defining valuation process of capitalism. The values it produces are obsessively monitored by market participants, who judge the specific values produced as "solid or weak, meaningful or flawed, useful or useless" through subsequent buying and selling that produces a new set of capital values. CasP theorizes these values to be to an objectified expression of the relative power of capitalists, as evaluated by capitalists. I am applying this insight to create a map of power redistribution. The map does not explain that power. Instead, it shows power shifts to then be explained. To my knowledge, this is a unique conjunction and application of CasP, ANT and the work found within *Valuation Studies*.

What Do Capital Values Mean?

Capitalization is ostensibly a straightforward calculation that discounts expected future returns to establish the present value of an asset. However, as Muniesa et al. note, "capitalization has certainly to do with finance proper, but it is also *more* than that" (2017: 11, emphasis in original).

Muniesa et al. examine the ways that capitalization operates across and beyond the domain of finance. This needs to be situated in relation to capitalization as a process of finance proper, where it is also more than its ostensible operation. In particular, consideration should be given to the ways that capital values are subsequently evaluated as part of the ongoing process of price formation. There will be various timelines for the use of capital values in subsequent calculations. High-frequency algorithmic trading will immediately translate changing values into trading decisions. Conversely, market participants in the Warren Buffet mode of "value investing" will try to assess whether stocks are undervalued relative to their "fundamentals." None of this processing occurs purely in the minds of capitalists. Rather, financial values are both input and output of the distributed cognition of capital markets. Study that engages with the values created and the processes of creation can help us understand better the meaning of capital values to capitalists.

Capitalization

Nitzan and Bichler (2009) theorize that capitalization folds the diverse institutions and processes that bear on earnings and volatility into capital. Capitalization is an obligatory passage point for capitalist metrology. Its meaning and practices get carried outside finance (Muniesa et al. 2017). These extra-financial operations subsequently inform measurements folded back into capital values via the calculative practices within finance.

Fabian Muniesa (2011) writes, "Valuation is about considering a reality while provoking it" (32). In the case of capitalization, the purpose of provocation is accumulation. Provocation is always an indeterminate process because (a) different accumulatory undertakings will seek different social transformation; and (b) the objects of intervention do not behave deterministically. Nitzan and Bichler (2009), drawing on Cornelius Castoriadis, have emphasized the potential disobedience of the populations subject to capitalist *creordering*—the creation of order. I argue, drawing on ANT, that things must also be considered potential sites of unruly behavior that defy intervention and, therefore, calculation. Conjoining the language of ANT with CasP confirms: the disobedience of things announces their status as *mediators*. Capitalization treats obedient things as intermediaries. For example, the capitalization of BP would consider, among much else, the productivity of the company's drilling operations, of which blowout preventers (BoPs) are a vital part. The Deepwater Horizon's BoP did not perform according to the expectations of either the operators of the drilling rig or the capitalists invested in BP. Blowout preventers are actants with an affective role in the extraction of oil, and therefore, the profitability of oil companies.

The drastic decline in the capital values of BP—and other firms—as the disaster unfolded is perhaps unsurprising. There was little doubt that BP's future included fines and lawsuits. As the disaster grew from an explosion on a drilling rig to an undersea oil leak of unprecedented proportions, the company's very existence was called into question. In that context, it is obvious that shareholders would seek to unload the company's shares. To do so, the shares had to be offered at ever lower prices to attract buyers. In the course of making these trades, market participants constructed a price. In assigning meaning to these prices both mainstream and critical political economy excluded the construction process. The meaning of these prices is narrowly conceived in terms of productivity. Yet, only a small portion of the decline in BP's valuations could be assigned to the disaster's effects on either company's productive capacity or output. According to the most widely used theories of economic value, the rest of the decline must be deemed "non-economic."

Irreduction

CasP makes the price-constructing process central to the meaning of capital values. Rather than a representation of underlying productive capacity, capital values express an evaluation by market participants of a capitalized entity's social power, of which productive entities are only a part. Government policies, consumer trends, technological changes and big weather events, among many other agents, can all be assessed and translated into the prices of capital. As such, there is no

"economic" and "non-economic" distinction to be made. Adopting Bruno Latour's conception of irreduction (Latour 1993a), I argue that financial values become the measure of the irreducible entities that comprise owners' matters of concern.

Latour introduces his conception of irreduction in a small work of aphorisms, published in English as the second half of *The Pasteurization of France* (1993b). The very first aphorism (1.1.1) reads, "Nothing is, by itself, either reducible or irreducible to anything else" (158). Aphorism 1.2.2 adds that "nothing is, in and of itself, either commensurable or incommensurable" (163). Applied to value theory, this means that the value of an asset cannot be ontologically reduced to production, productivity or anything else. Rather, "[w]hat is neither reducible nor irreducible [commensurable nor incommensurable] has to be tested, counted, and measured. There is no other way" (158). Measures perform an epistemological reduction and commensuration that is added to the world. Capital is the universalizing mechanism that allows owners to commensurate their control over the broad social order.

Productivity

The removal of productivity from the core of capital valuation is not a removal of productive entities from our understanding of value. However, their role in valuation needs to be reconceptualized and resituated. Things exude "unintended consequences" and necessarily exceed "dead labour" or marginal productivity. The construction of capital values is a translation of information about the complex, enfolded social order. That translation takes place along myriad intersecting metrological chains (Latour and Lepinay 2010). Systems of production, such as oil rigs, exist within "resource environments" that comprise "the complex arrangements of physical stuff, extractive infrastructures, calculative devices, discourses of the market and development, the nation and the corporation, everyday practices, and so on" (Richardson and Weszkalnys 2014: 7) that allow for production itself. The processes of financial valuation are entangled within these complex arrangements. But those valuation processes *add a reduction* into the complex arrangements in the form of financial values. Valuation takes into account much more than productivity, not least because productivity is not independent of the prices that emerge from financial valuations.

According to productivist value theory, increased oil rig efficiency—improving their potential output per unit of input—ought to increase their value. However, increasing the output of oil can reduce its price, lowering the value of the increasingly productive oil rigs. Therefore, oil output needs to be carefully controlled to bolster profitability (Nitzan and Bichler 1995, 2002; Mitchell 2011).

It is control of productivity, termed "sabotage" by early twentieth-century political economist Thorstein Veblen (1921), rather than productivity per se, that is the mechanism of accumulation. Hence, Nitzan and Bichler's claim that *capital is power*. My argument is that capitalist control is contingent not only on the human components of productive entities but also on the things involved in the process of production. Things are part of the domain of evaluation and their "obedience" is quantified into financial values. Productivity is an emergent quality of the worker–object assemblages that comprise productive entities. It cannot be ontologically reduced to human and non-human component parts. In other words, it is irreducible. When the valuation process constructs a price for an assemblage of production it does so on the basis of an assemblage's overall productivity, putting most of the worker-objects involved into a "black box" (Latour 1987). However, when a crisis emerges, as in the case of the Deepwater Horizon disaster, the black boxes will be opened, and market participants will peer inside to evaluate particular impacts on expected profits and perceived risks. Both humans and non-humans will be subject to this evaluation.

Evaluation

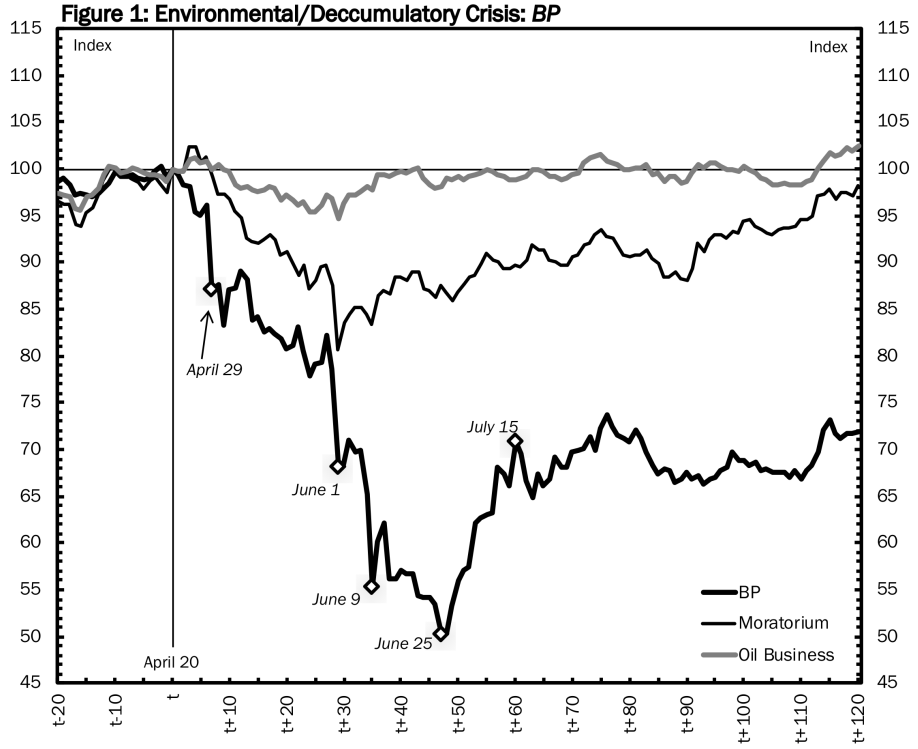
Importantly, the evaluations performed do not necessarily agree. Indeed, they are guaranteed not to. As will be seen below, although the capitalization of BP declined precipitously, the process was a fitful one, as sellers of shares were finding buyers. Both buyers and sellers are heavily equipped with economic technologies in the form of computing power, databases, algorithms, calculative techniques and much more (MacKenzie 2008). Among the buyers and sellers there are both widely shared and highly guarded technologies as they seek evaluative advantages that will translate into differential gain.

Fourcade (2011) notes that "the mere availability of certain economic technologies does not guarantee their performative effect" (1724). She said that these objects may lack institutional, political or cultural resonance. However, there is another factor in the murky performance of economic models within the calculative practices of capitalization. These technologies must be implemented by market participants pursuing a differential advantage. They will deploy myriad other techniques, often deemed intuition or genius. These differentiating practices are slavishly analyzed after the fact by the business press both when financial figures experience extended periods of beating the market, but also when those figures appear to lose their godlike market-beating ability.

Power

Power, as deployed in the CasP approach, does not explain constructed prices. Rather, conceiving of capital values as the market's evaluation of capitalists' power enables analytical insights in need of explanation. As such, CasP should be considered an analytical method rather than an explanatory framework. It highlights that which needs to be explained. So conceived, we bring into the analysis of business activities Foucault's insistence that the "mechanics of power" should be analyzed in "its specificity, its techniques and tactics" (Foucault 1980: 116). What the CasP framework adds to this perspective is recognition that the possessors of power are also evaluating their power. The assessment informs subsequent activities to maintain and expand that power. We can learn much about power by studying the mechanism by which the powerful assess their own power. It allows us to move beyond the common, widespread recognition of social asymmetry to identifying the topological shifts in that asymmetry. With the asymmetries identified, we can begin to answer the question: "where do they come from and what are they made out of?" (Latour 2005: 64). I argue that the decline of BP expressed the market's falling confidence in the obedience of the entities that bear on its profits, including the things that comprise its productive capacity.

Figure 1: Environmental/Deccumulatory Crisis: *BP*



Key: t = April 20, 2010, the day of the accident.
Source: Centre for Research in Security Prices. Series calculated by author. Note: Data points are indexed differential market capitalization (relative to S&P500; April 20, 2010=100).

The Quantities and Qualities of Disaster

Although placing a financial value on human life is widely considered crude and ethically objectionable, it is common (Zelizer 2010). For example, the fund established for the families of victims of 9/11 had three measures to establish payments: (1) financial loss; (2) set amounts for pain and suffering; (3) subtraction of life insurance paid. The first metric meant the lives of well-paid victims were valued more highly than those of poorly-paid victims. The high profile of the differential among payments provoked outrage, contravening moral sensibilities, but the act of valuing lives was accepted as a necessity of our thoroughly monetized society (Fourcade and Healy 2017). The extent of quantification facilitates capitalization.

Calculating Financial Quantities

Eleven men lost their lives in the Deepwater Horizon disaster.[1] Within moments of the disaster, calculations were being made, including expected liabilities for the lives of these men. In addition to this computation, calculations would have been made about the probable distribution of liability, since the rig was being operated by the oil services company Transocean on behalf of BP. At the time of the explosion none of the markets listing BP's shares—New York, London and Frankfurt—was open. Nonetheless, market participants would have been speculating on the possible costs to the company and the reaction of their fellow participants. These costs would reduce expected earnings and could increase the risk to earnings.

At this stage, it is worth noting that the actual decision making involved in the evaluation process of market participants is incredibly opaque. First, social scientific attention to these activities is relatively new (Cetina and Preda 2004; MacKenzie 2008; Muniesa 2008; Preda 2009; Lepinay 2011). Second, and more importantly, with profits on the line, market participants are reluctant to share their time or knowledge. I will not try to interpret the intentions of market participants but rather focus on actual market outcomes—the price fluctuation and trading volume of BP shares—and interpret those

[1] Jason Anderson, Aaron (Dale) Burkeen, Donald Clark, Stephen Curtis, Gordon Jones, Roy (Wyatt) Kemp, Karl Kleppinger, Keith Blair Manuel, Dewey Revette, Shane Roshto and Adam Weise.

outcomes from the analytical perspective of capital-as-power that the goal of all market participants is differential accumulation. Undoubtedly, interviews with market participants that bought and sold BP shares in the wake of the Deepwater Horizon disaster, as well as documents created by them at the time would illuminate how the objects of evaluation became financial values. Unfortunately, gathering such knowledge is beyond this article.

In the early stages of the disaster, the scope was not well understood. There had been a blowout, the drilling rig was on fire and the deaths were reported with uncertainty. The continued fury of the flames indicated the BoP had failed. However, no one could know that the rig's eventual sinking would result in an uncontrolled spill that would last months. Early uncertainty meant calculations had very little effect on the valuation of BP. Any single event can be difficult to discern in the movements of a large transnational corporation, since the translations are accounting for ongoing processes and events around the world. One disaster on one drilling rig—as horrific as it was—is a minor event relative to BP's global operations. The volume of trading of BP shares would not reach an unusual level until April 26, the Monday following the disaster, despite the fact that the vessel sank on April 22 and the leak was announced on April 24. In the first four days after the disaster, the value of BP shares declined 5 percent relative to the S&P 500 (Figure 1). As per the capital-as-power analytical standpoint on accumulation as a differential process of redistribution, all descriptions of capital values are relative to the S&P 500, which serves capitalists—and CasP analysis—as a benchmark for "capital in general." This perspective will be described in more detail below.

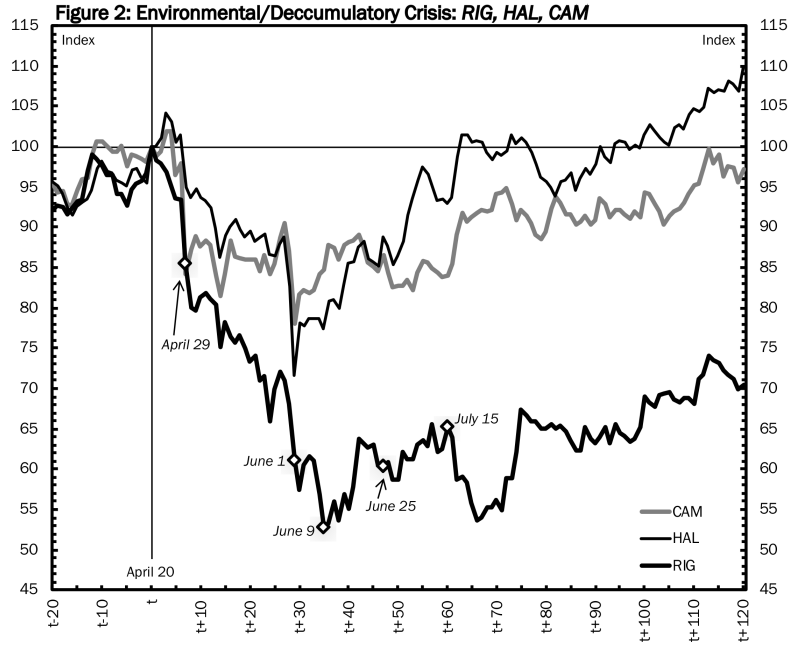
The initial increase in trading activity saw daily volumes double relative to average 2009 volumes. Of course, not everyone was bidding the value down, since each seller required a buyer. In fact, the divergent assessments of the event are evidenced by the large spread of daily high-low trading values relative to the closing price. By the end of the trading day on April 28, the value of BP had actually recovered 1 percent of its pre-disaster value. Those who expected the value of BP to recover outbid those who expected it to decline further. That changed on April 29. BP opened down 1.5 percent from its close the night before, and then lost another 6 percent. Although this decline is modest compared to the eventual loss BP's valuation would take, market activity increased markedly at 13 times the company's usual trading volumes. Just over a week after the explosion, and a week after the sinking of the Deepwater Horizon, the divergent calculations of market participants rendered extreme price volatility. Over the next week the company's market capitalization would fluctuate wildly between 7 and 22 percent below its pre-disaster value. During that week, BP's daily high-low spread averaged 6 percent of its closing

price, compared to a 3.6 percent spread for the S&P 500, expressing the efforts of market participants to calculate the future of an ongoing, indeterminate event.

This volatility moved around a precipitous, but not continuous, decline. On May 3, BP was 17 percent below its relative pre-disaster value, while the S&P 500 had changed by less than 1 percent. By June 1, BP had lost 32 percent of its relative value, shedding 13 percentage points over the prior weekend. Its most volatile day would be June 9, with trading volumes 37 times greater than usual, an 18 percent spread between the day's high and low, and the largest one-day decline in closing value of 15 percent. The bottom would come two weeks later, on June 25, when BP's market capitalization would be just over half its pre-disaster value. The trading volume and high-low spread for that day were greatly reduced from the high volatility two weeks earlier. There was a much tighter consensus among market participants about where the price of BP ought to go.

Over the next 20 days, the company would recover about 20 percent of its relative pre-disaster value, effectively returning to the value established on June 1.

Figure 2: Environmental/Deccumulatory Crisis: *RIG, HAL, CAM*



Key: t = April 20, 2010, the day of the accident.
Source: Centre for Research in Security Prices. Series calculated by author.
Note: Data points are indexed differential market capitalization (relative to S&P500; April 20, 2010=100).

BP's capitalization fluctuated around this relative value for over a year and a half. It would take until the end of August for both trading volumes and daily price spreads to return to relatively stable levels.

BP was not the only corporation whose capitalization was negatively affected by the disaster. Drilling platform operator Transocean (RIG), as well as Halliburton (HAL), which manufactured and poured cement used in the well, and Cameron International (CAM), the manufacturer of the Deepwater Horizon, all saw sharp relative declines in the first weeks of the disaster (Figure 2). RIG, in particular, saw substantial, lasting losses. Notably, the significant points for these three firms do not perfectly align with those of BP as different calculations had to be made to account for the effects of the unfolding event on the various companies.

Importantly for my account, other members of the oil and oil services industries also had relative declines, particularly those active in the Gulf. Figure 1 includes a series for the broader oil business and one narrowed down to companies in the oil industry significantly affected by the U.S. moratorium on deep-water exploration in the Gulf of Mexico, enacted on May 30, 2010[2]. After a brief increase relative to the S&P 500, both categories of companies saw a marked decline. Both saw their nadir on June 1, the first trading day after the U.S. Government announced the drilling moratorium. The non-BP oil business would return to its relative pre-disaster value by June 10. Market participants seemingly anticipated that any effects of the disaster on oil business profits would not extend to the entire field of companies. Unsurprisingly, companies affected by the moratorium would continue to feel the calculative effects of the disaster into October 2010, when the ban was lifted on deep-water drilling in the Gulf.

All of this quantitative movement emerged from hundreds of millions of trades involving an unknown number of owners, asset managers and traders mobilizing hundreds of billions of dollars. This quantitative flux took place alongside, and in contact with, the qualitative events of the unfolding disaster and BP's efforts along with the U.S. Government to stop the leak and respond to the spreading oil.

A Disaster's Qualities

The explosion on the Deepwater Horizon occurred when a "kick" in the Macondo well allowed hydrocarbons to enter the riser that

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2 "Oil Business" includes companies, other than BP, that satisfied the following conditions: (1) classified under SIC13: Oil & Gas Extraction, SIC291: Petroleum Refining, SIC3533: Oil & Gas Field Machinery & Equipment, SIC46: Pipelines, except Natural Gas, SIC517: Petroleum & Petroleum Products; (2) valued at US$1 billion or more on April 20, 2010; (3) had data for every day included in the chart. "Moratorium" is companies in "Oil Business" that saw a decline of 5 percent or more on June 1.

stretched between the drilling rig and the wellhead sitting on the floor of the Gulf.[3] Once the hydrocarbons reached the drilling rig, they spread to the engine room and were ignited. The fire was fed by the hydrocarbons that continued to flow from the riser. At this point, the automated dead man's mechanism on the BoP should have been triggered, clamping the well shut, stopping the flow of hydrocarbons and making it easier to extinguish the flames. However, for reasons that were unclear at that point—and long debated in the courts afterward—this did not happen. Once the Deepwater Horizon lost power, the dynamic positioning system that kept the rig in place above the wellhead stopped operating. With the vessel adrift, the riser stretched and buckled, likely initiating the leak. When the rig sank, the riser collapsed, resulting in a number of leaks along its bent, twisted length.

Over the next two and a half months, the well uncontrollably gushed millions of barrels of oil into the Gulf of Mexico. Initially, there was a great deal of uncertainty about the scale of the leak. Partially, this was because the hydrocarbons were flowing out of several fissures in the collapsed riser. The first estimated flow rate was 1,000 barrels a day (b/d). On April 29, this was increased to as much as 5,000 b/d. By June 19, the Flow Rate Technical Group, which was organized for the sole purpose of providing an estimate, suggested the oil was flowing at 35,000 to 60,000 b/d. The final estimate that would establish the total size of spill, was an average of 53,000 b/d, with an initial flow of 62,000 b/d that dropped off as the reservoir was depleted and its pressure lessened.

BP undertook several failed efforts to capture the oil and stop the leak. The first response was the use of a remote operated underwater vehicle to trigger the BoP. However, the BoP did not respond. Next, BP attempted to place a custom-made containment dome over the leak, with a spigot on top through which the hydrocarbons were to be diverted and captured. This failed when the hydrocarbons coming into contact with the dome crystallized, blocking the spigot and causing oil and gas to spill out the bottom. We might say that the hydrocarbons refused to obey the material order imposed by the containment dome. When that disobedience was publicly announced on May 10, BP's relative value fell by almost 5 percent. That decline undid most of a 7 percent increase in the days leading up to the lowering of the containment dome. Had the crystallization not occurred and the oil been successfully captured, BP's quantitative decline would almost

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[3] The information in the qualitative description of the disaster is taken from several reports on the event and its aftermath as well as news reports. These include BP's investigative report (BP 2010) and the President's Report from the U.S. National Commission on the BP Deepwater Horizon Oil Spill and Offshore Drilling (2011).

certainly have been much less. On that day, disobedient hydrocarbons cost BP over a quarter billion dollars.

The company also tried a "top kill," which involved pumping heavy drilling mud into the well in an effort to staunch the flow of oil and gas, after which cement would be pumped to seal the well. A last-ditch effort as part of the top kill was the "junk shot," which involved sending small pieces of rubber into the well to plug it up. These failed, in part because BP was reluctant to ramp up the pressure due to concerns about how obedient the surrounding rock could be. Although the engineers and other officials involved were confident the rock would obey an order translated into a certain magnitude of pressure, there was concern it might defy an order accompanied by higher pressures. If the rock formation cracked, then hydrocarbons could escape from multiple, widely distributed places on the seabed. Such leaks could not be contained, and it is possible BP's liability would have bankrupted the company entirely. The decision was made not to risk the indeterminate disobedience that could bring with it an accumulatory death sentence.

BP was able to seal the well on July 15 (Figure 1; fifth marker) with a custom-made cap that attached tightly to the BoP. While short-term closure efforts were being made, BP was also drilling two relief wells that intersected with the original well. Drilling mud and cement were pumped into these relief wells to permanently seal up the leaking well. On September 19, the well was declared "effectively dead."

As the leak was occurring, BP made efforts to collect some of the hydrocarbons spewing from the well. At most, the company was able to recover half of the flow. To deal with the oil on the surface of the Gulf, the company used chemical dispersants. Dispersant breaks up the oil, causing it to sink below the surface. Critics have speculated that this was not the best environmental course of action, but undertaken as a public relations effort, since it would eliminate the oil from view. Although there are no clear traces of how these efforts translated into the company's capitalization, market participants were watching. Success or failure would be assessed and translated into decisions to bid share prices up and down.

Prices and the evaluation of qualities

Although it is taken for granted that a relationship exists between quantitative movements of equity prices and qualitative events, the actualities of that relationship are unclear. The purpose of the trades that moved BP and other corporations' capitalization is largely beyond dispute: accumulation. However, the process of price construction is an opaque one, in part because on the one hand, mainstream political economic theory has conceived of stock markets as perhaps the ultimate example of the invisible hand, where supply and demand

converge to realize a fair and rational price. The reigning theory of stock market behavior is Eugene Fama's "efficient market hypothesis" (Fama 1970), which contends that securities prices emerging from new information are optimal.[4] Most critical political economy, on the other hand, has focused on the "real" economy, conceptualizing financial markets as a realm of fictional representations and dangerous speculative behavior. Financialization has emerged as a critical concept, in part, as a result of the long-standing productivist bias of critical political economy.

The sociology of finance emerged in recognition of the importance of finance as a social institution (Cetina and Preda 2004). A foundational theorist for the sociology of finance was Michel Callon, who also produced one of the original works of actor–network theory (Callon 1986). The Callon edited *The Laws of the Market* (1998b), along with *Do Economists Make Markets?* (MacKenzie et al. 2007), edited by Donald Mackenzie, Fabian Muniesa and Lucia Siu, are key texts in the "performativity" approach to the sociology of finance. Economists, equipped with the knowledges, technologies and materials of their trade, are centered in the analysis as actants informing, shaping and creating financial markets.

The sociology of finance research is concerned with the processes of price formation. This analysis has focused on the subjects, objects and relations that constitute markets as networks of connected localities with prices as their output. For example, Karin Knorr-Cetina and Urs Bruegger's (2002) analysis of the "global social system" in currency markets looked at patterns of behaviors among currency traders. The pair connected the behavior to the steady stream of currency values as the output of the financial processes. However, no attempt was made to assess what those values mean or what they do.

In a recent survey of the sociology of markets, Neil Fligstein and Ryan Calder (2015) identified institutions and objects that support market activity, including financial markets. They did not include the important feedback process by which the outputs of financial markets shape those very markets. Fligstein and Calder note that a critique of the performativity thesis in the sociology of finance is that "financial markets, once constructed, take on a logic of their own" (11). Capital-as-power argues that capital values, assessed in differential relation to a benchmark, are the mechanism of that logic.

As complex as stock markets are, they generate perhaps the simplest of all entities: a single number. For most stocks that number continually changes but remains a single number. When the markets close on any given day, a value has been assigned to every stock traded,

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[4] See Nitzan and Bichler (2009: 192–196) for more critical insight on the efficient market hypothesis.

which makes for a price on each corporation. Yet, each of those corporations is comprised of an incredible array of seemingly incommensurable entities. How does one price BP when it consists of a head office in London, staffed by technical experts, accounting clerks, human resources personnel, office administrators, and executives? To that are conjoined hundreds of wells and service stations around the world. The company subcontracts much of the actual drilling work and leases its name to franchisees operating service stations. It has proven oil reserves, refinery capacity and marketing campaigns. BP engages in R&D that generates technologies and alters the practices of oil exploration, extraction and refinery. BP also lobbies governments that pass laws concerning resource extraction, environmental protection and worker safety that will affect the profitability of the company's operations. Despite the globe-spanning array of entities comprising BP, just a small swath of which are described here, at the end of each day, BP bears a single value.

The magnitude of the Deepwater Horizon disaster actually allows us to connect specific events to drastic price movements of one of the largest corporations in the world. We know that speculation about the size of the oil spill would have been of great interest to market participations, since it would be used in the calculation of a fine to be levied on BP. If government spokespeople had said that the spill was much smaller than initially estimated, the price of BP would have risen. That rise would not just happen as a necessary, rational outcome. Rather, market participants would bid the price up. When, instead, the flow of the leak was continually ratcheted up, the value of BP continued to fall, pushed down by the recalculations of market participants.

When the "top kill" failed on Saturday, May 29, and the Gulf drilling moratorium was announced on May 30, BP's share opened on Monday, June 1 down 13 percent from their Friday close. Whatever else might have been happening in the sphere of BP's operations was dwarfed by the failure of this high-profile effort and the U.S. Government's actions. Traders mobilized shares at 19 times their usual volume, although price movements were only at three times the usual high-low spread. Yet, how these calculations were actually made is unknown. We can connect the capping of the well on July 15 with 12 times the usual trading volume, four times the usual high-low spread and the return of almost 5 percent of BP's pre-disaster value. However, how market participants arrived at this value is unknown. What is needed is a retheorization of capital and accumulation that accounts for the pricing process itself. My contention is that pricing accounts for both things and humans as consequential mediators.

Retheorizing Capital and Accumulation

The accumulation of capital is widely understood to mean an increase in productive capacity. These gains are measured in nominal financial quantities which, according to both Marxist and neoclassical political economy, constitute a distorted representation of the real, underlying value of capital. Problems with this productivist conception of capital and accumulation, both analytical and theoretical, have long been identified and they were once the subject of heated theoretical debates (see Nitzan and Bichler 2009: 67–124 for a summary of these criticisms).[5] Unfortunately, the response to the problems has been eschewal by political economists of critical engagement with the concepts, despite their key role in all political economic frameworks.

The fundamental theoretical criticism of the standard conception of capital is an ontological one. It requires that "real" capital, i.e. productive capacity, has underlying quanta that make commensurable qualitative diversity. In other words, a vineyard, a tannery, a missile factory, a wind turbine, and all the rest of the heterogeneous material complexity of our systems of production have something within them that can be agglomerated in the process of accumulation. This is true of both Marxist and mainstream theories of capital. We can think of the standard theoretical conception as a "dual quantity" approach: observable quantities represent unobservable quantities, bypassing qualities. Much analytical energy has gone into converting nominal quantities into these postulated real quantities (see for example Shaikh and Tonak 1994). Now, however, that laudable project has been largely abandoned and most critical political economists simply use the problematic national accounting statistical calculations of "real" quantities, exemplified by real GDP (Stiglitz et al. 2009).

The CasP theory of value revisits the concepts of capital and accumulation and reconceptualizes them without the real–nominal dichotomy. Rather, observable financial quantities, the ones that capitalists construct and engage with every day, and which have earned a prominent place in western media, both in the daily coverage of changes in stock market indices, and reporting on notable financial events, are treated as consequential in their own right. In other words, financial quantities are *irreducible*. The calculations are added into the world. They are rendered objects through a process of objectification and have affect. Although CasP gives these values a representative function, that representation is not merely reflective of an objective

[5] The Cambridge capital controversy, involving economists at MIT facing off against economists at Cambridge University, was the most high-profile debate about the nature of capital. Among the combatants were Paul Samuelson, who defended the neoclassical conception, and Joan Robinson, who poked substantial holes in the concept. See Cohen and Harcourt (2003); Hodgson (1997) for a history of the controversy.

reality. Rather, the representation is *poetic* in the sense given by Elie Ayache (2010): the buying and selling of traders *brings forth* a price. Those prices become actants added to the world that have consequences overlooked by productivist political economy.

Within CasP, the capitalization formula is the ultimate translational mechanism of capital. The basic calculation of capitalization is:

$$k = \frac{\pi_e}{\beta \cdot r}$$

where k is the present value of capital, π_e is expected profits, β is a risk coefficient, r is the normal rate of return. The calculated value discounts expected profits by the uncertainty of those profits, and the expected returns from a safe asset, such as U.S. T-bills. This value can be calculated for a machine, a factory or an entire corporation. Capitalization is used by banks when they offer credit, by hedge funds when they identify a takeover target, by manufacturers when deciding whether to repair or replace a piece of machinery. The calculative mechanism for publicly traded corporations is the buying and selling of shares. Regardless of the complexity of an asset, whether a painting or an entire corporation, capitalization makes it possible to assign a single value.

One of the most important insights of CasP is that the value of capital is forward looking. Marx conceptualized the value of capital as the "dead labour" included within it. Therefore, within the labor theory of value, the price of a piece of machinery represents the previous labor expended in its manufacture. Capitalization, however, is calculated using the expected future stream of earnings. It is the future, not the past that is expressed in the value of capital. Or, rather, it is the capitalists' vision of the future, translated into the quantities of finance. This means that the capitalist vision of the world can be found, in part, by understanding the calculative process of value construction.

The qualities being accounted for in the calculations of value are much broader and more diverse than just the labor involved, although labor is undeniably important. Anything and everything that market participants understand to affect future profits will be translated by the calculation of capital values. Government policies, consumer trends, resource access, protest movements, community norms, product hype and much more will be taken into account—literally. This fact is one that "everyone knows." However, it is an uneasy reality at odds with standard political economy, not least because it obliterates the divisions between the economy and the other segments of the social order. Production cannot be isolated as a privileged domain

functioning free of these relationships. Both production and pricing are affected by non-economic processes since engineers and traders alike take account of these relationships.

As stated above, financial values are the way capitalists simplify the qualitatively complex world into commensurable terms. However, stand-alone financial values have no meaning in and of themselves. While early political economists tried to discern the meaning of financial quantities according to the perceived underlying real quantities, Nitzan and Bichler emphasize the relational meaning between financial quantities. Namely, accumulation is not meaningful in absolute terms by reducing nominal quantities to real ones, but rather in differential terms. Capitalists care less about an absolute gain than "beating the average."

If a company's share value grows by 10 percent, while its sectoral competitors grow by 15 percent that is a differential decline. Conversely, if the company endures a 5 percent drop in value, but its competitors drop by 7 percent, they achieve a differential gain. Capitalists assess their successes and failures not against any absolute register, but against continually changing benchmarks that average across segments and subsegments of the corporate world. This insight into the differential nature of accumulation should be uncontroversial, as benchmark comparison is commonplace in popular business writings and familiar to most people who engage with political economic issues.

Nitzan and Bichler's (2009) central theoretical claim is that the differential measure of capitalization is an expression of the relative power of capitalists, and differential accumulation charts the redistribution of that power. Again, this is the capitalists' own understanding of the power of themselves and their brethren. Capitalization occurs via market participants' translation of the world as it bears on what Nitzan and Bichler refer to as the "elementary particles" of capitalization: expected profits, hype, risk and the normal rate of return. Differential accumulation occurs when the assessment favors one asset over another. Rising oil prices may mean greater profits for Exxon, but higher transportation costs for Wal-Mart. Increased royalties on copper in Chile would be bad for transnational mining company Freeport-McMoRan, but of little consequence to Coca-Cola. Unrest in Cameroon might mean higher cocoa costs for the Hershey Company, but new defense contracts for BAE Systems.

As noted above, Nitzan and Bichler have defined power as "confidence in obedience." Resonant with a Machiavellian conception of power, capitalist power exists as potential rather than in action. A government is powerful when its populace is pliant, not when it must deploy the army to quell unrest. A corporation is powerful when all that bears on its earnings unfolds predictably. That means the power of

capitalists exists in their control over diverse parts of the broad social order, including but not limited to, labor. Accumulation occurs when they can either increase the confidence of market participants that those parts will behave according to expectations, or when more of the social order is rendered obedient. While the word obedience connotes human–human relations, insights from ANT and STS mean things have to be included in our understanding of obedience, corporate power and accumulation.

Things and the Growth of Capitalized Entities

Although machines have played an important role in political economic theory since Adam Smith, they have been rendered by the theorists into what Bruno Latour (2005) calls "intermediaries". Intermediaries "transmit meaning or force without transformation" (39). According to Marxist and neoclassical value theory, machines provide a relay for the flow of value from labor to capitalists and/or consumers, but they are given no difference-making capacity of their own. This is a feature of the dual quantity perspective of both Marxist and mainstream value theory: visible quantities represent hidden quantities. Within these theories, the passage of "real" quanta through the qualitative world to become nominal quanta distorts them but leaves them fundamentally unchanged. While theorists acknowledge that machines perform a qualitative transformation on the materials that pass through them, they do not allow for machines to contribute quantitative meaning. According to the labor theory of value, machines serve as a repository for accumulated surplus-value that originates in labor, but are inert, hence their status as "dead labour." For the hedonistic conception of value of neoclassical theory, the machines are simply the means to satisfy the quantified desire of *homo oeconomicus*: individual utility-maximization.

Trevor Pinch (2008) observes, "the Marxist analysis neglects the enabling aspects of materiality and technology" (463). The capacities of equipped labor cannot be reduced to either the labor or the equipment. Instead, they emerge from the hybrid. Latour and others have advocated for things as the "missing masses" of the social sciences (Latour 2008). Rather than intermediaries, things must be considered "mediators," which "transform, translate, distort, and modify the meaning or the elements they are supposed to carry" (2005: 39). Mediators have affect.

Things are essential for our complex social orders. Things make it possible to stabilize distant human relations, which cannot be achieved when bodies constitute our only materials (Strum and Latour 1987). That stabilization is essential for the expansion that has been an important feature of human institutions. In one of the original works

of actor–network theory, John Law (1986) called attention to the role of things in long-distance navigation and empire-making. European navigational knowledge and colonial mindset meant nothing without objects to consolidate, standardize and spread that knowledge and actualize colonial practices. The possibilities of empire only existed because of human-thing assemblages that can transcend the limits of pure human-human sociality. Law identified three classes of "emissaries" necessary to the task of long-distance control: documents, devices and drilled people. They made it possible for those at the center to monitor and regulate activities at the periphery. This role of things in stabilization makes apparent their indispensable role in accumulation.

Alex Preda (1999) describes a conjunction between Foucault and Latour, which links the agglomeration of objects to power, arguing that "the larger the network with its objects, the stronger its force will be, and hence its authority, legitimacy, and power" (358). However, the linear equation of power with size overlooks the fact that expansion can also weaken entities, as many mergers and failed product releases have demonstrated. Indeed, one could point to the Deepwater Horizon disaster as evidence of just such a weakness. Had BP been smaller, perhaps it would not have subcontracted the drilling operation. Perhaps this particular well would have been better known and understood by the executives at the head of the company. Perhaps those monitoring the operation would have been the owners whose financial stake was directly tied to the well. Instead, absentee owners were left to respond after the fact, translating the disaster as a revelation of weakness. That is precisely the CasP interpretation of BP losing half of its value in the wake of the disaster: the company had become weaker.

The relationship between adding things and gaining power is complicated, which is one of the reasons nominal financial values cannot be reduced to "real" material quantities. Knowing that a corporation is adding things to itself is not enough to know its value will increase. Instead, additions are assessed within multiple affective contexts, such as current consumer trends, the pace of technological advance, and an innovation's degree of discontinuity. The corporations with the most employees and the most machines are not the most highly valued. Apple, for example, has demonstrated that a smaller customer base, but highly loyal to a restricted stable of products is of higher value than a more diffused product line. From the CasP conception, only expansion that translates into greater expected earnings or reduced risk, and thereby increases capitalized value, is interpreted as an increase in power.

Equipment, Expertise and Experience

Objects can be considered more obedient when the relations they mediate become more stable. This can occur through greater knowledge that is distributed between the object and its operator (Hutchins 1995). The knowledge of the drilling workers was comprised of equipment, expertise and experience. All three are required to identify a "kick"—the unwanted intrusion of hydrocarbons into the wellbore. With the kick identified, an appropriate response can be formulated. Kicks are not uncommon events and workers quell the vast majority. Identifying the kick depends on reliable equipment that translates signals from the well, expertise about oil formations and drilling operations, and an experienced operator who develops intuitions combining the equipment and expertise. The operator can then trigger responsive actions that are relayed through a series of worker-object assemblages to quell the kick. Past experiences become standardized knowledge that gets passed on through textbooks and manuals. An expert operator is one who embodies the industry knowledge, one who utilizes the signals from monitoring equipment to recognize that a kick is occurring and enacts established protocols.

Preda draws on Latour's network conception of power and connects it to Foucault's insights on the relationship between power and knowledge. As Foucault (1980) argued, power can be increased by augmenting and improving knowledge of the entities under one's control, including things. Preda argues that things are essential participants in the development of knowledge and the performance of control. He remarks that while explanations for the social order should include artifacts, they should also consider the "strategies and resources through which human actors manage to account for a social order in which they take themselves as different with respect to the artifacts to which they are related" (Preda 1999: 361). In other words, not only are things an essential component of confidence in obedience, so too is their exclusion from our understanding of the social order.

Things play an important role in the transfer of power that is expressed in accumulation. An alternative to equipped, expert, experienced operators are mechanisms devised to internalize a task, incorporating the industry's knowledge and the operator's skill into an automated response. Skilled operators, when they perform according to expectations, are—from the perspective of a company's owners—intermediaries. Unfortunately for the owners, workers have a history and a habit of disobedience, becoming indeterminate, unpredictable mediators who defy the calculative expectations of market participants. Workers pose a constant threat of work withdrawal and more. While collective bargaining agreements and other negotiating mechanisms have made strikes more predictable and financially manageable, worker agency remains much more uncertain than that of

things. Hence, the history of technological development in the twentieth century is marked by automation as skill internalization, substituting relatively obedient machines for relatively disobedient workers (Noble 1984; Braverman 1998).

The relative obedience of machines contributes to making them calculable. As Callon (1998a) writes, "if calculations are to be performed and completed, the agents and goods involved in these calculations must be disentangled and framed" (16). The operating parameters of machines are well known. They break down at predictable intervals that typically occur as a function of the pace of operation. This means optimal levels of output can be calculated, making profit levels more certain. This can then be translated in the capitalization formula into a lower risk factor. Conversely, things can disobey in an unpredictable, contingent manner. When that occurs, an operator's agency is required; they must be mediators. In such an event, the worker must transcend their skills, combining knowledge and equipment in a new way to create an emergent procedure. Things provide the means to predictable, stable functioning. But humans are needed to restabilize a system that deviates in an unpredictable way. That said, restabilization will also require things with unwavering stability that cannot be matched by even the most heroic of humans.

It was the Macondo well's disobedience that triggered the enormous loss of BP's power. Human ingenuity enlisted things to perform in unprecedented ways to finally stop the leak. As seen in Figure 1, reports of the impending capping drove up the capitalization of BP. Market participants assessed greater power via the human-object assemblage responsible for stopping the leak. All the ingenuity in the world would have been useless without the things. The stabilization of the company's new relative valuation required numerous things whose behavior was calculable for the fact of being stable and predictable. Those calculations will black box the vast majority of BP's operations, with both humans and things inside, operating together in ways that are irreducible, but measurable (Latour 1993a). Typically, those boxes will remain closed as predictable, obedient entities unless there is an event that defies the calculations, as occurred with the Deepwater Horizon disaster.

Going Deeper through the Blowout Preventer

The title of chapter 2 of the National Commission's Report to the President (National Commission on the BP Deepwater Horizon Oil Spill and Offshore Drilling 2011) comes from a quote by an oil industry consultant uttered in 1970: "Each oil well has its own personality" (28). Knowledge of past wells can only partly inform engagement with present wells. Each well can be considered a subject,

according to the simple definition offered by Peter Sloterdijk (2013): unpredictability (58). Oil-bearing formations have to be studied to get a sense of what the well might be like. As the well is drilled, it is constantly monitored to understand its unique characteristics. The deeper is the well, the more unpredictable it will be. The task of drilling operations is to tame these unruly subjects. From the perspective of ownership, these operations are largely black boxed. Yet, within the black box, the drilling grapples with the subjectivity to increase confidence in the obedience of the well.

One of the most important pieces of equipment for taming a well is the BoP. The BoP serves several functions of well control. However, the most vital function is to kill a well in the event of an emergency, such as an uncontrollable kick. The mechanism of last resort is the morbidly named dead man's switch, which activates rams to seal off the well if the BoP loses contact with the surface. During the unfolding Deepwater Horizon disaster, the dead man mechanism failed to perform as expected. The reasons continue to be subject to dispute.

The BoP was invented in 1922 and made commercially available in 1924. Before the use of the BoP, wells were allowed to blow out until the subsurface pressure was reduced enough to allow capping. This led to the iconic scenes of thick, black oil gushing forcefully out the top of a drilling rig. The practice was dangerous, environmentally damaging and financially wasteful. The BoP made it possible to control the pressure differential and became a universal mechanism of oil exploration and extraction. Although the BoP continues to evolve, growing capable of handling higher and higher well pressures, its vital role is unchanged. As such, it is a stable—black boxed—part of the capitalization of firms involved in the oil industry.

Thomas Hughes (1993) identifies technological systems as a combination of technical, political and economic factors. It is the total combination that gets priced by capitalization. When something goes wrong and recalculations need to be made, the combination gets opened and parts identified for more precise recalculation. Those parts have to be situated within their technical trajectories, but also political and economic trajectories in order to perform such recalculations. Within the CasP framework, these examinations and resultant recalculations constitute a reassessment of power. The volatility of the price of BP during the disaster evidences the confusion about the make-up of the company's power. Some of the reassessment was an examination of the BoP, and its position within the broader assemblage of equipment, experience and expertise.

Was the failure of the BoP on the Macondo well because of material shortcomings? If so, were these material shortcomings because it was poorly formulated by its producer or because it was mishandled by its user? Was such mishandling due to cost cutting measures by the well owner and/or drill operator, or was it due to the faulty practices of

well workers? Might government regulations regarding BoP operation be revisited and changed in response? Might BoP installation and monitoring practices be changed? Might the structure of BoPs be changed? Each question opens up further questions, all of which have financial, and therefore accumulatory consequences. As well, each question has material indeterminacy built in. How might the BoP respond to these changes? What will be required to "tame" it and ensure the necessary compliance that will make its use predictable and therefore calculable? What will be the future political-economic-technological trajectory of BoPs? What will be the financial consequences? How will this impact the control of BP and other oil and oil services companies?

Early suspicions, confirmed by subsequent investigation, held that the problem of the Deepwater Horizon's BoP was unique rather than endemic. This suspicion, along with the expectation that the disaster would not result in widespread, costly changes in deep-water oil exploration practices, is likely the reason the differential decline of other Gulf exploring oil companies was relatively short-lived. By the end of 2010, these companies would be beating the S&P 500.

As part of the Deepwater Horizon drilling assemblage, the operation of the BoP—or one channel of its operation—took for granted an experienced, equipped expert who could recognize failures within the drilling assemblage and trigger the various rams capable of closing off the well. On the one hand, should everything go as planned, then the worker's actions will be black boxed as unfolding in accordance with established and expected routines. Owners can have confidence in the obedience of the entire assemblage. On the other hand, in expectation that the workers' actions may be disrupted, there are redundancies built into the system that are supposed to automatically trigger the BoP. However, these systems assume some prior work by others within the assemblage that are translated into material mechanisms, such as the dual battery systems that are supposed to drive the blind shear rams in the event that communication with the rig is lost. In the case of the Deepwater Horizon disaster, these batteries had not been properly installed or maintained.

There are multiple lines along which failures occur, including the regulatory line. There was no oversight to ensure that these batteries, and the systems they were to power, were functioning properly. Another line passes through the workers who were blamed for the error, but we could follow the line further and possibly find problems with their training or with training manuals. Was there a limit to their expertise that could be addressed? Perhaps the disaster exposed a gap in the experience of the crew, despite their collective years of operating drilling rigs. Might another crew have recognized the problem before it

became a disaster? The investigation of the disaster constituted a long line of opening black boxes and the quantifications of some market participants would have followed along trying to translate the findings into capitalized values.

Conclusion

The neglect of objects from our accounts of social asymmetries is itself a mechanism of power. The more we overlook the irreducible role of equipment in the emergence of tactics used to order society the easier it is to develop and deploy such mechanisms of control. The dominant theories of value leave no place for things as mediators. According to these theories, objects are either intermediaries for the satisfaction of desire or stores of dead labor. I argue that Nitzan and Bichler's (2009) power theory of value, which conceptualizes differential capitalization as an expression of power, makes it possible to understand things as dynamic participants in the constant evolution of the qualities of capitalism. The construction of values is an ongoing recalculative assessment that closes and opens black boxes, inside of which are assemblages of worker-objects quantified through a variety of measures, but passing into the quantities of finance, culminating in capitalization. Capitalization is an ongoing epistemological reduction while accumulation is vitally connected to ontological irreducibility.

The Deepwater Horizon disaster unfolded as a complex, indeterminate event that market participants translated into uncertain valuations of BP and other capitalized entities. The capital value assigned to the company fluctuated wildly as it trended downward. The repricing occurred as black boxes were opened. First, market participants had to make qualitative sense of the contents, including such objects as BoPs, nitrogen-rich cement, float-shoes, blind-shear rams and hydrocarbons. Then, all this qualitative diversity had to be translated into the commensurable units of finance.

Financial markets have a single-minded purpose: evaluation. That evaluation is based on a remarkably simple criterion: discounted expected profits. However, the actual process of evaluation, one that tries to bring the future into the present, is incredibly complex. It draws information into and along what Latour and Lepinay (2010) call "metrological chains." Out the other end, via the process of buying and selling shares, a single number emerges. That number gets folded back into the calculations, which are without end. The incredible complexity makes it difficult to identify (1) what is being accounted for; (2) how anything is being evaluated; or (3) when new entities and processes get counted. Much of what counts is black boxed because market participants are confident in the obedience of what is inside. However, moments of crisis, such as the Deepwater Horizon disaster, can offer a window into the struggle of evaluation, as black boxes are thrown open and entities must be re-evaluated. The CasP method

offers a means of identifying the market's efforts to make sense of the world remade by the crisis.

Sociologists of finance are concerned with price formation, while the meaning and affect of prices have remained outside their analyses. In the analysis above, I noted the lack of information about the process by which social qualities are translated into the quantities of finance. This suggests the need for research that moves among these three domains: values, evaluation and evaluated.

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Temporality in Academic Evaluation: 'Trajectoral Thinking' in the Assessment of Biomedical Researchers

Björn Hammarfelt, Alexander D. Rushforth and Sarah de Rijcke

Abstract
This paper builds on emerging concerns with how temporality and spatiality unfold in, and order, academic evaluation practices. We unpack how the notion of 'trajectory' – a simultaneously prospective and retrospective narrative device permeating contemporary academic evaluation discourses – is mobilized within a particular evaluation site. Materials for our study are drawn from reports commissioned by Swedish universities when hiring for new professors. These texts are authored by external referees who rank and compare candidates, in this case for associate and full professorship positions in biomedicine. By using the theoretical perspective of 'narrative infrastructures' we explore how the referee reports mobilize 'trajectories' to weave together disparate bits of evidence extracted from the bylines of biomedical researchers' CVs: publication numbers, impact factors, authorship positions and 'earning power'. Our analysis finds certain resemblances across reports of what constitutes an ideal candidate's career trajectory, but none of these are completely identical. We consider how 'the trajectory' is evoked as a singularity within this genre of writing, thereby bestowing retrospectively a sense of coherence and purpose on the past performance and prospective development of careers. We discuss the implications of our findings in terms of how 'trajectorism' shapes evaluation in academic biomedicine and possibly beyond, and propose suggestions for how this dominant narrative might be challenged.

Keywords: biomedicine; peer review; temporality; spatiality; trajectorism; valuation

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Introduction

Central to the lively emerging interdisciplinary field of valuation studies is *time*. Clearly, many instances of a 'moment of valuation' (Antal et al. 2015) involve anticipating what kind of future could and should be brought into being. When we make judgements on what products to buy, which educational degree to pursue, or where to invest our money, we are betting on how various decisions might affect our – or someone else's – future. Hence, imagined futures often form the background for valuation, and projections of future value or performance are one of the main outcomes. Estimates and predictions are thus central to the 'systematic organised guess work' of evaluation (Mennicken and Sjögren 2015: 4). This future-orientation is very present in contemporary academia and its ever-expanding audit cultures (Strathern 2000). Similar, future oriented evaluation is visible in many other evaluative contexts; the stock-brokers prediction of the market, the football scouts work in picking talents, and the art curator trying to buy big names early.

Despite this, how temporality and academic evaluation practices relate to one another has only just recently started receiving attention from scholars in STS and related fields (Vostal 2016; Ylijoki 2016; Felt 2017). This paper builds on one of the themes within this broader discussion, namely how temporal and spatial dimensions become intertwined with specific infrastructures for evaluating academics. Focusing on extensive analysis of the external referee reports used to form and legitimatize hiring decisions in Swedish academia, we unpack how 'career trajectories' are constructed in order to evaluate candidates for academic positions based on their CVs.

According to Appadurai (2013: 223f), a key characteristic of western civilization is to understand the world – and our own lives as individuals within it – as a trajectory. Trajectorism postulates that we are – or should be – on a journey from here to there, from the past to the future. We want to be able to describe the world as a cumulative journey into the future, a journey that we can analyse, calculate and explain. It also means that we, and nobody else, should be in control of this journey into the future. In applying the concept of 'trajectorism', Felt (2017) suggests that the measures and indicators of papers, funds and other outputs is constitutive of trajectoral thinking in academia: '…by lining up indicators over time, stability, improvement or decline might be rendered visible'. (Felt 2017: 59).

A trajectory, in physical terms, is defined by velocity and position. Thus, 'trajectorism' encompasses more than temporal processes, as it includes "a problematic ideology of spatial expansion" (Appaduari 2013: 225). Although the kind of expansion – in terms of European imperialism – which Appadurai discusses, takes us far from the topic of our study, we still find it valuable to consider this additional aspect of 'trajectorism'. In the study of evaluation reports of biomedical CVs

such features might be expressed in terms of where a researcher has been, with whom they have worked; where they went intellectually, and whether or not they were mainly in the clinic or in the lab. In analysing the trajectories of researchers we therefore emphasize how the temporal and the spatial interact. For example, where someone has moved in his or her career by a certain point in time can be indicative of a particular career trajectory.

An important function of the trajectory as a narrative device is to reduce complexity and ambivalence. In a finite time period external reviewers must re-order dozens of CVs packed full with lines of information into expert accounts which sort 'the best from the rest'. In our materials, various bits of information are extracted from the bylines of candidate CVs and rearranged as 'evidence' of particular trajectories candidates' academic careers have taken (which in turn represent a proxy for likely future performance).

Our approach here is not so much to study how candidates for professorships in biomedicine are valued, or what kind of judgement, indicators or metrics are used for assessing value. Rather, we study how time becomes folded into narrative practices of valuing a career in biomedicine. We ask how valuation is performed and enacted in these documents, how valuation is narrated, and the role trajectoral thinking plays in these documents. In short we focus on the work that these documents do: "the production—in practice—of what comes to count as valuable, desirable, or otherwise worth caring for" (Dussauge et al. 2015: 10).

Our focus on academic biomedicine is motivated by it being a large and resourceful field in which debates about evaluation, specifically (mis)uses of metrics, have been prevalent in recent years (Alberts et al. 2014; Benedictus et al. 2016). The increasing influence that performance measures and indicators have on research has been documented in a range of studies (Weingart 2005; Burrows 2012; de Rijcke et al. 2016), and more specifically the epistemic consequences of indicator uses in the field of biomedicine has been highlighted (Rushforth and de Rijcke 2015; Müller and de Rijcke 2017; Rushforth et al. 2019). As might be expected, much of the information extracted from these biomedical CVs took the form of relatively crude indicators, such as the h-index and the journal impact factor, as well as even more simple outputs in the form of publications and funding.

Before we delve further into how trajectorism is an important narrative feature in these evaluation documents, a description of the role of 'external referee reports' and an overview of the structure of these documents is needed. Hence, we first provide a short introduction to the genre of the referee report and how it relates to other types of academic evaluation. In the background section we also briefly describe the process of recruitment in Swedish academia.

'Narrative infrastructures' and their role in crafting trajectories is introduced in subsequent parts of the article, alongside the materials and methods used. Thereafter the findings of the study are outlined in four sub-sections focusing on different ingredients in the narrative infrastructure, while simultaneously trying to capture the predominant 'master stories' which emerge in these documents. Finally, the discussion expands on how temporal notions of efficiency and expectations of ever increasing production can be understood through the concept of 'trajectorism'.

Academic valuation and the genre of the referee report

Researchers act as evaluators in many roles, and a considerable degree of their work time is devoted to this task. Langfeldt and Kyvik (2011) identify several evaluative tasks that are regularly performed by researchers, from journal peer review to institutional evaluation. And these are only the formal roles. If we consider valuation more generally this list can be extended almost infinitely, with supervision and seminar discussions as typical activities in which valuation plays a central part. Moreover, we might view these activities as folded into each other, where for example peer review of journal articles is a pre-requisite for later evaluation of the research quality of an institution and so forth (Helgesson 2016). Hence, researchers are used to being assessed, and to evaluate others. How judgements are made and justified is dependent on several factors: the evaluative task at hand, discipline specific norms, gender and seniority of the evaluator, and different epistemological styles (Lamont 2009).

The genre of referee reports for academic positions has much in common with other types of 'remote peer review' (Bozemann 1993), such as the peer reviewing of projects and journal articles. In both these cases external and independent experts are brought in to make impartial statements on the quality of study, or the innovativeness and feasibility of a project. A main difference in the assessments procedure studied here is that the valuation of candidates for academic positions operates within a longer temporal dimension, as it stretches to include both past achievements and imagined future performances (Nilsson 2009; Hammarfelt 2017). It is indeed true that judgements made on grant proposals usually include the 'track record' of the applicant and estimates on how fruitful a particular research idea might be, but these are additional concerns: the main focus usually is on the project, the ideas behind it and its design. Moreover, the valuation of candidates by necessity also involves biographical elements (age, family and gender), which usually are of less concern, or at least less openly so, when journal articles or grant proposals are evaluated. The broad temporal scope, as well as the focus on the individual, thus distinguishes the evaluation of candidates from other types of peer review. In fact, in

several aspects, these texts resemble other genres, like the scientific bibliography (Söderqvist 2011) or academic obituaries (Hamann 2016), in which careers are summarized.

Obituaries are a particularly interesting comparison as these documents feature distinct evaluative features. Hamann (2016) shows how two main strategies for positioning are used in these texts. First, academics are situated based on their position in the landscape of academic knowledge; the community and discipline they belong to, and their standing in this field. 'Symbolic ties' to other prominent members of this community serve as important markers in this regard. The second strategy of positioning involves connections to institutions, and may involve positions at universities, visiting fellowships and editorships, to mention just a few. While the narrative structure of obituaries shares features with referee reports, it is the overall purpose of ordering "the distinct, sometimes, accidental and incoherent, stations and achievement of an academic life course into a linear trajectory" that marks the affinity between these two genres (Hamann 2016:1). But whilst the obituary is largely backward-looking and celebratory, evaluating candidates is a practice with a firm eye on the future. For example, a candidate might be described as having a positive trend (in terms of publications) which signals that a bright future is ahead, while diminishing output is interpreted as signs of deceleration and disorientation.

A similar reading of academic CVs is made by Latour and Woolgar (1986), when they describe scientists' movements between positions as 'trajectories'. The building of a positive career trajectory is in their analysis dependent on the accumulation and investment of 'credit', which allows researchers to move into new positions. Notably, 'position' here suggests academic rank, as well as 'situatedness' in the field of research, and geographical location. The complexity of studying position is, according to Latour and Woolgar (1986: 211), due to their constant (re)negotiations at the intersection of 'individual strategy' and 'field configuration'. This complexity is also evident in our study where a researcher's location in a broader landscape is an important dimension when evaluating their individual performance. 'Trajectory', which for Latour and Woolgar (1986: 214) is mainly is used to analyse the accumulation of credit, is in our approach a broader notion, which relates to the overarching ideology of 'trajectorism'. Here, trajectoral thinking is viewed as a way of making sense of the world which is manifested in many contexts, including that of academic evaluation. Our approach broadens out to include spatial, institutional, epistemic and interpretative dimensions (Kaltenbrunner and de Rijcke, in press).

Recruitment procedures in Swedish academia

The use of external referees has a long tradition in Sweden, where it originated in the late nineteenth century. Originally the system was introduced to ensure the independence of universities and professors by safeguarding the impartial judgement of merits when recruiting academic staff. The importance of referee reports has lessened somewhat and yet the system plays an important role, both in practice and as a symbol for academic autonomy (Nilsson 2009).

The procedure for recruitment differs considerably between national academic systems (Musselin 2009), and the Swedish system has two distinctive features which makes it particularly apt for studies of this kind. First, the recruitment procedures are largely similar across institutions. Second, government institutions in Sweden should, according to the 'principle of openness' (´offentlighetsprincipen´) make all documentation of recruitment decisions available to the public. Yet, while our material originates from a Swedish context we expect that the judgements made also reflect a broader, cross-national and disciplinary dependent culture of evaluating academic candidates. This assumption is further strengthened by the fact that many of the appointed referees are based outside of Sweden.

The customary routine for recruiting professors at Swedish universities can be outlined in a few steps: first a decision to begin a recruitment process is made and a description of the position and the qualifications needed are advertised. Then applications from candidates, containing a CV, a selection of publications in full text (usually 5–10 papers or books) as well as a description of pedagogical merits, are welcomed. In the next step referees are selected among colleagues at other universities in Sweden or abroad (to avoid bias). The referees should be experts, usually professors, in the research field. The referees are then assigned the task of writing assessments – which we hereafter refer to as *referee reports* – in which the qualifications of each candidate are evaluated. These referee reports are written independently and remotely, based on materials provided by the applicants. The referee reports, together with possible trial lectures and interviews with top candidates, are the basis on which a definite ranking of candidates is made. Finally, the department head, or the dean, takes the formal decision to employ specific candidate(s). This process is to a considerable degree formalized, and candidates can appeal a decision in cases where rules have not been followed. The degree of openness in this process – all formal documentation is publicly available – is quite unique to Sweden.

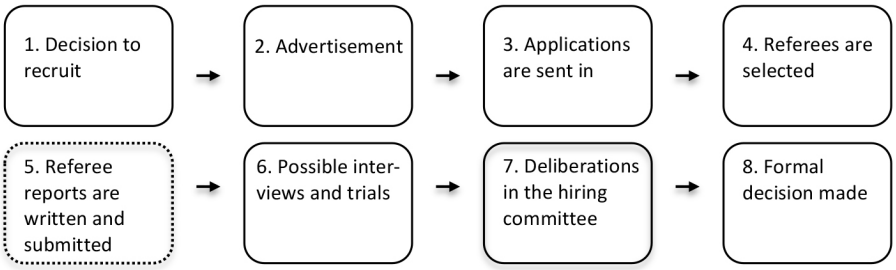

Figure 1 Schematic overview of the hiring process
Source: Authors' compilation.

While the recruitment process as a whole is highly interesting and worthy of study, our analysis is limited to the referee report, and how valuation and ranking is performed in these documents. Thus, we limit ourselves to stage five (see Figure 1); deliberations made before and after this step in the recruitment procedure are not part of the analysis.

Narrative infrastructures and the reduction of uncertainty

Given the importance and stability of the stories told in the referee reports we might view these as 'narrative infrastructures' (Deuten and Rip 2000). Deuten and Rip analyse how stories around a specific innovation form a 'narrative infrastructure' which directs and explains actions within an organization. The infrastructure emerges in the form of narrative 'building blocks', with specific 'ingredients' that become widely acknowledged and established. Eventually a 'master story' evolves out of these accounts where typifications emerge such as *heroes*, as well as *allies* and *users*. Analytically a narrative infrastructure allows actors to guide both future possibilities and relations in a certain setting, while also constraining the stories and interactions that are possible (Deuten and Rip 2000: 74). Moreover, it should be noted that the master story is constantly rewritten by several actors ('authors') and this separates it from a single authored text. The narrative infrastructure reduces '...possibilities (and thus complexity and uncertainty) which enables the various actors to be productive, while at the same time constraining them in certain directions' (Deuten and Rip 2000: 85). While these characteristics are typical of narratives more generally, we find it likely that the specific narrative infrastructure of career trajectories produces its own typification. The reduction of complexity and uncertainty is a key factor to consider, and the journey in the documents studied here is one from ambiguity

(how can research quality be valuated, and who is the best candidate?) to one of relative clarity and order.

The tendency of 'peer review' to take similar form regardless of specific instructions is a further argument to why trajectorism may be described as a 'narrative infrastructure' within these academic evaluation reports, and can help to explain 'how coherence can emerge in multi-actor, multi-level processes, without any actor specifically being responsible for it' (Deuten and Rip 2000: 71). Moreover, a focus on the commonalities of the narratives makes it evident how these documents together form 'master stories' that possibly have an influence far beyond the individuals that are affected by a particular evaluation process. Yet, it is important to emphasize how the 'stories' analysed here, compared to Deuten and Rip's material, to a considerable degree point forwards. This means parts of the trajectorism narrative remains untold, as one goal of the evaluation is the projection of who will perform best in the future. Indeed, we would argue it is the predictive and forward-oriented focus of these assessments which generates the inclination to describe candidates and their careers in the form of trajectories.

Reading and analysing referee reports

Referee reports from a ten-year period starting in 2005 and ending in 2014 were collected from four major universities in Sweden (Table 1). We focused on referee reports with two or more applicants; cases with only one applicant were excluded, as we were particularly interested in how comparisons and rankings are made between candidates/careers. Making candidates and their merits commensurable, and thus enabling direct comparison and ranking is a key element in these reports, and this procedure, we argue, triggers particular 'trajectoral' narrative repertoires as referees are invited to calibrate, and highlight certain features of the CV over others. In cases where two or three referees wrote joint reports these were treated as one document. In total the material consists of 132 reports from four universities (Table 1).

Table 1 Referee reports from four Swedish universities

	Lunds University	Umeå University	University of Gothenburg	Uppsala University	Total
Reports	46	3	22	61	132

Source: Authors' compilation.

Referee reports for professorships at state financed universities in Sweden are publicly available without obtaining permission from either referees or candidates. Still, we decided to not reveal the identity of referees and candidates. Therefore, all reports were coded based on year and university (Lund University: LU, University of Gothenburg: GU, Uppsala University: UU, Umeå University: UMU).

Given our theoretical framing of narratives and trajectories, it made sense to first analyse the dominant logic and structure of these documents. Hence, our first readings focused on analysing the main story told in these documents, and through this 'structural reading' we were able to identify the main features of the dominant narrative. Attention was given to genre specific elements concerning style and argumentation. In the next step, we focused on specific ingredients found in the referee reports, such as how the actors in the document are presented, which values are at stake, how these are measured and ranked. Specific attention was given to the tools and devices used to accrue value, as well as stylistic features. While a more formalized coding might be advantageous when looking for distinct topics and concepts, we found that such an approach tended to put focus on specific themes (authorship, metrics, mobility) rather than on the overall narrative. Consequently, we found that a more holistic reading was better suited for unveiling the broader logics and narratives found in these reports.

In the next step we brought these readings together to tease out the functions of specific features in this narrative. For example, presenting a metric (e.g. h-index) may have certain connotations when introducing applicants at the beginning of a report, and another when used in the final ranking of candidates towards the end of the document. Practically, our method consisted of readings and re-readings of these documents where we looked for distinctive formulations, while also focusing on the more general structure. Framed by the theoretical lens of 'narrative infrastructures' as well as the concept of 'trajectories', these documents were first analysed independently by each author (except for some documents that were only available in Swedish, and thus had first to be translated by BH), and thereafter we brought our findings together.

Framing evaluation: coherence, independence and rigour

The structure of these documents follows a particular order, which is visible in nearly all reports. First, the task at hand is introduced, and the referee might comment on specificities regarding the particular position that is advertised – if it is a position that is mostly geared towards research, if teaching is the main task or if administrative

duties are an important part of the job description. While pedagogic and administrative merits are considered, and sometimes these have a decisive influence on the ranking, the major part of these documents focus on research merits. What happens here is that the 'character' of referees is introduced into the narrative as independent agents that rely on specific knowledge and resources. While the referees are given a great deal of freedom in performing the valuation, they are still, as actors within the narrative, bound to play a specific role, and only small deviations from the expectations are allowed (Deuten and Rip 2000: 87).

One of the referees describes the process in six steps, and while not all assessments follow the same structure this quote reflects quite well how the reports are structured:

> I have undertaken my assessment in the following way:
>
> - Detail [sic] scrutiny of each application with notes of major achievements, particularly in relation to research, publications, PhD supervision and range of teaching experience;
> - Preliminary assessment according to *checklist*;
> - Initial identification of candidates unlikely to meet criteria for the post as specified;
> - Detailed assessment of likely candidates and review of checklist;
> - Calculation of citation rate and h-index from Web of Science;
> - Ranking, excluding those that I did not consider fulfilling the requirements, mostly because of insufficient experience, but also where important information was lacking.
>
> (Bio UU 2012:11, emphasis added)

The checklist referred to above is used by Uppsala University, as an aid for reviewers. In short it details a range of requirements, from rather concrete ones, such as 'The applicant can present a minimum of 15 scholarly publications' and 'The applicant has been a supervisor or co-supervisor for doctoral students', to more abstract ones, such as 'The applicant's publications are of good quality' or 'the applicant demonstrates independence'. The list in itself is quite extensive, and except for requirements in 'research expertise' it lists 'educational expertise', administrative and leadership expertise', 'collaborative expertise' and 'clinical expertise'. While the list is extensive it does however seem to play a lesser role in forming the narrative in the referee reports, and this parallels earlier findings suggesting that formal requirements and instructions have little influence on how evaluation is performed in practice (Langfeldt 2001: 837). One obvious reason is the rather abstract requirements such as 'quality' or 'independence',

which leaves much room for external referees to manoeuver (see also Lamont 2009). Hence, some of the universities have more detailed instructions for how to write referee reports but when comparing the reports from different institutions there is little difference between them.

After the introductory preamble, the referees usually present each candidate separately; this can be done in alphabetical order or, in the case of many applicants, the referee might choose to separate candidates into groups depending on an overall ranking. Usually the top candidates are discussed last, and at greater length than those with lower rank. In cases where there are many applicants – some reports concern more than 40 candidates – it is common to make a first selection where five to ten applicants are singled out as a top group, which are then scrutinized further. Generally the evaluation of individual candidates begins with a short biographical introduction where information on age, gender, former positions, and supervisors are given. In some cases indicators, such as total citations or h-index, are provided as a background fact or to offer 'unbiased' data on the performance of applicants (Hammarfelt and Rushforth 2017). Thereafter referees usually discuss research, teaching and administrative merits where the former almost always take up considerably more space than the latter two (Brommesson et al. 2016). While teaching and administrative merits are usually discussed more generally, research achievements are scrutinized in greater detail, often with a focus on specific publications: this is why in this study we primarily chose to centre on research merits. A reason why referees mostly concentrate on research is that they generally feel more comfortable when judging on research merits. Moreover, in assessing skills in teaching referees must rely on the information supplied by the applicants themselves, which may, as expressed by this referee, make it difficult to make comparisons: 'Generally it can be said that the information regarding pedagogical merits is harder to compare between applicants as the material is presented in different forms and scope' (Bio LU 2005: 8).

When assessing research, referees quite frequently demonstrate that they have read parts of or whole paper(s) and base their judgement on their reading; but more often their account could most likely have been arrived at by scanning the abstract and judging quality based on publication channel or measured 'impact' in the form of citations or other indicators. This external and numerical information then plays an important role when candidates are compared and ranked.

The final section of the reports contains summative judgements of candidates' quality, and applicants are compared and ranked. In some cases referees initially rank all candidates into two or three categories (research, teaching and administrative merits), and these then provide

the basis for a final ranking. How conclusive the final ranking is varies considerably and often referees deliberately formulate their assessment in a way that gives the hiring institution room to manoeuver. For example, a top group can be distinguished (rather than in a ranked list), or the referee might state that a particular candidate is suitable if one kind of profile is looked for but another might be better if slightly different competencies are required. The report might also end with a recommendation that interviews, and even trial lectures, should be conducted to distinguish between top candidates. So, in its most generic form we find that most reports comprise an introduction (including comments on method), a descriptive and evaluative part, and a summative and comparative conclusion (often, but not always, resulting in a ranking). The general narrative then follows a quite well established structure, with many reports following the logic of the scientific article. The 'scientificness' of many reports is further emphasized through the inclusion of various numbers and tables. In a similar manner to the scientific article, these reports are directed at a specific community, and the way they are written, read and analysed is shaped by interactions within the discipline. Hence, the structure and language, as well as judgements and rationales, in these documents are field dependent (Hammarfelt and Rushforth 2017). Analysing these documents may then, as expressed by Bazerman (1988: 47), '…reveal something about its discipline, not so much in the specific writing choices as in the context in which each of those moves makes sense; not in the moves, but in the hints about the gameboard revealed by the moves'.

'Brilliant start': getting on board and keeping the course

Where you have been, and who you have been with, will give some indication of where you are going, and in introducing applicants the referees often provide some background on the current context in which they work: where is the applicant situated, with whom, are they part of a group, and which role does she or he play in this group? Working in a large and established group may be advantageous for making 'groundbreaking results' that can be published in leading, and prestigious, journals; however the ability to lead a group of one's own is a prerequisite for being recognized as a mature and independent researcher for senior positions such as these.

Undergraduate studies by the candidates are often mentioned but the educational role usually plays a lesser role compared to graduate and postgraduate positions. However, being a medical doctor, and thus being able to work as a physician in a hospital, may for some positions be an advantage. These candidates are also seen as having a greater ability to take the leap from 'bench to bed' (LU 2008–1: 5). The main spatial aspect expressed in these documents is the possibility to move

geographically between (similar) institutions, yet here another quality is evoked: the ability to move between the context of 'discovery' and the context of 'application'.

Supervisors, during both PhD and postdoc are usually mentioned and by attaching the candidate to more famous names the referee positions the candidate in a broader landscape of research. Similarly to the 'symbolic ties' used in obituaries (Hamann 2016), the naming serves the purpose of placing the candidate both in an institutional and intellectual landscape (Latour and Woolgar 1986). Moreover, it is not uncommon that evaluative statements of these places and persons accompany the descriptions:

> After receiving his doctorate xxx held a position as a postdoctoral researcher at Research center A, which is an internationally leading laboratory in cancer research. His postdoctoral studies were supervised by yyy, who is a pioneer in computational biology. (GU 2013–8: 1)[i]

Such an introduction sets the background for describing the continuation of the career, and the 'dropping of names' also situates the candidate in a hierarchal space of institutions and renowned researchers. Naming people and places provides a starting point both academically (gaining the PhD) and geographically, from which the trajectory can take off.

Being associated with famous researchers and prestigious institutions is generally perceived as advantageous. Yet, the future performance of high performing candidates having such connections is sometimes questioned as there might be a suspicion that they are too dependent on former supervisors or lab leaders:

> [the applicant] got off to a brilliant start in his career and has received much appreciation and recognition. He is now on to a new phase in his career, but it is not yet clear that he is able, as an independent scientist, to achieve the same success as he did with mentorship. (Bio LU 2014–2: 5)

Therefore, movement between contexts and the ability to collaborate with different researchers is an important quality of a successful candidate in biomedical research. The geographical movements between labs reflects a norm where postdoctoral studies, ideally abroad, represent a transient phase leading either to a permanent position, relatively often in the home country, or it might result in the researcher leaving academia. Yet, as pointed out by Garforth and

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[i] From Swedish: "Efter sin doktorsexamen fungerade xxx som post-doktoral forskare vid forskningsscentrum A i New York, som är ett internationellt ledande laboratorium inom cancerforskningen. Han utförde sina post-doktorala studier under ledning av yyy, som är en pionjär inom beräkningsbiologin."

Červinková (2009), the 'transnational' tends to become more of a permanent state as prolonged periods in different labs as postdoctoral researchers becomes more common. Ideally however the postdoc period remains a key ingredient in becoming an independent researcher, and in many ways it tells the story of the apprentice being sent out into the world and then returning as a master. A rivalling narrative then is that of the wandering postdoc who fails to become a master and find a home.

If mobility is a key for embarking on a career in biomedicine then a steady stream of financial support is central to upholding it. In our documents we see how funding received is seen as a necessity for financing oneself and possibly a whole research group. Not to bring in money, or to be dependent on others to do it for you is not an available option. In order to be considered for a senior position a candidate must show a record of receiving external funding. To bring in a few major grants during a career is not enough, as a steady stream of funding is needed. This is why it is common in these documents to refer to amounts per year rather than to discuss individual grants. Resources, in the form of contacts and finances, are thus necessary in order to move both geographically and intellectually. As formulated by Gregg (2016: 114): 'Valuable lives attract investment to move with agility, comfort and ease while others are left to lag, accumulate weight, and ossify.' Overall, what is valued first and foremost here is independence and portability.

Besides being a necessity for pursuing a career, grants serve as recognition that a particular line of research is deemed fruitful by society, and by fellow researchers as funds are often granted based on decisions made through peer review. Not all grants are equally prestigious, however, and larger funders, which often are more oriented towards basic research, and where proposals are judged by other researchers through peer review, are often given more value compared to smaller and application-oriented funders as the quote from this referee illustrates:

> ... for the grants I gave +++ to applicants who have current grants from at least 2 sources, including VR, EU Vinnova and Cancer Fonden. The ++ means good grants mostly from local organizations; the + limited grants. For my evaluation I mostly considered ongoing grants. (Bio GU 2013: 11)

Receiving resources from commercial entities, for example pharmaceutical companies, is seen as advantageous, yet too much reliance on this kind of resource might cast doubts regarding the applicant's devotion to 'pure research'. Hence, all money does not have the same value when careers are assessed.

In summary, by positioning and attaching candidates to famous persons and institutions the referees fix in place a landscape from which a journey and a trajectory can take off. The leading narrative

told here is that excellent researchers will be associated with, and appreciated by other excellent researchers, and organizations financing them will also be of the highest standard. Yet, we observed a rivalling story, which questions the ability of some high performing candidates to continue an independent career when leaving a prestigious lab or a successful supervisor or lab leader. Despite rivalling stories this part of the narrative is rather uniform. For example almost always a list of past and present institutions with which the candidate is associated is provided. The complexity in evaluating 'research quality' makes the latter parts, in which candidates merits are more directly compared and evaluated, less uniform, and as will be evident there are many ways through which the 'quality' of research is assessed and made comparable in these documents (cf. Lamont 2009).

Scoring high: the measurements of a career trajectory

The research record of a candidate is evaluated in a range of forms, and while a shallower appraisal of submitted publications is the more general route, there are many examples of referees making quite detailed comments regarding specific publications or findings. A key issue for being deemed of high quality is that the research is viewed as 'groundbreaking' while competent but more descriptive work has less value. However, as expressed by the reviewer below, making the distinction between innovative work and more mundane contributions is a hard task, especially when evaluating a long list of candidates from different disciplines.

> I have avoided making qualitative statements on specific research projects since my own competence is obviously variable in the wide array of research fields represented among the 36 applicants. However, I have still tried to identify specific breakthroughs in the research and to give less credit for 'bread and butter' type of research. (LU 2005–5: 1)

Typically what is valued highly by referees is 'groundbreaking research' and research that has the potential to become clinically useful. In many cases the judgement of whether the assessed research qualifies as being regarded as groundbreaking and useful is made based on reading of papers. Still, as indicated in the quote above, many referees – and especially in cases with numerous candidates – feel that their own ability to make judgements on the quality of research is too limited. In these cases additional information, such as number of citations received, is used in order to judge quality, and in the case of more applied areas of clinical or commercial relevance, indicators like patents, or clinical or industry relations become clues that help form judgements on the quality of research. In short these indicators are

used as forms of 'judgement devices' that are employed to assign value to rather disparate and not easily compared candidates (Karpik 2010). Judgement devices serve as shorthand for assessing quality, as well as for legitimizing claims and decisions. For example, a particular paper might be assigned a 'value' by using the status of the journal where it is published, or citations received might be seen as an indication of its value for other researchers (Rushforth and de Rijcke 2015).

Two main judgement devices employed for assessing quality in biomedicine are the 'journal impact factor' scores for journals, as well as citations to papers (Hammarfelt and Rushforth 2017). The impact factor is assigned to journals and not to individual articles or researchers and might therefore seem less applicable when a career is evaluated. Yet, by aggregating impact factor scores for several articles referees can use the 'average' impact factor as a proxy for the quality of the journals in which a given candidate publishes, and eventually use this information to form a judgement on the candidates' career as a whole. This sometimes involves a rather complex manoeuver where the average impact factor scores of journals in which a specific candidate has published is calculated and used as an indicator of 'quality': '[the candidate] has published 55 original papers in international journals with a moderate to high impact factor. The mean impact of the ten selected papers is 4.5' (Bio LU 2005–6: 4). At other times, the inferred link between impact factor and quality is more impressionistic – with statements to the effect that a candidate has a track record of publishing in 'high impact' journals.

One particularly prominent indicator in our material is the h-index. This indicator takes into account both the number of papers and citations. In short the h-index of an individual is the number of papers (x) that have received (x) citations. Hence, an h-index of 10 suggests that the author in question has ten papers which have been cited ten times each (Hirsch 2005). As it takes time for an individual's h-index score to climb it is often considered more relevant for measuring individuals with a longer career in academia. Despite its many limitations, the h-index is a popular indicator, which referees use when performing their analysis. In some cases the h-index becomes a key indicator for illustrating the position that candidates have on the idealized career trajectory, and it is not unusual to find that the h-index score aligns with the final ranking of candidates. In some cases the recommendation of candidates almost completely follows their h-index, and thus forms distinct benchmarks for qualifications for a professorship: a candidate with h-index 15 is deemed as borderline qualified and one with 26 as fully qualified (UU 2014–1).

Citations, both when used independently and when integrated in composite measures such as the h-index, have the advantage of being easily aggregated and compared over time. Thus, it is not unusual to

compare the total citations that candidates' papers have attracted, and referees may also reflect upon the citation trend – is it increasing or decreasing over time?

> His total amount of citations according to http://isiknowledge.com are 3,491 and h-index 29, while where I am searching (Web of Science) I find 2,905 citations and an h-index 28. In any case activity with both publications and citations has shown an increasing trend. (Bio UU 2012–9: 7)[ii]

The applicant ranked in the last position by this referee has their performance compared across different indicators, with the following extract comparing their h-index score with the citation scores of publications that they managed to acquire in a given year: 'She has a surprisingly low citation rate, albeit with a high h–index (max citation <60 in 2010, h-index = 17, Web of Science).' (Bio UU 2012–11: 8). Hence, while the applicant in this case has been able to produce a quantity of papers, which have been cited with some level of consistency, they have not yet managed to reach a level where they visibly impact on the research of their field (measured in terms of citations). Given that the candidates are applying for a professor position, such a high level of influential contributions would appear to be expected by this stage of a career. While they perform less impressively in terms of recognition and fame (measured in papers with citations above a certain number), they are partly redeemed in terms of the consistency with which they produce papers, indicated by a steady stream of papers above a minimum limit of citations (the h-index). The fact an individual has a relatively high h-index score (at least in comparison to their own citation impact score) is given as evidence of a trajectory of 'performance' which has at least remained consistent, although clearly not impressive enough to be ranked more highly. This comparison is illustrative of how different temporal orders emerge around bibliometric evaluation indicators. Notably in this case the evocation of performance over time provides a slightly more flattering image of this particular candidate's publication trajectory than the citation score. The 'generous' reading of a candidate's past performance appears to be a form of procedural politeness that accompanies a lower ranking. It is probably a means of conveying that the candidate is not 'bad' per se, just not impressive compared to the others.

Overall, different bibliometric indicators infer distinctive temporal orderings when evaluating research. Impact factors can be used to

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ii From Swedish: "Hans totala citeringar enligt http://isiknowledge.com anges vara 3491 och H-index är 29, medan där jag söker (Web of Science) finner jag 2905 citeringar och H-index 28. I vilket fall en god aktivitet där både publikationer och citeringar visat en stigande trend.

assess research early, before it has managed to gather citations, and even sometimes before it has been published (e.g. when a paper is referred to being under review for a particular journal). Citations, on the other hand, can only be used retrospectively as it takes at least a couple of years for them to accrue, but on the other hand they are easily aggregated and transformed into more elaborate indicators. Such an indicator is the h-index, which captures both productivity and 'impact', and it does so over a whole career. Still, the role of metrics in these narratives is not to actually form the trajectory, but rather metrics in the form of for example publications; authorship positions and citations are instruments which can be used to estimate where candidates are positioned compared to an idealized trajectory, which then facilitates a comparison with other candidates. Together, these examples illustrate how different temporalities associated with particular indicators can be combined to complement one another, or to undermine the other, in statements which justify rankings.

If number of papers is a means of evaluating the productivity of an author, and the journal impact factor and other bibliometric indicators are used to access 'impact' or even quality, then authorship (position) is the means through which 'independence' is assessed. Generally, the ideal trajectory is from first author – a position generally associated with the PhD and postdoc phase – to the last position, often known as 'senior author' position. As will be shown in the next section, the ratio of authorships positions over time becomes an important measure when candidates are compared and ranked.

The ideal career trajectory and the masculine norm of linearity

The candidates in first position in referees' ranking reports tend to score very high or highest across a number of measures, denoting a very 'progressive' course through their academic careers: 'He has an outstanding research record; 172 published papers, first author on 17 and senior author on 68. There were >200 citations in 1999 and >700 in 2010 and 2011, and an h-index value of 50 (Web of Science)' (UU 2012–11).

While scoring well on a range of indicators supports a first placed ranking, a tactic for legitimating the ranking of a candidate below first place is to juxtapose two or more measures, thereby demonstrating a 'mixed record' of performance. Thus those falling short of the top positions do well on some indicators but tend to be undone by how they score on others. For instance, in the same referee's evaluation report as above, the candidate in fifth position scores well on productivity and citation impact, but is commented upon for the lower prestige of journals in which they have published:

> She has a very impressive publication record (96 papers, 21 as first author, 9 as senior author) although not perhaps in the most prestigious journals but with significant citations (consistently above 250pa [*sic*] since 2004, max 459 in 2007, h-index 29, Web of Science). (UU 2012–11)

Clearly the productivity and impact of the candidate's publication trajectory has been strong, yet she loses credit on the basis of the journals targeted, with 'prestige' of journals often being premised on difficulty associated with peer review processes. This is used as a proxy to measure both the intellectual credentials and 'ambition' of the candidate. Although the candidate does well on some of the major temporal virtues (productivity and celebrity), taking 'shortcuts' in the publication process by avoiding the tough peer review processes and high rejection rates of prestigious journals appear to undermine the candidate's credentials for the position.

This type of trajectory, perhaps best described as 'mixed records', shows how candidates are matched against an ideal trajectory. Here we have a candidate who is preforming very well in terms of number of publications, but lacks top journal publications. However, the candidate has attracted quite a lot of citations. Hence, this is a researcher that almost, but only almost, matches the highflying trajectory, and while a high citation rate partly compensates for 'top journal' papers this divergence might still be at her disadvantage. (In this particular case she ended up in the top group of highly qualified candidates, but was ranked rather low, five, within this group). Most candidates have somewhat of a 'mixed record' especially if other criteria as teaching and administrative skills are taken into account. However, it appears that some 'flaws' (not being involved or interested in teaching or leadership) are more easily overlooked, whereas not having a stellar publication record is more damaging. One explanation might be that referees judge that great researchers can become good leaders and teachers, but the opposite does not apply.

What we call 'mixed records' have been described by Garforth and Červinková (2009: 179) as a 'patchwork or horizontal career'. These are careers that do not match with the 'linear bioscience trajectory'. Having such a career does not necessarily mean that a career in science must be abandoned, although it might eventually come to this point, but it will be more precarious and marginalized compared to the high flying model.

Still, disrupted careers may be repaired by the use of 'compensatory devices' as in the cases below where the h-index (which is highly dependent on the age of the researcher) is adjusted not only for different lengths of career but also for parental leave.

> Their academic careers are of different lengths which makes it interesting to study h-index divided in years after PhD-defence (minus parental leave): yyyy 0.68; zzzz 1.56 and xxxx 0.9.
>
> During recent years she has had two children, which must have slowed down her science a bit (GU 2014–1: 2).

Yet, it remains that the 'masculine norm of linearity remains invisibly connected to excellence' (Garforth and Červinková 2009: 185). In fact, attempts at fixing the problems associated with this masculine norm appear to reinforce the norm, and rather than questioning the linear trajectory it repairs and strengthens the narrative.

While the linear trajectory is an ideal, we also find that there is recognition that eventually careers reach a peak and plateau, and especially for more senior candidates, referees relatively often discuss their ability to keep pace, rather than accelerating. Thus, rather than projecting future accomplishments it might be said that a candidate is 'still going strong'. There are also examples where the innovativeness of more senior researchers is questioned explicitly: 'He has done well recognized work within lipoproteins, but his production has declined and lost focus during the last 5–10 years' (Bio LU 2011–2: 3). Thus, a decrease in research intensity, a deceleration of the academic career, is here accompanied with a sense of disorientation. Thus, an ideal 'trajectory' combines velocity with a distinct sense of direction and purpose; and this quote clearly illustrates how the temporal and spatial are dependent on each other. While the main question for more experienced researchers is to keep up the pace and the sense of direction, more junior candidates still have to prove their capability of establishing an independent research line: 'He has contributed to an internationally well recognized scientific production, also with papers published in high impact journals […], but has yet to show whether he will be able to continue a high profile production' (Bio LU 2013–1: 8).

Making comparisons: the role of lists and tables

When making comparisons, and presenting a ranking, referees highlight certain qualities that can be readily compared. One relatively common strategy for achieving and justifying a final ranking is to gather key metrics on candidates' performance in a table. These tables can include a range of data – from birth year to number of citations and supervised PhDs (Figure 2).

Table 1. Merits of applicants

Name	Years from PhD	Year of Docentur	Original papers			Review articles/book			Total # citations	Current Grants	Supervision of				
											PhD students				Post-docs
											Completed		Ongoing		
			T	F	L	T	F	L			Main	Co-sup	Main	Co-sup	
Candidate A	17	2004	52	8	8	13	7	4	1732	++	2	3	1	2	2
Candidate B	15	2007	24	11	3	4	2	2	573	+	2	--	1	1	4
Candidate C	12	2009	25	5	13	17	8	3	514	+++	2	2	1	--	6
Candidate D	9	2011	30	6	3	3	--	2	837	+	1	1	1	--	2
Candidate E	13	2011	23	6	6	--	--	--	708	--	--	2	--	2	1
Candidate F	17	2001	42	8	21	3	1	1	1715	+++	5	1	2	1	2
Candidate G	11	2009	38	8	6	--	--	--	643	+++	4	3	2	2	5
Candidate H	20	2000	40	11	14	12	8	1	1030	++	3	--	4	1	2
Candidate I	12	2009	22	8	4	5	3	--	975	+++	2	1	1		3
Candidate J	11	2009	29	10	5	7	5	2	810	+++	--	2	2	1	2

Figure 2 Picture of table titled 'merits of applicants' (anonymized)
Source: Bio GU 2013: 13.

This table provides a range of numbers that for an experienced reader can easily be translated into a career trajectory. For example: the relation between first authored papers (col. F) and last author papers (col. L) will help to distinguish between candidates that have their own research group, and those that are still dependent on others. Reviews which you are invited to write, as well as citations, show your recognition in the wider community. Current grants are an interesting feature in this table as the system of assigning candidates' scores (one, two or three) is based on a previously introduced rating of grants. In relation to the practice of coming up with a ranking system for grants one would ask why other possible merits, for example connections to industry, or clinical practice are not ranked. Moreover, years from PhD and years of *docentur* (equivalent of the German *habilitation and in English roughly corresponding to associate professor*) are considered important, but not for example parental leave, clinical work or teaching.

By outlining achievements such as receiving PhD and publishing first paper on a timeline, the temporal dimension becomes even more pronounced. A particularly illuminating example is this handcrafted illustration (Figure 3).

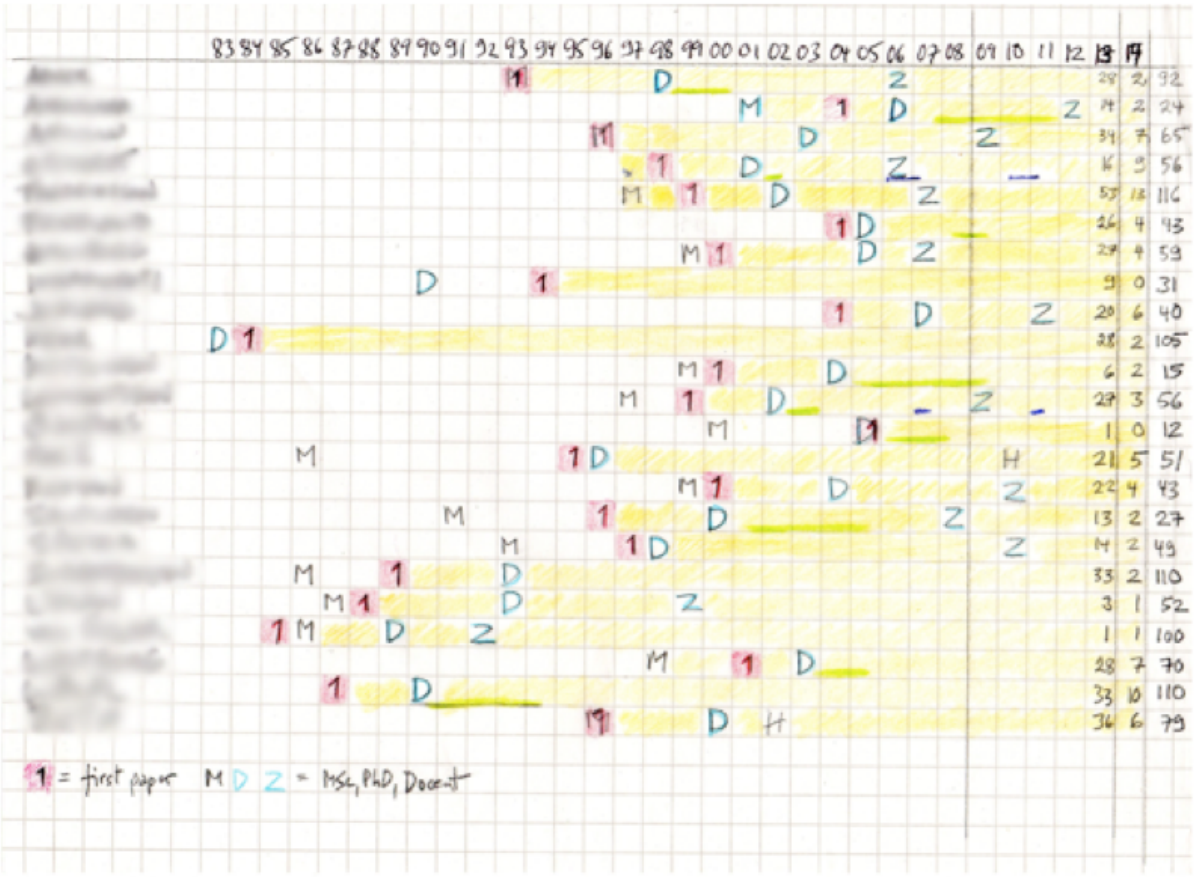

Figure 3 Picture of illustration titled 'A schematic view of applicants' careers in science' (anonymized)
Source: Bio UU 2014–1: 33.

Here a whole career is effectively summarized using key data such as first paper (1), degree in medicine (M), PhD degree (D) and Docent (Z). Yellow colour appears to be used to highlight the number of years that applicants have been an active researcher. The last three columns comprise the number of papers between 2009 and 2013, number of papers in 2014, and total number of papers. The importance of the last five years is further stressed by it being marked as separate from the rest of the table. Positioning publications over the last years (2009–13) as distinctive criteria will place doubt on candidates having many published papers in total, but showing a less impressive (declining) output over the last years. The table, which is introduced with the title: 'A schematic view of applicants' careers in science', is given as an

appendix following the actual report. Its placement and the rather informal note-taking design suggest that this illustration was not primarily meant to be part of the report. Rather it appears to have been used as an aid for the referee in turning disparate sets of data into distinct trajectories that can easily be visualized and compared.

Thus, tables, lists and rankings serve as an important ingredient in the narrative infrastructure. Their function is to summarize key information on the merits of applicants, and at the same time make merits directly comparable by commensuration. Moreover, by structuring and making information uniform the table appears to render a sense of impartiality, as the table only conveys information that is already given and established earlier in the report. Indeed, both the table and the list effectively assign every item, in our case candidates, to a specific and stable position. This operation reduces the complexity of information, yet it may also result in a loss of 'real understanding' of the phenomenon at hand (Goody 1977: 73): for example the particular epistemic orientation of a candidate.

Discussion

In this paper we have described how practices of making a summative judgement of the career trajectory of individuals in report writing is made possible by extracting key pieces of information from the candidates' CVs and comparing this with the equivalent information on others. We have argued that the trajectory is a means that reviewers have of handling the material form of the CV and its masses of dry information, which somehow need bringing to life in the written reports: it is an economical and interesting way of persuading their audience about the merits of one candidate over another. While not the only or necessarily best way of narrating differences between candidates based on the information at their disposal, it is, we suspect, probably one of the most common ad hoc solutions reviewers draw on to accomplish this task. We note that within the reports, providing the same information for the different applicants is a tactic used to legitimate the position of a candidate within a final ranking. It serves as a rhetorical strategy which demonstrates that the ranking is based on a considered, systematic, evidence base. Although most referees do not state that their final rankings were made mechanically on the basis of these scores, the rank ordering of candidates is often consistent with the citation scores (citation numbers, h-index, etc.). Listing this same information for each candidate clearly provides an implicit justification/support for the ranking. The comments accompanying such figures provide interesting moments in revealing how temporal orderings attached to different indicators are made to relate when explaining a ranking.

In a sense, this means condensing the entirety of research activities with which an individual has been associated into a few marks on an electronic document, rendering the candidates' career achievements commensurable. A common feature of the report writing in this respect is to provide information on various quantitative indicators of authorship. Drawing on Deuten and Rip's (2000) notion of narrative infrastructure, we see trajectories as a master narrative which figures prominently in this institutionalized academic evaluation setting. A master story which is repeatedly articulated in our material is the one from 'dependence to autonomy' and from 'apprenticeship to mastery'. It describes the journey from student to lab leader and professor, and one of the central ways in which this transition is manifested is through authorship: position in the author list of published outputs reveals one's progress along an implicit or explicit trajectory. Generally, this means following a pattern of going from first (primary investigator) to last authorship (research leader). Researchers being caught in the middle for too long, it is assumed will have to abandon the 'high flying trajectory' and instead embark on a more horizontal career – thus making them unsuited to the posts of associate and full professor (Fochler et al. 2016). In many ways this master story mirrors Appadurai's (2012: 26) description of 'trajectorism' as a progressive 'cumulative journey from here to there' which he views as deeply ingrained in western thinking, and in modern (social) science.

In many ways our analysis mirrors Latour and Woolgar's (1986) description of career trajectories and cycles of credit in the biomedical sciences, and it relates to accounts of academic capital more generally (Fochler 2016; Munesia et al. 2017). Importantly, trajectorism goes a step beyond conventional sociological accounts of commensuration (saying how A is made comparable to B), because it effectively combines the dimension of time and space. In bringing in time, one thing the trajectory device seems to evoke as a central value is efficiency. According to the *Heritage Dictionary* efficiency is 'the ratio of the useful work performed by a machine or in a process to the total energy expended or heat taken in'. Metaphorically the individual's career is imagined in the referee reports as a machine/process which has had various resources poured in – one thing the reviewers are effectively inferring from CV information is whether the individual is likely to give a good, efficient 'return on investment'. This resonates with arguments made elsewhere about the Taylorization of academic work, where rankings and ratings amplify valuation in terms of productivity e.g. quantifying how much valuable output an individual and institution produces within a given time window (Nedeva et al. 2012; Mingers and Willmott 2013). Thus, the trajectory brings efficiency and consistency of individual performance over the career as a whole to the fore, by re-presenting a candidate's career (based on

their CV) as measurable–accountable against an ideal career path characterized by linear and proportional progress.

Consequently, we suggest that the logic of 'trajectoral thinking' limits the ability of 'heterarchical' valuation (Stark 2009) as it assigns worth based on a fixed and ideal conception of how a successful career is structured. 'Trajectoral thinking' could thus become a mechanism that risks locking individuals into particular evaluative practices. The persuasiveness of 'trajectorism' entails that such consequences may also be visible outside the academic context. In fact, many contexts in which a narrow register of performance is employed can be said to suffer from similar preoccupation with ideal career paths that take the form of trajectories. Contexts, especially those in which 'progress' is easily measured – for example in sports – will trigger thinking in these terms, while other contexts, such as art and literature, with equally demanding activities, may be less prone to fixate on an 'ideal career trajectory'.

The 'narratives' both assess past achievements and predict future performances. In order to achieve these two goals the referees not only have to judge past achievements but they also have to make projections for the future. The trajectory helps referees to construct an independent, expert account of the 'track record' of candidates upon which decision makers will be 'placing their bet'. 'Track record', if we look at the etymology of the term, comes from records of how well a racehorse has performed on a particular track over previous races. Thus, in following the logic of the bookmaker it is not always evident that the candidate having gathered most 'merits' over a whole career should be ranked first. The logic of the gambler is not necessarily compatible with scholarly peer review which usually, for example when assessing a manuscript for publication, is supposed to focus on existing qualities of the work, and not on its projected future value. Hence, different temporalities of evaluation result in a situation where different evaluative logics might come into conflict with each other, and one obvious tension is when the age of candidates is brought into discussion: how should a younger and promising candidate be valued compared to an older and more experienced researcher?

By analysing referee reports as 'narrative infrastructures' we also bring to the fore how referees come to act both as 'narrators' and 'characters' in the reports. In recognizing their role as characters – often in the role of the impartial, unattached judge who proceeds systematically and rigorously – we open up for new possible venues of reflexivity when understanding how valuation takes place in these documents. Furthermore, such a reading displays two kinds of heroes: the referee that through his or her own knowledge and experience brings order and clarity, and the highest ranked candidate who emerges as a 'winner' in a highly competitive context. Furthermore, the

concept of 'narrative infrastructure' accentuates how these documents come to sustain the trustworthiness and independence of the academic system at the same time as they strengthen disciplinary formations and identities. Consequently, the performative function of these documents should not be underestimated as they come to define what is needed to become a professor, and what is needed in order to be recognized as 'one of us'. The semi-openness of these documents – the evaluation reports of candidates are shared with all applicants, and they are available to anyone upon request – positions them as exemplars of how research is evaluated. The evaluations thus provide concrete guidance to what is valued in a particular field at a specific moment in time.

As with any approach, an emphasis on 'narrative' aspects has certain drawbacks. Our study deliberately focused on a very limited part of the recruitment process and the evaluative process associated with it. For example, the actual outcomes and decisions made based upon these documents was not part of our analysis. Neither did we explicitly discuss the fairness of the assessments made or its consequences for gender equality. Nonetheless, there are clearly potential tensions between the ideal career trajectory found in these documents and how real lives are lived by women and men in academic biomedicine, and the 'masculine' norm is very much present in many accounts. Especially, discussions concerning 'independence' appears as a particularly interesting perspective to analyse further in relation to gender, as it seems that women were more often judged as dependent on lab leaders and former supervisors (see also Thornton 2014). More generally, we might ask how the rather narrow definitions of being a 'good' or rather 'hire-able' researcher expressed here might influence the lives of those being evaluated. What does it take to perform a career that fits with the ideal trajectory in these documents; how is the life of biomedical researchers shaped by the pressure to perform according to this script; and does it dissuade biomedical researchers from pursuing work which is possibly more clinically relevant but less likely to lead to career advancement and stability (Rushforth et al. 2019)?

The narrative infrastructures found in these referee reports are not easily challenged, and our tendency to think in terms of trajectories is, as Appadurai (2012, 2013) points out, deeply ingrained in western thought. Yet, other narratives are feasible and one way in which the linear trajectory outlined here can be challenged would be to evoke a set of more heterogeneous temporalities when evaluating careers. These temporalities could highlight qualities such as temporal autonomy, care, sustainability and inclusion (Vostal 2016; Gill 2018), which would stand in contrast to 'trajectorism' with its notions of (global) competition, conquering, speed and movability. In relation to assessing academic performances manifestations of merit in terms of

teaching, caring for joint work and leadership would be important building blocks in such a narrative. Generally these are qualities that are highly valued within organizations yet in academic evaluation they tend to play a minor role. We suggest that one reason for these merits being devalued compared to research is the failure to formulate competing narratives of performance, which challenges the prevailing, and rather one-dimensional, 'trajectoral' mode of thinking.

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Communicating Credibility by Expert Service Workers: The Credibility Tactics of Fiction Critics and Management Consultants

Phillipa K Chong and Alaric Bourgoin

Abstract
One of the fastest-growing occupational groups in the US is expert service workers: knowledge workers who sell their expert knowledge and services on the free market. In this paper, we offer a comparative case study of how expert service workers, whom are hired for their professional evaluations, navigate the tensions of the expert service-client relation in a specific but critical way: How do they convince others that their professional recommendations are credible? Specifically, we draw on two disparate cases of expert evaluators, book reviewers and management consultants, and document two communicative patterns that these professional groups use to build the credibility of their professional recommendations: (i) transparency and (ii) distanciation. Similarities in the credibility tactics of these two sets of expert service workers from two very different worlds, the Arts and business, suggest their generalizable value. Hence, we conclude by discussing how our findings offer a general approach we call, the evaluative triangle, for studying the credibility tactics of expert claims across multiple worlds of work.

Keywords: evaluation; critics; management consultancy; credibility; art; business

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Introduction

Expertise has been described as the "*sine qua non*" of professional work (Gorman and Sandefur 2011: 278). However, changes in mass education and the nature of work have engendered a new breed of workers who sell their expert knowledge and services on the free market, yet lack the traditional hallmarks of the professions. They include public relations specialists, management consultants, freelance editors and related creative workers; and they constitute the largest and fastest-growing occupational group in the US (Gorman and Sandefur 2011).

The changing structure of expert work in today's knowledge economy calls us to reconsider questions such as: *What is expertise? And whose expertise counts?* In the sociology of work and professions, questions around the legitimacy of a group's expertise were addressed through case studies recounting battles for jurisdictional control and related processes of social closure (Abbott 1988; Vallas 2001). However, we examine expert work from a different angle, drawing on another literature that has also dwelt on contests of expertise: the sociology of knowledge.

Our focus is on how taking on the market role of expert service worker affects how individuals produce expert knowledge as a market good. Specifically, we home in on a specific but crucial concern for any expert service worker: *How do they make their recommendations credible to their patron, client, or other external audience?*

To answer this question, we offer a systematic empirical portrait of how expert service workers engage in communicative work to gain the trust of their respective audiences in two different fields: the arts and business. Our empirical gateways into these worlds are interviews with individuals hired for their expert services in each one: fiction critics and management consultants, respectively. Both are exemplars of expert service workers: they sell their expertise on the free market and are hired by clients to apply their specialized knowledge to a specific problem and produce recommendations for an external audience. Yet, book critics and management consultants lack the professional autonomy, status, and accreditation characteristic of traditional experts such as doctors or lawyers. The warrant here being that since expert service workers lack such hallmarks of professions may have to engage in additional communicative or symbolic work to ensure their recommendations are accepted by their audiences.

We choose to focus on these expert evaluators—as opposed to straightforward informational experts—because part of their work is to convince their clients that their evaluations are sound. Hence, drawing on in-depth interviews with both groups, we ask: *How do*

expert service workers convince their audiences of the credibility of their advice and recommendations?

We begin by briefly reviewing previous work on expertise, and situating it in relation to studies of credibility. We then introduce our two empirical case studies as well as our analytical approach, which focuses on the micro-practices with which expert evaluators attempt to make their claims credible to their audiences. We identify two similarities across our cases. The first is an emphasis on the *transparency* of the evaluative procedure. The second is what we call *distanciation*, or separating the evaluator from their evaluation, which can be achieved through what we describe as obfuscation in good faith. While such strategies have perhaps been observed in other studies, the novel contribution of our analysis is to empirically elucidate how the same credibility ends are accomplished through different means. Moreover, we also show how the specific means used by our expert service workers are constrained by features of the particular evaluative context in which they operate. In concluding, we consider some of the theoretical implications of our study for a more general understanding of evaluation as an expert service.

Credibility in New Expert Service Work

Expert service workers as experts

How should we define an *expert*? According to Abbott's (1988) study of professions, experts are those who possess specialized knowledge of a field acquired through extensive training, and who can apply their knowledge in a decontextualized manner. That is, in contrast to the amateur, experts possess a deep rather than superficial understanding of a field, enabling them to apply their knowledge in meaningful ways across different situations.

Yet, there has been much debate about the *substance* of expert knowledge—and, as a corollary, how to draw the line between the expert and the non-expert. In the sociology of scientific knowledge, many more types of expertise have come to be recognized.[1] Lay expertise, for instance, refers to the range of technical knowledge, acquired through experience, possessed by people who are not institutionally recognized as experts. The idea of a lay expert emerges from case studies showing how the knowledge of non-scientists—such as farmworkers (Wynn 1996) and drug-trial patients (Epstein 1995)—

[1] See also Eyal (2013), who argues for conceptualizing expertise as a network in his study of diagnoses of autistic spectrum disorder (ASD), and how this disorder came to encompass a wide range of developmental disabilities previously associated with mental illness.

was productively incorporated into technical problem-solving (see also Irwin 2002). However, Collins rightly points out that "lay" populations in such studies are rarely *truly* lay people, but rather those who have actually acquired expertise through their experience, making them "experience-based" experts (Collins 2014). Furthermore, Collins and Evans (2007) have produced a typology of expertise, with types differentiated by how the expertise is acquired and what it enables the expert to do (i.e., trivia knowledge vs. contributing to the specialized knowledge of a profession). In clarifying the boundaries and contents of the "expert" category, these studies echo early efforts in the sociology of professions to delimit what counts as a "profession."

Notwithstanding the importance of these discussions, we do not question the status of the expert workers we study, and nor do we wish to pass judgment on whether what they offer is "really" expertise. Expert service workers are hired to provide some specialized set of knowledge and apply it to help their client achieve a particular goal. Hence, we take a *relational* approach to expertise: we presume that expert service workers' status *qua* experts is partially determined by their specialized knowledge being recognized as such by clients. [2]

In privileging relations over definitions, we do not wish to dismiss studies that have explored the meaning of expertise. Rather, we hope to explore the modern workplace on its own terms, and according to its nature—permeable, transient, amorphous. We are concerned with how the unique organizational circumstances in which today's expert service workers find themselves differ from those experienced by professionals in the past, and how they may influence their work. Specifically, many expert service workers are unlikely to enjoy the same degree of autonomy, status, reward, and normative orientation towards their professional communities as did the professionals of past decades (Gorman and Sandefur 2011).

Expert service workers as service workers and the importance of credibility

We are specifically interested in the *service* relation between expert service workers and their audience. Expert service workers are hired to solve particular problems—whether that be helping readers decide what books to pick up, or telling corporations how to solve organizational issues. In this context, a central issue for expert service workers is to convince their client of the credibility of their recommendations as part of their professional service.

Shapin (1995) defines credibility as "the grounds on which scientists' pronouncements about the natural world are taken as true, objective, or reliable" (389), and argues that *trust-relations* are

2 We understand our respondents to possess "specialist expertise" that is both interactional and contributory according to Collins's (2014) scheme.

fundamental to the credibility of scientists' claims, including honesty in how data, methods, analysis, and expertise are presented. For his part, Epstein (1995) defined credibility as the capacity of actors to "enroll supporters behind their claims" and to have their voices and arguments legitimated as "authoritative knowledge" (411). Whether the focus is on trust between parties, authority commanded, or deference conferred by others, all these studies share a sense that credibility is a *relation* between speaker and listener[3]—and the crucial issue at stake is whether the listener deems the speaker's knowledge to be acceptable (Zelditch 2001). Credibility is a relational property; as such, it takes relational or communicative work to achieve. Hence, we ask: *What concrete strategies or methods do expert service workers use to convince audiences of the credibility of their advice and recommendations?*

The sociology of knowledge has much to say about how people make arguments or claims more compelling, convincing—or even factual. In the study of scientific fact-making in actor–network theory (ANT), the research program closely associated with Bruno Latour (1987, 1993), Michel Callon (1984), and Callon et al. (1986), "blackboxing"[4] refers to the concrete practices and processes by which an entity acquires an undisputed status, such as how a scientific *claim* is transformed into a scientific *fact*.[5] A key early component in this fact-making process is to distance a claim from the mouth of the speaker: Latour explains that claims become "less of a fact" once traced "back where they came from, to the mouths and hands of whoever made them" (1986: 26). Hence, making a claim more robust can involve inscribing meaning and claims into scientific tools, data, or other materials, and using them to build larger networks of

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[3] Others make this point using the concept of legitimacy not as a property of individuals, but as a relationship between audience and some producer (cf. Bourdieu 1993; Cattani et al. 2014); however, we use the term "credibility" to emphasize our micro-focus on the communication of claims.

[4]The literature on blackboxing typically concerns how scientific controversies are settled. For instance, Shwed and Bearman (2010) considered the temporal formation of scientific consensus manifested by closure in citation networks. They examined the macrostructure of citation networks, suggesting that "dissensus" presents as a segmented citation network, whereas "consensus" presents as a single group or a network with less distant modules. They proposed that, as a controversy becomes black-boxed, the process by which the consensus around the existence of this fact originally emerged becomes obscured, including the existence of dissenters. To quote: "Consensus formation is a black-boxing process: the weaving together of multiple elements of scientific propositions until their internal divisions are well hidden." (4).

[5] Note that Latour (1993, 1999) and Callon and Latour (1981) use this term extensively elsewhere.

associations comprising actors both human and non-human (Latour 1987; Callon 1981).

The more layered and extensive the associations between data, methods, and facts created by the networks, the more difficult it becomes to challenge the facticity of a statement.

The potential of material artifacts to make claims more credible is also seen in the study of demonstrations (Schaffer 1994; Rosental 2013), wherein material objects have been used to "demonstrate" some scientific or philosophical point. Studies have shown how the didactic potential of such demonstrations necessarily remains open-ended, and requires the practical intervention of the demonstrator (through gestures, for instance) to make the implication clear to audiences. Crucially, the power and appeal of such demonstrations lie in the fact these artifacts—as distinct from human actors who deploy them—embody or illustrate specific principles.

Research on public management and administration also has insights to contribute on credibility (cf. Power 1999; Strathern 2003; Shore et al. 2015). In this literature, a crucial pathway to credibility is transparency, or making workings visible. Insofar as credibility involves trust, transparency has been identified as a key means of gaining public trust, not only in science but also in policy-making (Moore 2018). Studies have typically focused on making outputs visible to the public; for instance, audit culture and associated benchmarking technologies act as a way to "check" the performance of government agencies and hold them to account (Power 1999).

The assumption here is that the greater the visibility, the deeper the trust. Yet, scholars have criticized the taken-for-granted or intrinsic value of transparency. Some emphasize how efforts towards transparency are often partial or nonreciprocal, and hence do not always equate to a more informed or empowered public (Gupta 2008; Moore 2018; Strathern 2003). Gupta (2008) argues that transparency too frequently lacks critical analysis, and suggests that more needs to be done to specify precisely how transparency and trust are related.

The studies described above explore how social actors in different spheres endeavor to bolster the credibility of their claims or actions. However, some gaps remain. First, while these studies provide good insights into how knowledge claims are fortified in the eyes of skeptical peers or citizens, for example, less attention has been paid to how expert knowledge is applied to offer recommendations in a *service* relationship.

Where there has been attention given to the performance of expert knowledge in a service relationship is in studies of business consulting. Credibility has always been crucial to professionals insofar as it secures clients' trust by guaranteeing service quality (Abbott 1981). For instance, to legitimize their services, auditors have been described as torn between a professional logic of action (focused on

ethics, expertise, commitment to the task, and the longstanding goals of the organization) and a commercial one (focused on the auditee's satisfaction, short-term financial returns, and the costs of assignment) (Gendron 2002; Wyatt 2004).

The issue of credibility is even more pressing for management consultants, to whom scholars will only grant the status of "quasi-professionals" (Alvesson and Johansson 2002). Indeed, such consultants are not governed by formal licensing or clear ethical rules as the foundation of their professional status (Greiner and Ennsfellner 2010); their expertise is considered "weak" and "ambiguous"; and their technical autonomy is contested (Alvesson 1993; Clark and Fincham 2002). In such a context, critical scholars have equated consultants with "professionals of persuasion" who use rhetorical tactics to build their credibility (Alvesson 1993). Such artifices include storytelling (Clark and Salaman 1998); packaged instruments (Legge 2002); managerial fashions (Abrahamson 1996); and theatrical performances (Clark 1995). In contrast, scholars inspired by psychodynamic theory emphasize the importance of establishing trust between consultants and their clients to build a common understanding of the problem, and fit the proposed solutions to the client's context and needs (Block 2011). Building trust implies also personal traits for the consultant, such as empathy and humility, but also expertise in communication and group dynamics (Schein 1969, 2013; Maister et al. 2000; Bourgoin and Harvey 2018).

The benefits of such studies, notwithstanding, while the literature has analyzed individual domains of knowledge-making in fascinating detail, there are few efforts to consider credibility dynamics comparatively.[6] We look at how individual agents make their claims credible to audiences in two distinct cultural–professional worlds of expertise: the arts and business. Thus we respond to recent calls for the comparative study of evaluation (Lamont 2012; Beckert and Musselin 2013; Antal et al. 2015), with an eye for crafting theory on credibility strategies and evaluation through comparison. In comparing what is common across cases we are able to abstract from the details of each expert service workers' practice to arrive at a more generalizable understanding of the features of credibility strategies – of how evaluators make their claims acceptable to their audiences—which is likely an important precondition, if not a general prerequisite, to many case studies of evaluation.

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[6] For an exception, see Osnowitz's (2010) study of freelance editors and IT workers; though she is primarily concerned with the experience of volatility of contract labor.

Case selection: comparing fiction critics and management consultants as expert service workers

We analyze the communicative efforts of expert service workers to make both their advice and recommendations credible to their audiences. Our analysis is grounded in qualitative case studies of fiction critics in the literary field and privately employed management consultants in business. These cases feature important similarities and differences.

The evaluative task

In each case, agents are hired to deploy their expertise in the service of producing some kind of solution or deliverable for a client. Our focus is on those who deploy their expertise to arrive at a professional *evaluation* of a particular entity.

There are multiple branches of book reviewing.[7] We focus on journalistic reviewers, who are a specialized form of cultural journalist. Specifically, journalists who have the broadest coverage mandate compared to other forms of book criticism: writing reviews of newly published works of fiction for the general reader. Critics' responsibility is to report on cultural news including the publication of noteworthy books. Reviewers do not evaluate which of the hundreds of new fiction titles published each week are worth reviewing. Instead, their evaluative task is limited to assessing individual books selected by the editorial staff of a publication. Readers rely on reviews, as evaluative devices, to help them choose from the many thousands of books published each year (Karpik 2010). As such, their task thus involves providing a gestalt of the book under review, as it will be the first time that readers will have encountered these materials (since they are newly published) and to proffer a written recommendation of whether they are worth reading, and why.

Management consulting is a sub-discipline within business and finance. Consultants are commonly hired by clients to assess the organizational efficacy of a team, a functional department, a technical process, etc. For example, the empirical data for this paper are drawn from three distinct cases of professional evaluation by consultants. In the first case, consultants focused on assessing the level of collaboration between the support functions (HR, finance, IT, and so on) of a hospital in a post-merger context. The second case was

[7] There are many different types of criticism, each with its own distinct aims and audiences. Of the three branches of literary criticism—essayistic, academic, and journalistic (Van Rees 1983)—literary essays and academic criticism focus on "high culture" rather than "popular" works. Journalistic reviewers, however, write in daily or weekly newspapers and magazines about contemporary and newly published fiction. Newspaper and magazine critics decide which select few titles among the leagues of newly published works will receive any critical attention, with far-reaching consequences for an author's success.

dedicated to assessing the task efficiency of a new procurement process in a major energy group, with the aim of reducing headcount. Finally, in the last case, consultants aimed at assessing three internal processes of a major law firm in the context of increased competition: communication, business development, and key account management.

The expert service arrangement

Both book reviewers and management consultants are hired by an external party to provide their opinions or recommendations as expert service professionals.

Book reviewers are hired by the editors of book-review sections within a publication (e.g., a newspaper). They are not employed full-time, but hired for individual assignments, and often make a living outside reviewing as novelists, freelance journalists, creative writing teachers, professors, or some combination of these. Editors usually decide which books they would like to cover, then reach out to a reviewer who they perceive as having the right expertise to evaluate it.

There is no professional accreditation for becoming a book reviewer, nor any professional association that controls who can practice, or how. Therefore, editors use their extensive professional networks and knowledge of authors to seek out individuals who might be a good "match" for a book. Editors report looking for those who have written professionally on particular themes or particular historical or geographic settings, or who have used certain narrative techniques such as interweaving multiple characters' perspectives (Chong 2018). Hence, the expertise that editors seek is non-certifiable (Shen 2015) and premised on critics' individual connoisseurship. As we will see, editors can offer guidance and notes to reviewers on the reviews they turn in; however, critics otherwise have a great deal of autonomy and independence in their evaluative process and outcomes. Insofar as the reviewer's "performance" is assessed at all, it will be on the basis of reader responses (if any) to their writing—and even then, such responses are only provisional because of the accepted relativism of taste.

Consultants are usually hired by the senior executives of larger companies for single assignments, based on a business proposal. The consultant's proposal frames the client's problem, proposes a method of analysis/intervention, and provides plans and costs. For major assignments, multiple firms compete for the contract by responding to a request for proposals. Finding the right consultant can be a challenge even for seasoned managers, who report being confused by the variety of expertise and methods available (Bourgoin 2015). Although in

practice most practitioners hold an engineering degree or MBA from a prestigious school, there is no occupational or institutional qualification process to becoming a consultant. In this respect, on-the-job or internal training is paramount. Major consulting firms function like brands in the sense that they develop proprietary methods for analyzing their clients' organizations that set them apart from competitors. Although individual consultants have their own backgrounds, they tend to act as representatives of a firm's analytical approach. Thus, individual consultants' expert status is entangled with their firm's reputation.

In contrast, in the case of reviewers, consultants, as professionals entwined in a service relationship, are enmeshed in the plot, evaluating the characters even as they interact with them—and are judged by them. Ultimately, the success of a consultancy project will be measured with the rather subjective yardstick of "client satisfaction." Clearly, this is driven by a commercial logic on both sides, but there is also a pragmatic rationale—all of which has implications for building the credibility of consultants' evaluations.

Two worlds of worth

One of the most meaningful differences between our two "worlds" is the contrasting institutional logics that characterize each one (Boltanksi and Thévenot 2006). The artistic world of fiction reviewing is characterized by an "inspired" logic. Connoisseurs are invited to provide their aesthetic recommendations based on cultural tastes, yet aesthetic *value* is ultimately accepted as a matter of private and idiosyncratic taste. The business world, however, is one of quantities, not qualities. Management consultants operate in a field governed by the logic of the market, competition, and price.

We would expect the credibility of expert claims in each of these worlds to vary, given the different logics intrinsic to each. It is precisely these variations that can enable fruitful theorizing about the fungibility of credibility strategies.

Data and methods

To investigate how expert evaluators attempt to guarantee the credibility of their recommendations, we conducted in-depth interviews with expert evaluators in both our chosen fields.

In the literary sphere, the first author interviewed 40 fiction critics who reviewed for prominent US newspapers oriented toward a general audience (including the *New York Times,* the *Los Angeles Times,* the *Washington Post*, etc). Respondents were selected by first generating a list of every reviewer who had published a review in one of three major American newspapers in a single calendar year. These publications were selected based on a combination of criteria including their having (1) one of the highest national circulations;

(2) comparable target audiences; (3) a reputation for covering books. For example, *USA Today* and the *Wall Street Journal* are among the more widely circulated papers, but do not have stand-alone book sections. Although only three publications were used to generate the initial population of reviewers, all informants had reviewed for multiple publications, among them The *New York Times, Los Angeles Times,* The *Washington Post, Chicago Tribune,* The *New Yorker, The Guardian, The Times* (UK), and other news outlets

The majority of reviewers worked on a freelance basis; only four had full-time staff positions as book critics or book section editors. Interviews were conducted over the telephone and typically lasted 1–1.5 hours. During interviews, critics were asked about the different aspects of their reviewing process, including how they determined the quality of books, and the various considerations that had a bearing on how they represented their judgment when crafting their reviews.

In the case of management consultants, our analysis is informed by 21 months of participant observation in a French consulting firm we call *ConsultCorp* (a pseudonym). *ConsultCorp* is a medium-sized enterprise founded in 1999, employing 160 consultants and generating a turnover of approximately US$40 million in 2017. Consultants at *ConsultCorp* work in small teams to provide generalist management advice on post-merger integration, reorganization, adaptation to market deregulation, and the like. The second author participated as a consultant on three separate auditing assignments. He refrained from conducting structured interviews while working as a consultant, so as not to create confusion between his two roles in the field. As a full-time consultant, however, he had conversations with various informants that can be considered as open-ended, informal interviews. These covered 52 different employees, including six partners, 12 managers, and 33 consultants. The conversations were friendly chats supported by what Spradley (1979: 60) calls "contrast" questions—i.e. those focusing on the meaning of an event for informants. We chose to focus on these informal conversations because consultants could openly describe credibility tactics that are usually hidden "tricks of the trade." Drawing insights from these conversations was also a way to make our two data sets more easily comparable.

The second author observed the evaluative practices and methods used by consultants, and probed auditing practices and success criteria. He kept a diary of each project, taking notes on the spot or shortly after the events observed. These observations were supplemented with analysis of the documents that consultants produced and used in the course of their evaluations, which included emails, notes, reports, minutes, and PowerPoint presentations.

We compared how our two groups of experts went about evaluating their respective objects for the benefit of a designated audience. Our methodology consists in comparing credibility practices across these two groups by focusing specifically on how they appeal to their audiences, and how their imagined effect on audiences influences what they do. What challenges do they face when rendering their judgments? How do they factor in their audiences, and how does this change what they do?

Our work draws on comparative case study methodology (Yin 2013) and mobilizes a range of data types to conduct a broader in-depth study of each case (Bourgoin 2015; Chong, in press)—primarily interviews and participant observation.[8] By bringing these two studies into a conversation with each other, we aim to identify both similarities and differences, and thus build new theory.

Findings

We begin by describing similarities in the ways both our groups of expert service workers construct the credibility of their claims. Specifically, we find that both groups engage in efforts on the one hand to (i) make their evaluative operations *transparent* to their audiences; and yet on the other hand to (ii) *distanciate* themselves from the evaluative process by obfuscating their own agency. Below, we describe how each group accomplishes each tactic, and highlight how these similar ends are accomplished through different means depending on context.

Transparency as a pathway to credibility

Transparency, or making workings visible, has been identified as a key means of gaining public trust (Moore 2018). In keeping with previous research, we find that both groups of expert service workers buy into the idea that by laying bare the factors that inform their evaluations, and the practices that generate them, they can make their final recommendations more credible to their relevant audiences. However, going beyond this, we find that transparency does not generate trust by functioning as a means of "checking" for impropriety, as has been previously suggested. Instead, we find that transparency in our case serves to enroll the audience into a particular way of "seeing" the object under evaluation, and that this helps to make the resultant evaluations acceptable. How this is achieved, and its implications for credibility, are clarified through the empirics of our two cases.

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[8] See Lamont and Swidler (2014) on the value of interviewing techniques and participant observation as complementary methodologies.

Fiction reviewers: transparency as a window on the reading experience

The object of literary critics' evaluation comes in the ready-made form of a manuscript. Therefore, all critics use the same source material for their evaluations: a book. Yet a book, as an object of evaluation, is deceptively complex.

Fiction reviewing involves multiple tasks, one of the most important of which is to describe what a book is about. The average reader consults reviews to learn what types of new books are available. And because most reviews are of newly published novels, reviewers can safely assume that most readers will not have read the book before them. Part of the reviewer's task, then, is to offer the general reader a sense of the book under review in terms of its content, as well as its tone and sentiment. This process is far less straightforward than it first appears, in part because of the interpretive nature of literary arts (and literary evaluation). Consider, for instance, Griswold's (1987) study, which looked at how literary critics from three separate nations had different readings of the same set of books by Barbadian writer George Lamming.[9] While the setting and characters may not change from reading to reading, scholars of literature have shown that the meaning of a book is a matter of interpretation, and therefore varies (Griswold, 1987; Corse and Griffin 1997; Corse and Westervelt 2002). While most reviewers report that their editors are generally hands-off, it is common for editors to give instruction on the level of detail to offer in descriptive summaries. In this, the editor acts as a proxy for the general reader, voicing their presumed views on what information should be included.

A second crucial task of book reviewing, and the one that we are chiefly concerned with, is to offer an informed evaluation of a book's quality. This is also far from straightforward, because aesthetic value is largely understood as a matter of personal taste. As one reviewer observes: "[Reviewing is] very subjective. You and I could both read a book. You could think it's brilliant; I could think it's tedious. And [it's not] a question of right or wrong." In other words, critics start with the same object of evaluation, yet can arrive at very different conclusions on its content and value.

How can reviewers make their reviews credible if there is no objective "right" or "wrong"? The answer lies not in the substance of

[9] Briefly, UK reviewers emphasized a stylistic reading, West Indian reviewers emphasized themes of personal and civic identity, and American reviewers focused on race relations in the books. Griswold takes this as evidence that the novels (and other cultural objects) do not have a stable set of meanings. Instead, how literary critics interpreted the novels was informed by the broader "social presuppositions" of their national context: for example, America's national preoccupation with race may have influenced American critics' race-relation readings of Lamming's work.

the judgment, but rather in *how* the critic arrives at it. One reviewer described this imperative when they noted that the task of the reviewer is "to be as clear about his criteria and his judging assumptions as he can be" when putting together a review. Reviewers insisted that because of the interpretive nature of reading and reviewing, it is critical that they lay out the factors behind their evaluation, in order to bolster its credibility.

Editors again play a mediating role in helping critics process their reading experiences into a review that clearly articulates their conclusions. One reviewer explained that editors act as a "filter between the critic and her audience … [U]ndergoing the process of being edited … is crucial because I think it's very easy to say what you like. It's not as easy to show readers *why they should also like it.*" The editor's input does not help an author evaluate a book's quality, but it *does* help them explain to readers why they should put faith in their evaluation, and even share it.

To justify their evaluation of a book's quality, reviewers must clarify how one understands what the book is about, and the criteria they used to make their evaluation. This is achieved through the selective inclusion of, for instance, plot details and extended excerpts, which critics note during their own reading and select in order to evoke the same emotional response that they had at that time (i.e. "showing" readers why they might like or dislike a book for the same reason that the critic did).

Using quotations is one way to demonstrate—rather than assert—something about the quality of a book. James Wood was singled out in part for his ability to use quotations in this regard. Describing Wood's strengths, one reviewer explains, "He'll *show* us, through quotations, what he is talking about … You know, categorically explaining why it was a bad book and *uncontroversially proving* that it was a bad book." That is, rather than merely claiming that a book has underdrawn or underdeveloped characters, a critic might share an excerpt of stilted dialogue so that readers can draw that same conclusion.

How reviewers craft their reviews influences how trustworthy and reliable their evaluations appear, inasmuch as the best reviews *show* readers why they should agree with the evaluation, rather than merely *telling* them what to think. The value of laying out the criteria and judging assumptions that bolster a reviewer's evaluation is that it brings the reviewer and reader into an evaluative alignment. The reviewer can get the reader to understand the evaluative criteria that the reviewer utilized when reading the book and, ideally, to draw the same evaluative conclusion based on the information provided in the review.

By attempting to recreate a stylized version of their engagement with a book, critics essentially treat their reviews as a "literary

technology," as Shapin and Schaffer (1985) described the writing of Robert Boyle. Boyle's writing meticulously laid bare the inner workings of his experiments, and the authors argue that this helped to convince skeptics of the validity of scientific claims by making them "virtual witnesses," so they had no need to conduct the same experiments themselves. In the same way, review readers become "virtual witnesses" of reviewers' reading experience, and may never validate the reviewer's conclusion with their own reading of the book. Critics' role in protecting readers from reading bad books is captured by the common conceptualization of them as "surrogate consumers" (Hirsch 1972).

A review is a necessarily stylized representation of the reading of a book. There may be many ways to read and enjoy a novel—for its formal writing structure, its humor, its sociopolitical relevance, or its examination of a particular contemporary setting, to name a few. Critics focus on those criteria that best approximate the needs of their audience: the imagined general reader. At the same time, by making transparent the particular factors and criteria that they employ to arrive at their evaluations, they are also seeking the audience's acceptance of a stylized way of seeing the novel. And once readers can see a book as the sum of particular qualities identified by the reviewer, the subsequent judgment that flows from this representation is likely to seem credible.

Management consultants: transparency as something more than accountability

Fiction reviewers prepare their assessment of a book for a remote and unseen audience. They are not involved with the book itself, or its author, and nor do they usually interact directly with their readers. Their client (the editor) wants their review to uphold the journal's reputation, but they do not have a significant personal stake in the quality of any single review.

In contrast, consultants are much more closely involved in the objects they are evaluating. Their "audience"—senior executives within the client firm—have a keen and immediate interest in their evaluations, which will have a direct bearing on the direction of the firm and perhaps their personal careers. They also pay the consultant's bill, giving them an individual power over the consultant that newspaper readers can only wield collectively over reviewers.

The "text" that the consultant reviews could be the entire organization, or some subset of it—for example, an acquisition to be integrated, a department to be reorganized, a strategy to be rethought. The "story" of the organization is a tale that is still being told, in

which the consultant themself plays a part. They review the "text" in real time, even as they participate in the "plot," and partly drive it. They must "read" the organization, not just through textual materials, but also in the sense of discerning the tangled relationships and conflicting motives of the "characters" who inhabit it. And even as the consultant evaluates the organization and attempts to rewrite its story, the other "characters" are evaluating them in return—and may have the power to make changes of their own.

The information asymmetry we saw in the book world is reversed for consultants. While book readers know nothing about the book until they read a review, the consultant's "audience"—the client—is already very familiar with the organization, and is looking for an outsider to take a fresh look and offer new insights into it—a different reading of the same text, so to speak. However, this is also the root of conflict, since the client may have entrenched views that the consultant must overcome in order to drive the changes that they believe are needed.

Reading and writing are as significant for the consultant as they are for the reviewer. Through reading, the consultant learns what the organization is about; through writing, they crystallize their thoughts on how it should change. Similar to reviewers, consultants must read texts such as reports, minutes, technical manuals, business plans, and so on, and form judgments based on what they read. Having done so, they must express those judgments to clients by embodying them in written materials such as proposals and plans, synthesizing disparate knowledge into a condensed, easily digestible form similar to a book review. Such deliverables can help to shore up the consultant's authority when the time comes to persuade clients of the best course of action.

Also, like the reviewer, the consultant cannot simply impose their evaluation on the client, and expect to have their counsel accepted without question. Instead, they must say *how* they reached their conclusion, and show clients *why* their advice makes sense in the context of the organization. For the consultant, one of the most powerful "showing" artifacts is the PowerPoint slide, which combines words and spatial representation to express complex organizational realities in a simple, intuitive way. Such slides play a similar role to material artifacts in scientific demonstrations.

At ConsultCorp, consultants turn what they call "results" into "insights" for clients. Insights are locally meaningful, relevant, and actionable propositions, which calibrate more generic analysis to the specific context of intervention, and conform to what is regarded as acceptable by clients in such a context.

As a ConsultCorp manager notes, "there is a slight touch of servility in a consultant's work […] you have to find a way to make your client happy." This concern for the proverbial "client satisfaction" is certainly

driven by commercial motives—happy clients are repeat clients—but also by consultants' genuine concern to see their advice put into practice. As a manager puts it, "You can be the best doctor in the world, but if your patient doesn't take the medicine, nothing will happen."

So, how do consultants persuade clients to accept their work and see them as credible? They rely on specific tools and formal documents to manifest their work, partly because the object of evaluation is quite evanescent. Organizations may inhabit a bricks-and-mortar building, but their processes, functional units, or overall performances are less tangible. Consultants must therefore sketch a stable representation of their object, which supports their credibility by grounding the boundaries of their analysis. This is partly done by framing the evaluation early on in business proposals, specifying the business area that will be targeted, parameters and relevant criteria of the evaluation before any intervention is made. For instance, in the procurement assignment, the consultants clearly stated on their proposal that their evaluation would include "all types of purchase except for the renovation program and several partnership programs" (Field document, Business proposal), which were considered exceptional. By setting clear and realistic boundaries early in an assignment, consultants lay the groundwork for establishing the credibility of the proposals they will submit later on, managing expectations and guarding against any possible "feature creep." This helps to secure clients' agreement on scope, creating a shared understanding of what will be delivered.

During the hospital assignment, the consultants also clearly stated their structure of analysis in a deliverable to enroll their client. The idea was to break down the problem into clearly definable sub-problems that would be easier to analyze. The chosen analytical structure was then used to organize the presentation of results and express them clearly to the client. As a partner explains:

> We chose to break down our problem [evaluating the efficacy of support functions in a newly merged hospital] by focusing on "frictions and the interfaces of functions" and then by "evaluating each function on its own." For each category we had several sub-categories, such as process, tools, human resources, governance and so on. And each aspect was further detailed.

> The key aspect is to be able to show a structured rationale to your client and clearly explain why we chose this rationale to make our analysis. The client can disagree, and we are very open to contradiction, but our structure is written down in black and white, we are ready to defend it, and to walk the client through it. If a client does not understand how we got to where we are, there is a strong chance that he won't be receptive [emphasis added].

This example again displays an emphasis on opening up the consulting procedure and revealing the inner workings of decision-making. Here the respondent is clear that the reason for explaining their procedure and rationale is first to help the client understand, but also to gain their assent and acceptance—what the respondent called the client being "receptive." This strategy stands in contrast to other types of experts, whose status and authority depends on the blackboxing of their decision-making processes. For example, lawyers may not necessarily feel required to explain the case law precedents behind the advice they give.

However, the framing of the problem can also be accomplished during the evaluation process itself. For instance, one consultant recalls the pitfalls of creating a clear image of the organization during an audit for an energy group. It was vital to arrive at a shared representation of the organization, so everyone involved had a solid basis for assessing and managing its performance. "We created a scorecard," he recalls. "But crafting key performance indicators is a major political struggle. They are never self-standing, and creating them is like pulling teeth." He continues, "Our only rule was to write down all our definitions, hypotheses, and sources, so we were always covered." Process mappings, scorecards, lists of activities, charts, and diagrams of all kinds are just some of the many material inscriptions of the object under evaluation.

This section shows how consultants make their work transparent by exposing the inner workings of what they are doing to public account, in order to make their work seem more credible. However, the *mechanism* by which this is accomplished is not a simple, one-sided act of revelation, but rather an effort toward mutual alignment. Book readers are brought into the reading experience by a review in a one-way fashion—they cannot shape the evaluation, or engage directly with the reviewer. The consultant, however, builds their evaluation through iteration and collaboration, adapting their tactics based on the audience's reaction. In both situations, however, the aim of transparency is to get the audience to see the object under evaluation in a certain light.

Providing proof through distanciation

The second move that both groups use to bolster the credibility of their evaluations is *distanciation*: abstracting the self from the evaluative process. Scholars in several fields have observed that excising individual beliefs or opinions can help to fortify knowledge claims. Such practices have been named and described in many different ways in the literature, including "inscriptions" in the sociology of science (Latour 1987); "eliminating personal references" through moving to higher levels of abstraction in debates about justice

(Boltanski and Thévenot 2006); and the "folding" of idiosyncratic into universal criteria (Shrum 1996; Lamont 2009) in the case of evaluation in cultural fields. What these practices share is the aim to be seen as speaking on behalf of something other than one's own interests or tastes. The individual deliberately obfuscates their own role as a locus of knowledge production, which helps to strengthen the credibility of their claims.

Previous studies have observed experts engaging in such acts of obfuscation as a matter of professional convention, rhetorical power, or the active effort to deceive and provide "defective" expertise (Pénet 2018; see also Proctor and Shiebinger 2008). However, our respondents report engaging in what might be called "good faith" obfuscation, in the sense that they use it not as a cover or alibi, but as a way to provide proof for their evaluations. By "proof," we mean factors or knowledge that help discern whether one's evaluation is robust; "to test if your case is a good one" (Hildebrandt 2007: 85). Or, to put it another way, to test the degree to which one is operating from an idiosyncratic standpoint.

Below we outline two distinct distanciation procedures that evaluators use to "prove" their evaluations. Furthermore, we also find important differences across cases with regard to *how* distanciation is achieved, which we argue varies partly because of the different relationships that our evaluators have with their respective audiences.

Book reviewers: proof through self-inquiry

Fiction critics are viewed, by themselves and others, as connoisseurs: individuals with specialized knowledge of literature that enables them to appraise and appreciate books in ways that the average reader cannot (Bourdieu 1993). Part of critics' self-image as judges concerns their deep familiarity with literature. One reviewer reflects that part of her job is to "know a little more than the average person" and to "have some literary expertise." She gives the example of the ability to look at a book and highlight an allusion to Camus, as in an "echo" of another text that only an informed reader will pick up, but is relevant for their appreciation of the text.

Critics' reviews appear as articles within a wider publication, but feature their own individual byline (writing credit). Thus, their reviews are recognized as reflecting their own personal assessment of a book. Nevertheless, critics report aspiring to a form of generality in their artistic judgments: their reviews should reflect their judgment as connoisseurs, not simply their idiosyncrasies as private consumers.

How can critics tell where their personal opinions end and their professional responses begin? Many described a "dual reading"

strategy (Chong 2013). First, they read the book to gain a sense of its content and quality, treating these first impressions as hypotheses. On second reading, they subject these initial impressions to a test or inquiry. Dual reading helps reviewers to investigate and distinguish between their taste as private readers and their professional judgment as connoisseurs, with the intent of excising the former and preserving the latter.

Both readings serve to distance critics' idiosyncrasies as readers from their final evaluations: first by approximating the stance of an ideal reader, and second by vetting their initial responses against formal criteria.

The first way of reading can be described as a "civilian" mode. As one reviewer put it, he began by approaching the book "as if I'm a *normal reader,* and try not to be picking it apart and evaluating it on the first read, because I think that really prevents a legitimate review. That's really not how anyone else is going to experience the book" [emphasis added].

Reviewers aim to approach their first reading as general readers (his/her imagined audience) would. This involves bracketing off not only their intentions as reviewers, but also their personal tastes as readers. For instance, several reviewers mentioned that they might find aspects of a book's structure interesting, but that such observations may be too "high-minded" for the average reader. By approaching the book as an average reader would, book critics are fulfilling their role as *surrogate consumers*.

During the second, "critical" reading, reviewers focus on validating their initial reactions with formal aesthetic reasoning. For example, one critic recalled a book he disliked because the author's voice was "irritating." He used his second reading to question, "Is it my personal idiosyncrasy, or is this book not very good?" He formulated a hypothesis, but had to subject it to scrutiny by identifying the origin of his negative reaction: his own tastes as a reader, or failures intrinsic to the book? By posing this question, the critic assumed that he would be able to distinguish between his subjective preference and the objective qualities of the book. In effect, book critics engage in "trials of strength"[10] that test the extent to which they are speaking on behalf of the book or on behalf of private (illegitimate) concerns, so they can base their professional judgment purely on the former.

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[10] In *Science in Action*, Latour (1987) follows the production of scientific "facts" (i.e., blackboxing processes). These include trials of strength that test the relation between instruments and the scientists who interpret their data. Scientists are meant to report on whatever facts and data their instruments reveal. But if a critic (or "dissenter") can show that a researcher's interpretation has been distorted by some kind of subjectivity, then the scientist is revealed as a "subjective individual" rather than an "objective representative" of the empirical world (78).

Hence, both readings serve to distance critics' idiosyncrasies as readers from their final evaluations: first by approximating the stance of an ideal reader; and second by vetting their initial responses against conventional evaluative criteria. Through an ongoing process of critical self-inquiry, the critic cements the perceived credibility of their final judgment.

Another way of interpreting these data is that they corroborate observations that evaluators "fold" their idiosyncrasies into conventional formal criteria (Shrum 1996). However, the interview data reveal that this is not simply a matter of pragmatic rhetorical convenience, but part and parcel of a process of evaluative inquiry and generating proof for the final verdict.

However, reviewers also have another group of imagined readers in mind: fellow writers and industry insiders. These peers' "gaze" (Foucault 1973) acts as a powerful deterrent to any reviewer who is thinking of abusing the autonomy and discretion they are afforded. So are critics' descriptions of their self-inquiry simply a way for them to present themselves positively for the benefit of external analysts? There are several reasons to think this is not the case.

First, if reviewers are unreflexive about their evaluations, and do not vet their idiosyncratic responses against conventional aesthetic standards, they incur reputational risk. One prominent reviewer recounts a time he reviewed a book that, for personal reasons, he was enthusiastic about—but that most other readers and reviewers regarded as clearly inferior. For years afterwards, he was the butt of jokes from peers, who would bring up his review as an example of the *irrationality* of taste. While he was well established enough to retain his professional standing despite this incident, others are less fortunate. If a reviewer is found to be too idiosyncratic in their reviews, this can lead to assumptions or allegations of improper behavior. For instance, they might be charged with having some kind of ulterior motive: whether positive (e.g., helping a friend) or negative (e.g., having an axe to grind). The best defense against these charges is a reasoned, justified evaluation that is in keeping with evaluative conventions.

Second, this reflexive "inquiry" is important because it distinguishes the professional's practice from that of the amateur. As reviews written by average readers on book blogs, reader-networking sites such as Goodreads, and online marketplaces like Amazon have become increasingly common, so many observers have questioned the ongoing use or relevance of traditional book reviews. However, our reviewers were skeptical of whether reviews written by and for the common reader can properly meet the needs of the general reading public. As one reviewer noted, "If you look at [amateur reviews], you're like,

'That really doesn't tell me what I need to know. It just told me that you liked it or didn't like it.'" The same reviewer continued: "All that 'thumbs up' and 'thumbs down' and all the stars and all that stuff—it's fine, but it's not reviewing." So another argument against the idea that the process of inquiry described by reviewers is simply fabricated is that it was a matter of professional pride and distinction for so many of them.

Critics' process of inquiry, and the way they subject their evaluative judgments to self-scrutiny as a method of proof, is also shaped by the simple fact that book reviews are not dialogic. Their audiences are not physically copresent, and the review must present their entire evaluation as final. This is very different from the situation faced by management consultants, to whom we now turn.

Management consultants: proof through consensus

Like fiction critics, individual management consultants proffering their recommendations should not be seen as speaking on their own behalf, as it undermines their evaluations. However, management consultants have a very different way of using distanciation to achieve closure or persuade others to accept their views.

First, consultants' situation is different from that of book reviewers. They are not connoisseurs with their own "personal brands"; they are subsumed into the brand of the firm they represent. They achieve this by downplaying their individuality as agents of evaluation and emphasizing a generic corporate identity. Clarifying this point, a respondent explains, "I want my client to know that he's not hiring Tony or Paul, but a consultant from *ConsultCorp*."

In the business proposal sold to a consulting client, the team that will perform the assignment is rendered completely generic and anonymous. No individual resumes or photos are provided—only a grade, a level of experience, and a generic description of capacity. For instance, the client will know they are buying a manager with an MBA, six to ten years of experience in project management, and several successful assignments in the energy sector. Similarly, several junior consultants with a generic profile will be working on the team. The client cannot choose specifically who will be working on their case; instead, they are buying "types of profile," as they are known at ConsultCorp.

Large firms put considerable efforts into "producing a standard consultant," as a partner describes it—that is, training their employees in such a way as to standardize the quality of services and the process of delivery. This is also a means for the upper echelons of the firm to facilitate the staffing of consultants and retain control over their core assets—the knowledge base and client portfolio—such that they belong not to unique individuals who have developed an *intuitu personae* relation with clients, but to the organization as a whole.

Second, the world of business is not one of "qualities" and "taste," but one that takes "quantity" as its basic procedure or unit of knowledge (Karpik 2010). Hence, consultants disappear into their method. The role of quantitative methods in supporting consultants' authority is illustrated by a second partner at *ConsultCorp*, who remarks: "A consultant shouldn't give his/her opinion. S/he should provide options and scenarios to his/her clients based on a systematic and objective analysis of the data available." *ConsultCorp* therefore invested heavily in business analytics solutions, just as top strategy firms such as BCG or McKinsey do, facilitating the systematic analysis of large amounts of comparative data.

Consulting services have been described as highly intangible, heterogeneous, and subjective (Clark 1995). Consultants combat this through the distanciation afforded by technical methods and material artifacts. Their personal idiosyncrasies as evaluators fade behind the corporate branded tools of which they are merely spokespersons.

Consultants deploy quantitative methods as tools of distanciation to establish the credibility of their claims. This tactic relies on the cultural association of impersonality that is attached to technical methods. For instance, the Scientific Method, as a set of practices, is colloquially understood to remove all bias and trace of the individual conducting the operation, thereby shoring up the apparent objectivity and authority of the resultant findings (Shapin 2008). We call consultants' methods "quasi-scientific," because although they use most of the technical apparatus of traditional science—formal theories, quantitative studies, demonstrations, analysis of causal schemes, etc.—they display far less concern for methodological rigor.

For consultants, one of the most important vehicles for "objectivity" is the PowerPoint presentation. Often derided as a vehicle for meaningless management-speak or tedious corporate waffle, the PowerPoint slide is actually a vital tool for the consultant. PowerPoint decks are used to provide a focus for high-level meetings between the consultant and senior managers at the client firm, and may also be shared more widely as a way to promulgate the consultant's ideas.

By combining words, numbers, and graphic symbols in PowerPoint, the consultant synthesizes what they have learned about the client organization and presents it back to them in an intuitive, simplified form—a form that "seems true." This allows the client to make a decision that feels rational and informed, even though the framing of the decision itself is controlled by the consultant. To support this work, consultant firms such as ConsultCorp maintain libraries of "ready-to-use" PowerPoint slides that have been proven to work, allowing consultants to provide "instant insights."

The consultant's use of PowerPoint decks to support the face-to-face presentation of their ideas has parallels with the use of demonstrations in science, where material artifacts serve to "show" the audience what is true. Previous work on demonstrations shows that the hand of the demonstrator is never really fully absent from the spectacle. For their part, consultants are not even trying to pretend that the data are free from "fingerprints"; instead, it is a question of incorporating others' opinions—specifically, those of the client.

Some observers have commented on the servility of client–service relationships. But consultants are not servants at the beck and call of their client. Instead, their work is about building consensus: generating proof via deliberation, checks, and balances. When a consultant works with a client, they come together as peers and equals to determine the truth.

However, there is something more: it is a matter of coproduction. Consultants attempt to frame themselves as extensions of impersonal tools of evaluation, which include not only the quantitative methods mentioned above, but also the industry knowledge and interpretations of their clients. Thus, data become social objects that represent a *bricolage* of the consultant's own expertise, the "tools" of algorithms and methods, and the expectations and representations of the client themselves.

That point is not reached with a single leap, but through a process of back-and-forth. The consultant aims to enroll their client through an iterative process that allows ongoing mutual adjustments, and create a shared understanding of what the results ought to be. This involves making the client feel included in knowledge-making practices, and showing them that their experiences and expertise are incorporated into the final result.

This also defuses potential criticism from the client side, in the sense that consultants clarify their expectations early in the process, and make the client an active contributor to the evaluation. This echoes literature in terms of the crucial role of the "co-production of knowledge" (Bettencourt et al. 2002)—knowledge-sharing practices resulting in highly customized output to which clients actively contribute—in securing audience satisfaction for professional services. In other words, if a client feels that an evaluation emanates partly from them, they will be more likely to acknowledge its outcomes.

Consultants allow their ideas to "prove themselves" by subjecting them to a "proving ground" of interrogation and questioning. In French, the notion is called *épreuve*: the sense that it will not do to work with "hasty consensus that has not been nourished with the resistance that is to be expected in real life . . . The opposing interests of both parties thus form an intelligent network of checks and balances" (Hildebrandt and Gutwirth 2008: 595–596). True and

strong agreement is only achieved once an idea has withstood the test of disagreement.

In contrast, book reviewers are not subject to the opinions of their readers directly, since reviewing is not a dialogic situation. For them, demonstrating credibility is closer to what the French call *preuve*: adducing evidence to substantiate their opinions, which they gather by subjecting their own process to critical and reflexive inquiry. In a sense, their "proving ground" is an internal one. There is dialogue and *épreuve*, but it is internal—between the two roles that the reviewer plays during their dual reading. The reviewer embodies two 'people', the 'general reader' and the 'critic', and hosts a dialogue between them.

Discussion and conclusion

This paper has examined the credibility strategies of two very different types of evaluators: book reviewers and management consultants. At first sight, the two groups seem worlds apart—yet they have much in common. Both are different types of expert service workers, who offer their expert evaluations on particular "objects" in response to clients' requests. And both express similar aims in terms of their communications with clients: specifically, the value of being transparent and generating proof.

Transparency refers to making inner workings visible, in order to enroll the audience in the means of qualifying the object and hence gain their trust. For fiction reviewers, that meant laying bare, in the text of their reviews, the various criteria and considerations that drove them to arrive at their evaluation. In a sense, they recreated their own reading experience for the reader of the review. Similarly, consultants break down the rationale for each part of their analysis to ensure that their clients understand and agree with not just their evaluation, but also their representation of the object under assessment. This stance is maintained continuously throughout the consulting assignment.

Previous work has established the importance of gestures towards transparency as a means of generating trust. We are particularly concerned with how our experts gain "trust" or acceptance for the specific evaluations that they produce. Our analysis reveals that transparency does not contribute to "trust" by revealing *all* the processes at play. All representations of the evaluative process are partial; this is particularly the case for book reviewers. Instead, transparency operates by laying out how the evaluator has *qualified* the object under consideration. Qualification refers to the practice of breaking down a social entity into discrete qualities for the purposes of

analysis or evaluation.[11] Transparency generates trust by aligning the audience with how the evaluator "creates" the objects under consideration. In the case of book reviews, we see this with the various interpretations and criteria employed, and with tactics such as quoting from the book to "show" the reader how it is. With consultants, this alignment manifests in the performance indicators they construct for how organizations should operate. Achieving this alignment in terms of how objects are qualified is a necessary step towards making any subsequent evaluation both acceptable and credible.

The second credibility strategy we observed is *distanciation*: drawing a dividing line between the self and the evaluation as a means of generating proof. In the case of book reviewers, we saw how they engage in a reflexive reading process that they report enables them to discern and maintain the distinction between their idiosyncrasies as private readers and their professional opinions as critics. Having done so, they can ensure that only the latter appear in their reviews. In the case of consultants, we see how they "fold" their individuality into the formal procedures and quantitative tools of consulting. This helps them obscure themselves from the picture, even as they "show" the client the reality of their situation, or the appropriateness of the consultant's own evaluation and advice.

Distanciation inevitably involves some obfuscation: concealing some aspect of the situation that is, in reality, present. However, we argue that this is not done with the intent to deceive, or as a rhetorical tool, but rather in good faith. Both groups exclude the self as a way of generating "proof"—meaning some indicator that one's evaluation is a "good" or "robust" one, and not merely an idiosyncratic opinion. In the case of book reviewers, the critical reading is a means of subjecting their first hypotheses about a book to a "test" against conventions—as opposed to merely "folding" their preferences into general language as a matter of rhetoric. In the case of consultants, the emphasis is on wisdom by contest and cooperation—specifically, that through deliberation among peers, a better assessment can be obtained. These two means of generating proof broadly overlap with two modes of proof described by Hildebrandt (2007); Hildebrandt and Gutwirth (2008). Specifically, in the first case, because the audience is not physically copresent and the evaluation is not dialogic, proof takes the form of a process of inquiry leading to a final conclusion ("*preuve,*" or proof based on evidence). In the second case, the conclusion is tested and strengthened through deliberation and consensus-building as a means of knowledge-construction ("*épreuve,*" or proving by testing). This contrast in credibility strategies is clearly related to the situation of the evaluator vis-à-vis their audience. While reviewers address a

[11] On qualification see Beckert and Musselin 2013; also Chong forthcoming: chap. 3.

remote, unseen audience unilaterally, consultants face a "live audience" with whom they hold an unscripted and unpredictable dialogue.

There is also a clear tension between transparency and distanciation: the former is about "opening up," while the latter involves some "closing down." While transparency is about laying bare procedural decisions, the second is a form of obfuscation, wherein the individual evaluator's "fingerprints" are erased in order to fortify their evaluation. How can we resolve this tension?

We suggest that it relates to inherent contradictions in the position of expert service workers. On the one hand, they are *experts*, and therefore are being asked to provide their professional advice, not their individual opinions. Work in the sociology of knowledge has shown how impersonal knowledge is understood as more reliable or scientific. The more the individual is absent, the more the *abstract* knowledge of the professional is understood as informing the final evaluation. Because the experts we study are offering assessments and recommendations, rather than merely submitting or verifying facts, they must balance impersonal and abstract knowledge against their idiosyncratic opinion. On the other hand, they are also *service workers,* which implies a certain "servility" and outward-facing accountability to their audiences. Hence, they must also convince their audience not only of their authority, but also the relevance of their evaluations as a consumer "product," through transparency.[12]

Although our experts work in two very different worlds, we find commonalities in their credibility aims, suggesting the generalizability of these findings. The fact that these two movements were observed in cases as different as the ones we study suggests that these credibility strategies may be generalizable. Our findings could be useful for other fields where agents are responsible for symbolic and material resources, and could be understood in terms of how well competing groups succeed at transparency and distanciation. However, we also found important differences in the ways our expert evaluators achieved these goals. Transparency is about achieving evaluative alignment regarding the qualities of the object, while distanciation is about generating proof (whether through evidence or testing). At the same time, as our findings show, there are variations in the ways that our two sets of experts accomplish them depending on the object in question as well as their relationship to the audience.

We offer the evaluative triangle (see Figure 1) as a heuristic for future researchers to extend to their own case studies of credibility in evaluation to help understand how the qualities of the *object* under

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[12] Osnowitz finds a similar tension in her study of the apparently oxymoronic category of "contract professionals."

consideration, the evaluators' relationship with their *audience*, and the qualifications and self-concepts of the *evaluators* themselves infuse the specific ways that credibility strategies are enacted. To illustrate the utility of this heuristic, we explicate how each point in the triangle shaped the credibility strategies presented in the above cases.

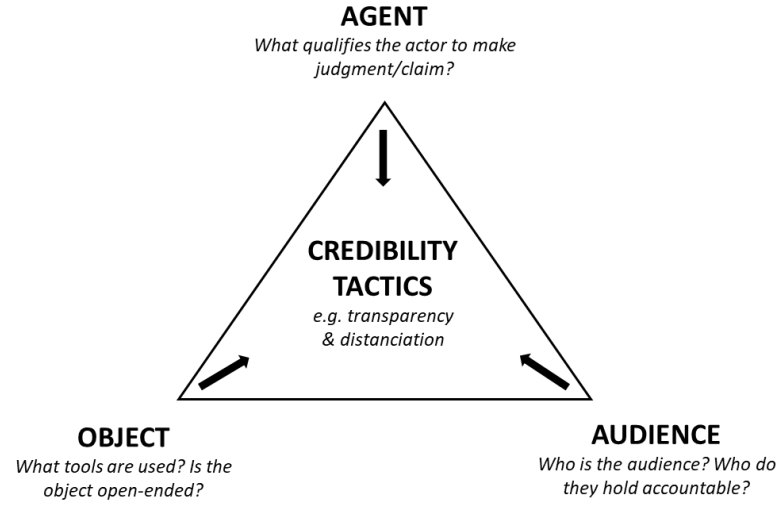

Figure 1 The evaluative triangle
Source: Authors' compilation.

We saw how transparency was important for qualifying the object under evaluation. In the case of fiction reviewers, the object is ready-made but the evaluative criteria are myriad. Hence, critics strove to be clear and convincing about their chosen criteria and how they supported their evaluation. In the case of consultants, the object is more evanescent, and thus consultants must be vigilant that their representations of the organizational processes and operations they assess are in keeping with clients' own expectations and experiences.

First, we saw how the *object* impresses itself on the credibility strategies of those who evaluate it. The object of evaluation must always be interpreted, but the degree to which it is understood as open-ended or closed varies. The more open-ended the object, the more work needs to be done to establish a consensus on what is being evaluated—as distinct from the individual idiosyncrasies or interests of the speaker—and to articulate a frame that all "viewers" of the object can share. Both cases show how the object of evaluation impresses itself upon the evaluative procedure. In both instances how to *qualify* an object, or make it amenable to evaluation, is an interpretive act, and must therefore be justified if audiences are to accept the final evaluation. In a situation where the procedure for assessing an object is less contestable or interpretive (e.g., measuring its cost) we might expect evaluators to use different credibility strategies, or that

transparency might be less important. Additionally, each group deals with very different objects: literary works on the one hand, organizational performance and processes on the other. Future work could examine the scope of how generalizable these credibility strategies are, for instance, across considerations of the status of the speaker, both within and across case studies. This continues the idea that objects are meaningful actors in the evaluation of things—a lesson widely shared within the science and technology studies and "new sociology of art," but in need of greater consideration within the sociology of evaluation.

Second, we also saw how our evaluators' relationships to their intended *audience* informed their credibility strategies in terms of generating proof. Specifically, because book reviewers do not directly engage with general readers, they must rely on their self-discipline and reflexivity as judges—along with some editorial guidance—and subject their own evaluation procedure to inquiry. In contrast, because management consultants are in regular interaction with the hiring organization, and engaged in a more traditional client–service relation, they have the benefit (or burden) of regular feedback from their audience, who also provide a check on the perceived acceptability of the consultants' work throughout the process. This suggests that evaluators' relationship with their relevant audiences—in terms of power, accountability, and means of communication—can have an impact on how evaluators enact credibility strategies. Our focus on the audience for professional recommendations was also instructive because it drew our attention to differences in the relative autonomy or interdependence of agents and their audiences.

Finally, we come to the *agents of evaluation* themselves. We saw how book reviewers' expertise is based on cultural ideals of connoisseurship, wherein they know more than the average reader for whom they write reviews. It is this position as connoisseurs that grants them the freedom not to "report" or seek feedback from their audiences in the first place. Hence, most of their work to fortify the credibility of their reviews is reflexive. It is largely done in the absence, but also anticipation, of the needs of their imagined readers pre-publication. In contrast, consultants' expertise derives from their familiarity and association with the procedures of the consulting firm. On the one hand, this means that they have to do relatively little symbolic work in terms of extricating themselves from the consulting process, because they are already framed as extensions of impersonal consulting practices. On the other hand, consultants' self-described utility in applying quantitative and analytical tools for the benefit of the client also means that the acceptability of their evaluations

depended heavily on the assent of their clients—demonstrating once again how audience relations matter. We venture that how *agents' self-concepts* vary—in terms of how formal or institutionalized are the bases of their qualifications to undertake particular tasks—will also impact their approach to credibility strategies.

Our analyses unpack how credibility practices are influenced by agents, objects, and audiences across two worlds of worth. In conducting them, we necessarily understate the level of internal heterogeneity within each field. For instance, we do not explore the various ways in which status might mediate the operation of credibility strategies. Indeed, we have an intentionally elite bias in our sample selection; we include book reviewers for the most prestigious publications and consultants at leading consulting firms. It is completely reasonable to presume there would be differences between the credibility tactics of high-status professionals and those who work in lower-status situations—for example, reviewers for popular magazines, or consultants who work on a freelance basis.

Research on status suggests that different evaluators might be more or less beholden to the credibility norms of the field, or have more or less influence in their credibility practices. In the literary world, for example, critics who are highly regarded within the field might have fewer concerns about "checking" their subjective preferences. Alternatively, one might hypothesize that the field will reflect the middle-status conformity dynamics described by Phillips and Zuckerman (2001).[13] People speak of things being "panned," or sometimes "mauled" by the critics. And this might be done by high-status books without impunity, while low-status reviewers can do so because they have nothing to lose. Meanwhile, the majority of reviewers—those in the middle-status range—will be most likely to write glowing reviews because their standing in the community is the least stable. Future work could examine how generalizable these credibility strategies are—for instance, across considerations of the status of the speaker both within and across case studies.

The finding that evaluations reflect the cultural embeddedness of evaluators is nothing new. Likewise, it is well established that intermediaries are important in the story of how value is constructed, whether as reputation entrepreneurs, advocates, gatekeepers, or mediators. The theoretical contribution of our analysis is a focus not

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[13] Phillips and Zuckerman (2001) describe an inverted U-shaped curve in the relationship between status and conformity, whereby high-status actors can afford to be non-conformist and low-status actors might as well be non-conformist, but middle-status actors have the most reason to conform; as Phillips and Zuckerman put it: "[M]iddle-status conservatism reflects the anxiety experienced by one who aspires to a social station but fears disenfranchisement. Such insecurity fuels conformity as middle-status actors labor to demonstrate their bona fides as group members" (2001: 380).

only on *how* mediators are embedded in contexts, but also how the contextual relations between mediators, objects, and audiences shape the credibility strategies of experts—especially those who rank among the fast-growing category of expert service workers.

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Valuating Practices, Principles and Products in DIY Biology: The Case of Biological Ink and Vegan Cheese

Morgan Meyer and Rebecca Wilbanks

Abstract
In this article, we study do-it-yourself (DIY) biology, by looking in particular at the different forms of valuation within the DIY biology movement. Building upon recent work in economic sociology and the study of valuation, we take as case studies different projects developed by DIY biologists. Our approach is attentive to the moments when these projects are valued, i.e. during competitions, investment pitches, and crowdfunding campaigns. The projects analyzed involve both market valuations (with investments, products and potential markets) and non-market valuations (be they social, ethical or cultural). Our key argument is that value is produced through distributed and heterogeneous processes: products, practices, principles and places are valued at the same time. We show that there is not only a valuation of technical and production aspects (well highlighted in the key literature on valuation), but also a valuation of social links and of specific forms of organization. Both are inseparable - it is neither the object nor the context in themselves that are valued, but the "good-within-the-context-of-its-making": the production of vegan cheese or biological ink *and* the places and communities of DIY biology or future markets are valued. The valuation practices we examine aim at producing an *interest* in a threefold sense: a general interest (a public good), an interest for the public (its curiosity), and a monetary interest (by making people financially participate).

Keywords: DIY biology: biological ink; vegan cheese: moments of valuation: non-market valuation

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Introduction

The mid-2000s saw the emergence of a movement known as do-it-yourself biology (DIYbio) that aims to make the practice of biology accessible to non-professionals. Motivating many practitioners is the idea that R&D in the biological sciences and biotechnology should not be the exclusive province of those who work in academic or corporate labs, but should be opened up to members of a broader public. Participants put this idea into practice by pursuing projects as varied as DNA barcoding, the fabrication of laboratory equipment, the organization of educational workshops, seminars and classes, the creation of artwork out of biological materials, and the production of food products such as yogurt or beer using fermentation techniques in home and community laboratories.

DIYbio aims to be open to all, and involves participants from a range of ages and social and professional backgrounds. Nevertheless, some demographics are better represented than others: a study by Grushkin et al. (2013) found that three-quarters of participants have a university education, about two-thirds are between 25 and 45 years old, and three-quarters are male. Half of the respondents in Grushkin et al.'s study work in a community lab while 27 percent work in their homes. (These figures might have changed over the past six years; but there has been no other comparable study done since 2013.)

Academic articles on DIYbio have analyzed the risks that it engenders (Schmidt 2008; Bennett et al. 2009; Gorman 2011), its political and social features (Kelty 2010; Kera 2012; Delfanti 2013), and its material aspects (Delgado 2013; Meyer 2013). Less attention, however, has been paid to the economic and commercial dimension of DIYbio. One of the few authors who addresses the topic, Alessandro Delfanti (2012: 174), affirms that DIYbio is "strictly related to entrepreneurship, academic capitalism, and neoliberalism" and that the movement is in the process of exploring new markets based on open source business models.[1] The fact that DIYbio has given rise to startups such as Pearl Biotech and Amplino shows that it is not outside the logic of the market (Meyer 2013). According to Philippe Brunet, "the structural limit of the DIYbio movement is an unconscious acceptance of remaining within the logic of value"[2] (Brunet 2014: upd).

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[1] On the open source biology movement more generally, and its different kinds of 'non-market valuations' (although this term is not used) see Hope (2008).

[2] Authors' translation

If ties between DIYbio and the market have been acknowledged, the manner in which DIYbio projects are valued and presented to different audiences in a market context or to attract funding has not been analyzed. The goal of this paper is to contribute to the academic analysis of DIYbio by exploring the heterogeneity and distribution of its valuations. We will, in particular, pay attention to the sites and events at which the values of DIY biology are being rendered explicit.

To this end, we mobilize recent work in economic sociology on valuation. Vatin points out that "economic value can no longer be solved by the market alone"[3] (2009: 21). It is therefore necessary to account for the social and material relations and institutions that make this value possible. Any act of valuation is at the same time an economic and technical act, and a moral act, because it also responds to problems of an ethical order and of the "general interest" (Vatin 2009). In other words, economic, technical, political, and moral properties are all inscribed together in a good (Callon 2009: 19). For Stark (2011: 7–8) the notion of *worth*, with its double connotation of economic good and moral good, offers the advantage of moving beyond two dichotomies: between economic value and social values, and between economy and social relations. He suggests that, methodologically speaking, the analysis of valuation practices requires a shift from institutional analysis to situational analysis (Stark 2011: 32). Value creation is not only achieved within the market, but also upstream of the market, through the measurement, evaluation, circumvention and reformulation of goods and services (Vatin 2009: 31). Recent work in valuation demonstrates the coexistence and continuity between market valuations and non-market valuations in cases such as biodiversity conservation (Fredriksen 2017). As an extension of these analyses, Callon proposes the concept of "valuation" to refer to the "narratives, mechanisms, devices, tools that constitute value and, at the same time, enable its measurement" (2009: 252), while adding that this assessment is both qualitative and quantitative.

Valuation is an activity that is produced in particular moments and places: we can thus speak of "moments of valuation" (Antal et al. 2015) and "valuation sites." An evaluation site, be it a court, a professional meeting place, or a laboratory, is spatially delimited. It is also delimited temporally: by duration of the test, or experiment, for example (Hutter and Stark 2015: 4). Muniesa and Helgesson (2013) argue that valuation sometimes involves "public witnessing" in which valuation is performed, watched, or put on display, thus drawing attention to the role that audiences may play.

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[3] Authors' translation.

Paying attention to translations of value across time and space has led scholars to more precise theorizations of the workings of contemporary capitalism (Ritzer and Jurgenson 2010; Kinsley 2012; Tsing 2015). These analyses have shown how economic value can originate in spaces that are far from the factory: spaces that may not be primarily conceived in economic terms. In a sense, they are analyses of valuation "at the margins," where Mennicken and Sjörgen write that power and politics become particularly visible (2015: 4).

The internet, for example, has contributed to new forms of valuation, changing processes of production and consumption. In the digital realm, users often produce content for free (and often expect to access content and services without paying). The "prosumer" – a hybrid of consumer and producer – who makes contributions of monetary value without seeing any financial reward undoubtedly finds other kinds of value in the activity: for example, maintaining relationships while adding content and divulging valuable personal information to Facebook; producing YouTube videos as a hobby; or developing open source code in order to network and build a reputation among other software developers (Ritzer and Jurgenson 2010).

While some scholars have characterized some of these non-monetary exchanges as potential harbingers of a new kind of capitalism or even a wholly new mode of production (Ritzer and Jurgenson 2010; Kinsley 2012), others have described them as a continuation of capitalism's ability to devise new means of extracting value: in this case, deriving surplus value from cultural consumption and leisure activities. From the latter perspective, the provision of free labor in digital realms or open source is akin to the free labor of social reproduction, usually performed by women, that has always sustained capitalism. Others have described it as in line with trends that move labor out of the factory and into the rest of society (Terranova 2000). In this analysis, the "gift economy" of open source is not at odds with but fully a part of the workings of contemporary capitalism.

Such phenomena are not exclusive to the digital realm. For example, in a study of mushroom foragers in the Pacific Northwest, anthropologist Anna Tsing concludes, "Amassing wealth is possible without rationalizing labor and raw materials. Instead it requires acts of translation across varied social and political spaces" (2015: 62). For the foragers who camp out in the woods during mushroom season, the mushrooms have a value as "tokens of freedom." Yet they gain additional, monetary value as they pass through a series of different hands and into different domains, eventually entering back into a gift economy after importation to Japan, where they are generally purchased to share or give away in a social ritual meant to strengthen interpersonal bonds. Tsing coins the term "pericapitalism" to signify the liminal position of the mushroom foragers: although they are not

outside capitalism, neither are they completely controlled by any of the actors that later derive surplus profit from their activities.

For our analysis, three elements are important to keep in mind. First, even if the equipment and technical processes developed by DIY biologists are generally not or, at least, not yet commercial goods, some are already being valued. Second, we are interested in *non-market valuations*, as well as those that take place in an explicitly economic or technical context, and in how economic and non-economic forms of valuation are interconnected. How and where does this valuation, whether ethical, political, cultural, or social, take place?[4] We term these practices "socio-political valuation" to focus on the narrative and argumentative way in which the value of DIYbio products is highlighted. Finally, we demonstrate how different forms of valuation are rendered explicit through public presentations and demonstrations. We thus follow this public performance at specific "moments of valuation" (Hutter and Stark 2015: 3) such as competitions, investment pitches, conferences, and crowdfunding campaigns.

Methodologically, we focus on the trajectories of two projects over the course of several years with particular attention to how they are valued during specific events. In each case, we attended meetings and public events, conducted interviews with project participants, and analyzed project publications and presentations as well as media coverage to discern the kinds of valuation at play during different moments. In the first case study, *Grow Your Own Ink,* we follow the project from its origins in a DIYbio lab to its commercialization as a startup company. In the second case study, *Real Vegan Cheese,* we draw on participant observation over the course of approximately 18 months, beginning in the spring of 2014, to explore valuation in a project that has not yet been commercialized at the time of this writing, although the possibility is under discussion. As a participant–observer, one of us attended biweekly meetings, helped with administrative aspects of the project, and participated in one of the moments of valuation which is reflexively analyzed below (see also Wilbanks 2017). These two case studies demonstrate the heterogeneity of valuation over the course of two DIYbio projects that were deemed valuable within and beyond the DIYbio community.

DIYbio: History and overview

In order to better understand valuation practices in DIYbio, we begin with the history and activities of this movement. DIYbio's origin is closely related to the field of synthetic biology, a postgenomic discipline that aims to apply engineering principles to biology in a

[4] Callon (2009) suggests that market valuation is only one form of valuation, but he does not elaborate this point.

more systematic way in order to decrease the cost and technical knowledge necessary to carry out genetic engineering projects. In 2000, in what may be considered synthetic biology's first grant application (although the term synthetic biology was not yet in use), Robert Carlson, Roger Brent, and Drew Endy submitted a grant application to he US Defense Advanced Research Projects Agency (DARPA) for the development of "open source biology," and predicted that developments in biotechnology could soon enable people to practice genetic engineering in their garages or kitchens. The year 2008 marks an important milestone, as it is this year that diybio.org, the first association dedicated to DIYbio, was created in Boston and the media began to take an interest in it.

The first laboratories associated with DIYbio, including Genspace in New York, La Paillasse in Paris, and BiologiGaragen in Copenhagen, were created in 2010 and 2011, and there are currently about 100 around the world. While most of these laboratories are in Europe and the United States, some are in Asia and South America. The emergence of DIYbio has attracted the interest of various actors and institutions: exhibitions, news articles, books for the general public (Wohlsen 2011); a documentary film (Die Gen-Köche, 2012, by Schlicher and Karberg); and a documentary web series (DIYSect) were devoted to it. The movement also has its own newsletter (BioCoder) and its national associations, such as diybio.be in Belgium.

How to explain the emergence of this form of biology and its increasing popularity since the 2000s? In part, DIYbio has been made possible by technical and sociocultural trends in biotechnology: in particular, the decreasing cost of DNA sequencing and synthesis and the development of synthetic biology. Since it was first organized in 2004, the iGEM (International Genetically Engineered Machine) competition has not only served as a site of disciplinary formation for synthetic biology, but has also been used as a meeting point for future DIY biologists. DIYbio is also linked to hacking and making, and the rise of hackerspaces. The mid-2000s saw a flourishing of interest in DIY more broadly, with the launch of *Make* magazine in 2005 and the first Maker Faire in 2006, both of which helped to make biology a "personal technology" (Tocchetti 2012). There is a triple proximity between hacking and DIYbio: a technical and spatial proximity (the tools and physical spaces of hackerspaces and DIYbio laboratories are often shared); semantics (through terms such as "biohacker" or "biohackerspace"); and ethics (i.e. the goals of promoting access, sharing, collaboration) (Meyer 2014).

Contextualizing these developments within trends at a still more abstract and broader scale, some authors have noted that the ethics of self-reliance and self-improvement that underlie hacking and making are compatible with broader neoliberal tendencies. The last several decades have witnessed the development of an increasingly flexible

labor market that values entrepreneurship and requires continuous reskilling by employees (Brown al. 2004; Gill and Pratt 2008). DIYbio also emerges as public funding for universities is in decline, and academic science is increasingly competitive (as more PhDs compete for relatively fewer academic positions) and aimed towards the commercialization of knowledge (Slaughter and Rhoades 2004; Lave et al. 2010). DIYbio often presents a rhetorical counterpoint to this trend, with calls for open science, experimentation, playful creation, and curiosity unconstrained by utilitarian and economic considerations. However, as we will see, it is not completely outside the logic of economics, and in fact in some cases is held up as a more innovative and thus ultimately more lucrative means of doing biotechnology.

The projects and activities that take place under the general term of DIYbio are diverse, but we can discern four major families of activities. First, a number of projects are dedicated to the development of low-cost technical equipment, including PCR machines, microscopes, centrifuges, and electrophoresis gels. Second are environmental or health projects. By building biosensors to detect the presence of melamine in milk, spectrometers to detect the presence of toxic substances, Geiger counters for measuring radioactivity, or tests to detect genetic diseases, DIY biologists have carried out low-cost research on environmental pollutants and health issues.

Third, many projects fall into the category of "bio-art." Examples include the production of "yeastograms" (a process for growing and visualizing yeast on Petri dishes) at Pavillion 35 in Vienna, the Do-it-together Bio project (discussions and events linking biology to art) at the Waag Society in Amsterdam, art projects within the Hackteria network, and the project Open Source Gendercodes by artist Ryan Hammond.[5] Fourth, education is a major focus of DIY biology activity. Madlab in Manchester and Genspace in New York, for example, often host activities meant for the general public (workshops, introductory courses, conferences, etc.). While the forms of this public participation are varied, DIY biology clearly sees itself as a movement capable of engendering a more active and engaged public.

Apart from these four main categories of activities – technical, environmental, and health, artistic, and educational – there has also been a certain professionalization and entrepreneurial transformation in the DIYbio movement. In the context of economic pressures discussed above, the DIYbio lab can be a place where people learn new skills: to take a common example, someone who works in information

[5] This project aims to develop open source protocols for making tobacco plants that can produce human hormones, imagining that transgender men and women might one day have "companion plants" that make the hormones that facilitate transition.

technology can acquire knowledge and practical skills in biotechnology. In this way, DIYbio is connected to the labor market even as it defines itself in distinction from the workplace.

The biohackerspace is also a place to network, since many members work in science and technology for their day jobs. The professional value of being a part of community of lab projects is shown by the fact that members proudly display their community lab affiliations on their professional LinkedIn profiles. In an article, Gewin (2013: 509, 510) affirms that "the option of launching an individual research operation is gaining traction" and that the "hackubator" form allows a fusion of "the independence and affordability of hacker spaces with the entrepreneurial bent of biotech business incubators."

To further illustrate this diversity of activities and vocations – and to show how such diversity is present both across and within laboratories – we focus on two DIYbio labs: La Paillasse in Paris and Counter Culture Labs (CCL) in Oakland, California.

DIYbio projects at La Paillasse have included the DNA barcoding project that aims to determine the genetic signature of plants, animals, or bacteria; the BlueNote project, an open source transilluminator for visualizing the DNA present in an electrophoresis gel; the production of biological ink; the manufacture of biological reactors for micro-organism cultures (destined to detoxify polluting waste for example); and the Epidemium program on cancer data. There is therefore a great diversity of goals and objectives. While some projects are addressed to health and food needs, others have rather technical goals, and still others address environmental issues. Many of these projects have received external funding or are in the process of being turned into startups. The bioreactor project, for example, received a grant of €6,500 from the SpaceGambit Foundation and is being "promoted in the form of a startup." The Epidemium program is the result of a partnership between La Paillasse and the Roche pharmaceutical company. Finally, as we will see, the Grow Your Own Ink project gave birth to a startup that aims to produce biodegradable biological ink on a large scale.

To finance these different activities, La Paillasse has mobilized various resources: donations of equipment from public institutions or private companies; one-off partnerships for certain projects; financial aid from Paris City Hall; a crowdfunding campaign through the KissKissBankBank platform (€22,000 in 2014); and individual donations.

On its end, CCL has also organized a variety of activities since its creation: hosting school-aged children for class visits; organizing social events, conferences, and educational workshops (on topics such as the Ebola virus or the intestinal microbiome); developing activities such as soil sampling or culturing starter for bread baking, and teaching more

extended courses.[6] Major projects include Fermentation Station, which produces fermented food products; the Bioprinter Project, which hacked an inkjet printer to deposit rows of cells instead of ink; the Open Insulin project, which aims to address the high cost of insulin and the lack of a generic option on the market and its high price by creating an open source method to produce insulin in yeast; and the Real Vegan Cheese project (discussed below). CCL is funded by a monthly membership fee of US$80, which allows access to the full laboratory. A US$20 membership option for "Biosafety Level 0" is offered to those who wish to work only on food projects, and a scholarship application process is provided for those who have difficulty affording membership fees. Finally, CCL raised US$37,000 on the Kickstarter crowdfunding website in 2015, and has also benefitted from sourcing used laboratory equipment from the plethora of academic and commercial labs in the Bay Area.

In Section 2, we analyze two of these projects in more detail. We believe that this type of project-based analysis has several advantages. First, projects are empirically rich sites that allow us to better understand the way in which scientific practices are articulated with broader aims. Second, this approach helps to shed light on how DIYbio activities are valued, whether this valuation is commercial or socio-political, or results from a combination of both. Finally, it avoids a too general, abstract, and homogeneous characterization of DIYbio in favor of richer description, situated discourse, and analyzing practices "in action."

Market valuations and socio-political valuations

Our first case study is the project Grow Your Own Ink developed at la Paillasse. The idea of this project, which materialized in 2012, emerged out of discussions between biologist Thomas Landrain and designer Marie-Sarah Adenis. Their aim was to create pigments that are "more easily recyclable, less polluting and [that] therefore constitute an interesting alternative in the field of colors" (project description). To this end, a species of natural bacteria was selected to produce pigments. Grow Your Own Ink has been, since the beginnings of la Paillasse, one of its "showcase" projects. One of the authors of this paper has encountered it on many occasions (presentations, interviews, maker faires, etc.) at which the project has been mobilized both as an example of a DIY biology project and as an illustration of working across disciplines, such as biology and design.

The convivial, collaborative, and "democratic" facets of the project have usually been highlighted. The project has also been presented as

[6] e.g. "So you want to be a biohacker?" which teaches the main laboratory techniques needed to know how to create one's own synthetic biology project.

being culturally significant, as writing is "what defines human culture" (Landrain 2014). In a presentation at a TEDx conference in June 2013, Thomas Landrain explained:

> What I hold in my hands is a Petri dish. And in this Petri dish there are bacteria that can potentially write the future of printing. [...] Ladies and Gentlemen, this is the first biological ink of bacterial origin. It's non-toxic and you can make it yourself, it's that easy. All this ... [applause] Thank you. All this is being made in a biohackerspace. It probably would have never come to fruition in a classical academic laboratory.

This excerpt is interesting for several reasons. First, the ecological and social dimensions of the project are both valued. Second, a clear distinction is made between a DIY biology laboratory and a conventional laboratory. And third, the project is staged both materially (the speaker presents the project and a Petri dish on a stage, in front of an audience that listens and applauds) and discursively (the innovation is explicitly announced and celebrated).

Grow Your Own Ink has also given rise to educational activities. Several workshops have been organized for children and adults, for instance at the Science Gallery in Dublin as part of the exhibition titled Grow Your Own – Life after Nature (2013–14), at the Capitaine Futur festival (2014) held at the Gaîté Lyrique, and at the Monde Festival (2015). During these workshops, the project was enacted in a specific form: it was not only displayed and celebrated, but participants were taught how to use it. In other words, beyond the argumentation that ink can be made yourself, the workshops delivered instructions for *how* to do so, with all the needed gestures, skills, and material practices.

Grow Your Own Ink has not, however, remained a community project. It has led to the creation in 2015 of a startup called Pili (by Landrain, Adenis, and two other persons). A collaboration with the company Bic (known primarily for the manufacture of pens) was established. During summer 2015, Pili carried out tests in Cork, Ireland, in a bioincubator called IndieBio. Scientific equipment and funds were made available to the members of the project for three months. Landrain states that in the course of working in the bioincubator they "met inspiring mentors and had the occasion to share our work with numerous potential investors" (cited in Garvey 2015).

During the final IndieBio EU Summer Party & Demo Dinner, held in August 2015, Pili was one of nine projects to present its after investment pitch to potential investors. Landrain explained that "at Pili, we want to use microbes to […] replace the petrochemical industry" and announced that a "proof of concept" had been obtained by printing a page with organic ink: "Pili has succeeded in printing with a standard Epson ink-jet printer, the first page using ink that was

grown by bacteria. This is amazing [applause]." While the scientific, ecological, and economic merits of the project were presented during the 8-minute presentation, several elements were, however, not presented: do-it-yourself biology, la Paillasse, and values such as sharing or openness. The presentation followed a specific format, a pitch, that is, a way of presenting and "selling" one's arguments and products typical within business circles. Pili's pitch was not only concerned with communicating *about* its potential, it was actively seeking to enroll actors and funds for fabricating ink *with* new business partners. "If we want Pili with its dyes to be able to distribute them around the world and really propose an alternative to the petrochemical industry, we need large distributors, large actors." The grammar used to present and advertise Pili tapped into a variety of registers to argue for novelty ("first"), feasibility ("succeeded"), and spectacle ("amazing," "magnificent," "exciting.")

The marketing and commercialization of the project is now a key element. The project is targeting a specific market (ink and biological pigments), while, at the same time, aiming to demarcate itself from the existing market, whose problematic nature is underlined ("toxic," "polluting," and "non-recyclable" colors). However, this marketing also means that the project has moved away from community values and do-it-yourself practices. In an article published in the newspaper *Le Monde*, one of the founding members explains: "If we want to have an ecological impact that is global, systemic, we must go further than our sympathetic protocols of home production, and produce in large quantities. [...] Not everyone wants to produce his/her jam at home" (Landrain, quoted in Legros 2015). In 2016, Pili left la Paillasse and joined Toulouse White Biotech, a "preindustrial demonstrator" dedicated to biotechnology. With this move, the Pili team has also increased in size: it now counts thirteen members of staff, including a "chief executive officer," a "creative director," a "chief scientific director," and people with various kinds of expertise in engineering and chemistry. In a 2017 promotional video, the scientific quality of the project is underlined: "state-of-the-art technologies in molecular biology" and "scientific ecosystems of excellence" are mentioned, and scientists are shown working in professional laboratories. While Pili has grown and professionalized, some former activities, such as public workshops, are no longer organized. As with other projects that started off as do-it-yourself projects, there has been a transformation of a collaborative and open project into a more commercial and closed venture (Meyer 2015).

Throughout its history, the Grow Your Own Ink project and what was to become Pili have thus been the object of different forms of valuation. All in all, the project has been presented by highlighting a range of values: ecological, economic, democratic, social, cultural,

educational, and innovative. The fact that the project has led to the creation of a startup, that it has been presented to investors, and that products are eventually to be launched: all these elements reveal an increasing market valuation. During the project's first years of existence, socio-political and market valuations did not seem to necessarily contradict each other. Different ways of communicating and highlighting the collective and commercial merits of biodegradable ink seemed to be able to coexist relatively "peacefully." But with its transformation into a startup, some forms of valuation of the project became more prominent at the expense of others.

Throughout its history, the project has seen relatively different moments of valuation. In a first type of moment – of which the presentation at the 2013 TEDx conference is an example – the project was not only valued in itself, but also for the organizational and (non)institutional contexts that made it possible. Biodegradable ink was celebrated as well as the alleged fact that it would not have materialized outside a DIY biology laboratory. There was a double valuation at work: the valuation of a project and the valuation of the place, community, and philosophy of DIY biology. Both were presented as being closely entangled – it was neither the object nor the context in themselves that were valued, but the "good-within-the-context-of-its-making." In subsequent moments of valuation – the 2015 investment pitch being an example here – the project was valued differently: the organizational and institutional context of its origins was no longer highlighted. Biodegradable ink was still celebrated as such, but not by being connected to an alternative space anymore, but to an entrepreneurial space, a space seen as an obligatory passage point for realizing its full potential. Yet, in this second moment of valuation there was also a double valuation at work: the valuation of the biological and technical qualities of the project and the valuation of its marketability, scalability, and future. Again, both were portrayed as being closely entangled – what was valued was the "good-within-the-(future)-context-of-its-making-and-marketing."

Our second case study, Real Vegan Cheese (RVC), is a synthetic biology project undertaken by two community labs in the San Francisco Bay Area: CCL in Oakland, and BioCurious in Sunnyvale, California (see Wilbanks 2017). The goal of RVC – which continues as of this writing – is to genetically engineer yeast to produce milk proteins, in order to create a synthetic cheese with the physical and phenomenological properties of the original. The project was motivated by environmental concerns about the unsustainability of animal agriculture, and ethical concerns about the treatment of animals. It was also motivated by the desire to find a suitable project to take to the iGEM competition that has played a key role in establishing synthetic biology as an academic field as well as a target of corporate research and investment. Work on the project started in

spring of 2014 and accelerated in the months leading up to the iGEM Jamboree in October 2014.

The project's first clear moment of valuation was the fundraising campaign that the team conducted shortly after initiating the project. Using the crowdfunding platform Indiegogo, the team surpassed their original goal of US$15,000 to raise US$37,000. A key element in this fundraising success was the team's ability to garner significant media attention: over 100 news articles covered the project. This feat was no accident, but the result of coordinated effort: team members spent significant amounts of time on marketing and media strategy, drawing on the expertise of different team members and their networks. For example, the partner of one team member designed a professional logo for the project, and a member of the adjoined hackerspace with experience in public relations for nonprofits helped to write a press release and the project description for the website.

To organize the media strategy, the team compiled a spreadsheet with contact information of journalists who had covered similar topics, and worked together to email each of them individually. Twitter and Facebook accounts were set up to attract further attention to the campaign and publicize each article as it came out, and a Reddit AMA ("ask me anything") was organized. RVC participants spent time meeting with reporters for interviews and photo shoots, designing T-shirts, stickers, and custom-made jewelry as rewards for the project's financial backers, and stuffing envelopes with said perks. This concerted attention to fundraising and publicity, which cumulatively took up at least as much if not more time as experimental work during the first year of the project, allowed the project to exceed its funding goals, converting page views and retweets – the currency of the "attention economy" (Crogan and Kinsley 2012) – into monetary value.

In presenting the project to the general public through the website, online platforms, and media interviews, project members foregrounded the project's ethical motivations. These moral dimensions had two aspects: first relating to RVC as a future food product, and second, relating to the process of conducting the project in an open and participatory manner. With regard to the goal of producing cow-free cheese, for example, the Indiegogo page stressed the environmental and animal welfare benefits:

> We believe that using animals as large-scale food production machines is ethically and environmentally irresponsible. We believe that our process is more ethically responsible and environmentally sustainable than the status quo. We believe that all humans, vegans included, should have access to delicious and healthy cheese!

With regard to the process, or the "good-within-the-context-of-its-making," as in the Grow Your Own Ink project, the idea of practicing open science in a collaborative and welcoming community was valued perhaps as much as the goal of achieving RVC as a product. The website states: "All information is published under free-culture licenses (e.g. Creative Commons). Any and all patentable material is put in the public domain; and all research is published via our wiki and mailing list as it is generated."

The commitment to particular kinds of practices extended beyond issues of intellectual property. The project was also "open" in the sense that meetings were publicized on social media platforms such as Meetup and open to the public. The organization of the project was deliberately non-hierarchical, with decisions made using consensus-based methods. During the first year and a half of the project, rather than prioritizing fast results and assigning lab work to those who were already skilled in the requisite techniques, the group encouraged newcomers to gain new skills through experiential learning.

Because of this commitment to open science and education, the team chose not to pursue the startup path during the first eighteen months of the project, instead filing for status as a non-profit corporation. While it was sometimes mentioned that RVC might partner with a local manufacturer down the line to produce a product, plans for this stage of the project were left vague. Other members imagined that individuals might opt out of an unjust and damaging food production system by home-brewing their own cheese in the future. Although the team's work style and internal conversations suggested that the goal of actualizing an edible product and the goal of practicing open science in a community lab setting were of equal importance, news articles and the team's own marketing materials (such as the Indiegogo page) tended to foreground the benefits of RVC as a future product, valuing product over process.

New values came to the fore during the project's second major moment of valuation: the iGEM competition. RVC's participation in iGEM showed the value that the project had as a proof of concept for DIYbio as a whole. One reason that CCL and BioCurious decided to organize an iGEM team was that many members desired to show that community labs could produce scientific work matching the standards of academic labs; 2014 marked iGEM's tenth anniversary and the first year that community labs were allowed to enter. Success at iGEM was understood to support the scientific validity of DIYbio's practices. This perspective was not universally shared, however; other members valued the position of the biohackerspace as being outside of the institutions of "Big Science," suggesting that iGEM did not share the values of the biohacking community. One team member argued that rather than submitting to the judging criteria of the synthetic biology

establishment,[7] biohackers should organize their own iGEM-like gathering with their own judging criteria – and without iGEM's participation costs, which ran to thousands of dollars per team.

Despite the ambivalence of some members about iGEM, the team attended the competition, and did well by its standards: the project won a gold medal (available to any team that scores highly enough on the judging criteria) as well as the award for "Best in Track." One of the authors of this article (Wilbanks) attended the competition as a participant observer, and was one of four team members to present the project in front of a panel of judges and audience members. Participating in the iGEM presentation was an active form of participant observation that can be particularly informative when analyzed reflexively to account for the positionality of the researcher, which inescapably comes into play in moments of collaboration and negotiation. For example, other team members requested that Wilbanks's presentation address public perceptions of synthetic biology and genetically-modified organisms because they felt that the project could improve public opinion in this area. In her presentation, Wilbanks addressed public perceptions by referring to research in the social studies of science suggesting that the context in which a technology is developed matters (Marris 2001). However, her presentation also changed the framing of the subject, a choice that reflected her own interpretation and desires for the project. Reflecting the team's ambitions to change the context of biotechnology by conducting broadly inclusive and community-driven research and development, she concluded that instead of changing *perceptions* of synthetic biology, the project aimed to change synthetic biology itself through wider participation.

The way in which this intervention was received is informative, for the judges quickly returned to the narrative of improving public opinion in their evaluation of the project. The team's highest scores were in the category of "Presentation," with second highest marks in "Policy and Practices," because of the "profound impact" that the judges thought the project could have on public perceptions of synthetic biology. One judge commented, "This project is really capturing people's imagination and changing the way people think about our field. I wish you great success!" Another wrote, "This project was exemplary for the blend of public outreach as embodied in the Indiegogo and the AMA … I think you should have pursued the policy and practices special award in connection with your work on

[7] Although some biohackers considered iGEM to be the "establishment," as synthetic biology has grown to encompass a diverse array of academic and industrial enterprises, iGEM exerts comparatively less influence over the field. For example, while iGEM continues to promote an open source ethos, many synthetic biology companies have pursued more restrictive intellectual property protections.

consumer sentiments in context of a fairly significant crowd funding campaign." For the members of the synthetic biology community who served as iGEM judges, the project was valued for its capacity to improve perceptions of the field and ultimately stimulate consumer demand.

The team's success at iGEM highlighted the ambiguous position of the project with respect to "Big Bio": on the one hand, as a non-profit organization dedicated to pursuing "open science in the public benefit," the team imagined itself as the "anti-Monsanto." Yet, by promoting public acceptance of GMOs and synthetic biology, RVC is doing work that Monsanto and other agribusinesses could get behind. This point was further highlighted when representatives of two major multinational companies that own household brands of cereal and other processed foods expressed interest in meeting to learn more about the project, and the team was happy to set up a meeting. One of these company representatives with experience in microbiology spent several hours learning about the fundamentals of the project, and also connected with team members to dairy scientists whose expertise might be useful.

As the project entered its second year, discussions about commercialization increased, bringing to the fore tensions between the value of RVC as product versus process. A participant who came to the project through involvement in vegan activism argued that her goal was to "get the product to market," so she was in favor of commercialization. Another member replied that she joined "for the open science part" and discussions of markets and startup companies made her "uncomfortable." Team members discussed trademarking RVC's logo and licensing its brand to a startup formed by some project members. One member argued that the team should take advantage of the project's "fantastic reputation" within the venture capitalist and entrepreneurial community to move forward with commercialization. These conversations suggest that although a product was still not yet imminent, much of the project's commercial value lay in these less tangible assets – making it similar to other biotechnology firms in which assets and organizations may be more significant than commodities in processes of valuation (Birch 2017).

During its first few years, the RVC project moved between the logic of the market and of a gift economy, driven by donations of time and money and the goal of contributing knowledge to a commons that would positively impact the world. While media attention and IndieGogo played a major role in constituting the project's value, the iGEM competition was the most important "valuation site" for the project with respect to synthetic biology. The judgment criteria, which are known in advance by the teams, framed the project in a certain way by highlighting its symbolic aspects (its mediagenic qualities) rather than its technical accomplishments. It can be assumed that it is

precisely this focus that has attracted the interest of companies and biotechnology investors. However, many participants instead see and value the project as part of a wider cultural movement of shaping alternative and open infrastructure: of "doing" biotechnology differently.

Conclusion

This article has focused upon the efforts and moments dedicated to the valuation of DIY biology. The support and legitimacy of DIY biology is constructed via crowdfunding campaigns, via presentations and pitches, via demonstrations and workshops, and via media communication.[8] This legitimacy is built in front of – and also by – an audience. To conclude, let us focus on three points.

First, we have seen that value is produced in various ways. The projects discussed involved both market valuations (with investments, products, and potential markets) and non-market valuations. The latter are deployed on several levels (social, ethical, and cultural). It is important to stress that valuation is produced through distributed and heterogeneous processes: products, practices, principles, and places are valued, each interacting dynamically with the others. We see here an essential characteristic of these forms of valuation: it is not only a valuation of technical and production aspects (well highlighted in the work of Vatin and Stark), but also a valuation of social links and of specific forms of organization and/or marketization.

In addition to the diversity and distribution of valuation, a second point to emphasize is the relationship to the economy and the market. While DIY biology may be seen as an example of "public understanding of science" and/or "public engagement with science," the relationships with the public cannot be summed up via these terms. DIY biology involves donations, votes, private funding, and crowdfunding, as much as education. What is also actively being sought is a *public convincing of science,* that is, a legitimization and persuasion of – and via – the public. This public is not only considered as a group of actors that should learn about, or start to practice, science. The public is also seen as a consumer that, through its commitment, makes public DIY biology interesting. To put it another way, valuation is supposed to produce an *interest* in a threefold sense: a general interest (a public good), an interest for the public (its curiosity), and a monetary interest (by making people financially participate). It is during moments and trials of valuation that this link

[8] If this trait distinguishes DIYbio from academic biology, one might still speculate whether these new sources and forms of funding and medializations are not equally likely to develop within the academic world (see Rödder 2009).

between public good, public interest, and financial interest is particularly visible.

Following authors such as Tsing and Callon, following the translation of value across different places – and across time – is essential to understanding the relation of these projects to the market. DIY biology laboratories can be conceived as "peri-capitalist" spaces in which capitalist forms of value and non-capitalist forms of value develop at the same time (Tsing 2015). While in these spaces value is often produced in a non-standardized way, it can nevertheless be integrated into capitalist projects by various kinds of translation. Hence the interest of economic sociology in examining these translations: for example, the translation of public/media interest into economic interest, the translation of ethical and social capital into entrepreneurial capital, and the translation (and physical move) of a project from an alternative, peri-capitalist space into a capitalist space. Our analysis suggests that through processes of translation, a valuation in one domain (such as a good reputation as a non-profit dedicated to education and open science) can increase the project's value in another domain (such as the for-profit world of biotechnology investment). However, these translations are not always smooth and may also involve contestation and conflict. At other times, translation may mean transforming and distancing the project from an earlier context of valuation (as in the case of Pili).

Third, we hope to have demonstrated that it is fruitful to attend to different moments of valuation across a project's history and trajectory. While at one moment of valuation, specific contextual and historic elements might be foregrounded, they might be absent at another moment. While at one moment of valuation it is the situatedness and the origin story of a project that counts, at another moment it is the future market and the upscaling of a product that is envisioned. Thus, rather than saying that a project is commercialized, we have been attentive to the ways in which a project is presented and valued "in-the-context-of-its-making" in order to be – and before being – commercialized (or not). The entanglement between a project and its various moments of valuation is important to problematize. The specific formats of the moments of valuation discussed in this article (competitions, investment pitches, crowdfunding campaigns) do pre-exist, of course, the two projects we have analyzed. Yet, while a certain perimeter and frame was predefined, it is important to stress that valuation is made *along the way*. The results and outcomes of moments of valuation (notes, successes, failures, funding, etc.) cannot be known in advance. A moment of valuation is a trial of valuation: an event where the value of a project is proposed, negotiated, and put to the test, in which its value – and, potentially, its future existence – is on trial.

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Economizing as Exploring Valuations: How French Engineers Came to Valorize Telephone Calls

Alexandra Bidet

Abstract
This study deals with the building of a specific set of economic valuations throughout the work of French telephone engineers between 1880 and 1938. In so doing, it contributes to our understanding of the complex interplay between economization and valuation. Tracing the changing practices that facilitated a shift from valuation aimed at minimizing force losses to valuation aimed at assessing and enhancing subjective utility, economizing is considered as an epistemic process, through which managers, engineers and workers are exploring, representing and transforming the world. From saving work and minimizing losses to creating value, engineers went from evaluating (telling what is worth, within an economy of force, optimizing the ratio of losses over total work) to valorizing (framing value as possibly produced and not only saved, the production of utility). This new concern for valorization points to the development of new ideas on what could create economic value. In this process, the very acts of measuring, optimizing and calculating, appeared as both "subversive" and "subverted".

Keywords: economizing; metrics; inquiry; engineers; valuation; work; phone; value.

Introduction

This study deals with the building of a specific set of economic valuations throughout the work of French telephone engineers

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between 1880 and 1938. This was a pivotal period caught between the reign of the telegraph in the nineteenth century and the rise of digital technologies after World War II. In 1877, a number of French telegraph engineers were called upon to take up a very recent North American invention, still hardly in service on the other side of the Atlantic: the telephone. Consisting in the association of a transmitting microphone and a receiver, this technology initially seduced physicists because of its extreme sensitivity. Opening "a world of sound where we thought total silence reigned," it could detect low-intensity electric power, previously immeasurable "for lack of a yardstick small enough to allow comparison."[1] In the late 1870s, engineers working at the *Postes et Télégraphes* (the French national post and telegraph service) focused on two tasks: understanding the nature of telephone electric power and producing it with high-performance devices. Beyond the task of mastering problems of noise and distortion of sound came that of coping with the long series of innovations the telephone set had called for: transmitters and receivers, lines and their amplification, adaptation to many use contexts, newly discovered physical phenomena, mining and undersea exploration, military applications, musical broadcasting, network subscription, etc.

The two broad technological branches of the telephone (that is, transmission and switching techniques) relied on the same electromechanical basis. Electric power was used for transmission, and the electromagnetic properties of the relays were used to establish the connections (the movement of the mechanical parts being controlled by electromagnets). On the transmission side, the main issue was to compensate for the weakening of electric current with distance and to increase transmission capacities. On the switching side, the limits related to the time taken by switch operators and the volume of the mechanical components involved. The history of telecommunication technologies has focused on the distinctiveness of the 1878–1939 period: Griset (1991) contrasts the "revolution of electrical communications" with that of post-war electronics semiconductors, and Carré (1991) distinguishes a phase of networks expansion from a phase of acceleration of technical innovation and service growth. The interwar period stands between two techno-economic systems, but does also represent a foundational period for French telephone engineers.

In the interwar period, basic telephone services emerged through constant investigation of their value. What was valuable, what was useful about them? What deserved care and effort? What bore a cost? What was a phone call worth? What about the worth of the work of the operator connecting two callers? Such questions were recurrently

[1] "Du téléphone et des phénomènes physiques qui s'y rattachent," excerpt from a text by W. H. Preece (*Philosophical Magazine*), translated in the *Annales des Postes et Télégraphes* in 1878.

raised among telephone engineers. Yet these were not given a straightforward answer stemming from the gradual discovery of an already given value (Dewey 1939). The telephone was often considered as a rare, expensive, useless gadget for the rich. The French State had bought telephone networks in 1889, but these were not granted any real economic role (see Appendix 1). Until more recent, state-led development programmes in the 1970s, the telephone remained an infrequent product in France. Before World War II, subscribers were mostly business persons, and telephone networks were at first lines connecting households to factories. In 1925, more than half of the 25,000 networks in France still had fewer than five subscribers. Until the 1960s, the telephone was a matter of unconnected point-to-point lines and a myriad of small, local and unconnected networks. One had to wait until 1974 to see the rate of household equipment rise from 23 per cent to 90 per cent in ten years. In the three years 1974–77, then again in the two years 1977–79, as many lines were built as in the previous century. Before the end of the 1960s, the French State was not really interested in the telephone nor did it finance it. The telephone's frivolous pointlessness was aptly rendered in literary work, as in Colette's 1943 *Gigi*, where the telephone was said to be "only truly useful for men who make big deals or women who have something to hide." Notions of information theory ("information" as such, but also "performance") only began to be formulated in the 1950s. Before Claude Shannon, the telephone's only value was in the "messages" it transmitted, not in their informational shape and content. And the very concept of "message" obscured the telephone's advantage over the telegraph: namely, that of being put in direct communication and having an immediate response, if not a conversation.

Yet, at the same time, French State telephone engineers had undertaken elaborate economic valuations. Paying attention to measurement practices and cognitive artefacts (Pezet 2009), we can see economic valuations emerging from the daily work of these engineers. It is part of their job to reduce complexity and to accommodate recalcitrant phenomena by delineating inputs and outputs, expenses and effects, and by creating metrics to render them commensurable. Engineers enter a "cycle of measurement failure and reform" (Kurunmäki et al. 2016). To analyse this cycle, I draw on these state engineers' professional journal: the *Annales Télégraphiques*, from 1855 to 1899, and the *Annales des Postes, Télégraphes et Téléphones*, from 1910 to 1939. I carried out an inventory of reviews, reports and didactic articles. In 1910, the new edition of the journal aimed to enable engineers to "keep abreast of the improvements made in France and abroad to the branches of services in which they are interested"

and to disseminate "the essential methods and general knowledge taught at the École Supérieure des Postes et Télégraphes," where all engineers came from and sometimes taught at. Altogether, I examined and classified nearly 200 articles from the "phones" section published between 1910 and 1938.

French State telephone engineers did not write about economics or the economy.[2] Late nineteenth- and early twentieth-century telephone engineers had almost no knowledge of academic economics, and their writings made no reference to authors in political economy. Very little economic justification backed the 1889 state monopolization of phone companies. "While the mechanism of price elasticity was mentioned frequently, we find only a few traces of such thinking in the notions of networks and economy of scale," notes Leroux (1991). Yet the idea was quite present for engineer Jules Dupuit, who justified the argument for nationalizing all networked businesses with the principle of the "natural monopoly," which corresponds to the idea of an economy of scale: when the productive system is such that efficiency increases with size, the market "naturally" moves toward the construction of a monopoly (Vatin 2002). This does not prevent engineers, when the opportunity arises, from calling for the construction of a "satisfactory telephone service that the public rightly requests as an indispensable tool for national development and a necessary weapon in the industrial, commercial, and agricultural competition between nations."[3] But they would not be heard until the 1960s. On the one hand, the telephone as a mode of transportation for sound was for long viewed as distinct from the idea of networked operations. On the other hand, tertiary activities, at the time, were devalued relative to primary or secondary activities, and messages could only be stand-ins, not real economic goods – as opposed to "information" today.

My focus here is not on marketizing but on quantifying and economizing (Kurunmaki et al. 2016). By showing how engineers work outside the market and shape the way in which technical devices are valued, I connect economic sociology with science and technology studies' older focus on the social construction of technological artefacts (Bijker 1989; Callon 1998). This reveals STS's "technological turn" towards the material reality of calculation as an even greater resource for economic sociology: not only has it long helped us understand how models, market devices and other material artefacts constitute and shape market behaviour, but it is also key to

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[2] I did not find any reference to economists in their productions, a course in political economy was nevertheless part of the curriculum from 1888 onwards at the École Supérieure des Postes et Telegraphes For the 1970s, see Bidet, 2010.

[3] "Le téléphone en France et à l'étranger. Progrès technique, organisation rationnelle," *Annales des Postes, Télégraphes et Téléphones*, 1923.

understanding the broader making of economic valuations and their metamorphosis, which also involves the formation of new objects of measurement. Moving attention from "calculating economic life" to "governing economic life," Miller assumes that "the concern with practices has achieved a much wider sociological significance" (2008). Yet, in this article I do not seek to reduce "epistemic culture" (Knorr-Cetina 2007 [1997]) to modes of power: measuring can be about managing conduct, just as it can be about exploring and disclosing the world. My aim is to show how French State engineers came to transform and value the telephone as more than an expensive device for physicists, and to unpack the role that metrics played in this process.

Economic valuations were there from the start and (re)produced, along with new devices and new horizons of seeing and doing, representing and intervening (Hacking 1983). Engineers are continually engaged in such inquiries (Section 1). But inquiring on the telephone provoked a shift in focus towards economic valuations: the practical genesis of an idea *producing value (valorization)*. The understanding of how a valuable effect is shifted from minimizing force losses to producing subjective utility. The first valuation frame relied on an economy of forces, valuing the "smallest loss": engineers mostly counted losses to reduce them (Section 2). The second frame values the production of utility: engineers invent an economy of the "greatest gain" (Section 3) that eventually considers the telephone call itself as *producing value*. Thus the telephone is not only evaluated (granted a value) but also valorized (viewed as producing value).[4] This valorization deepens when engineers envision a law of demand stimulated by rising traffic and start framing users as customers (Section 4). Following this dynamic of changing valuations, I see engineers as paying attention to telephone lines, operators, circuits or traffic (Bidet 2005a; see also Appendix 1 and 2). But this logical succession does not imply a strict chronological order, nor does it delineate phases in the history of telecommunications: various foci can coexist in the same period, or in the same article in the *Annales des Postes, Télégraphes et Téléphones*. However, the broader shift towards a valorized telephone is manifested by changing concerns about metrics, interventions and values. Moving from an economy of forces towards the production of utility, the understanding of how worth is shifted from work value to utility value: whereas the first one could only be spared, the second one could also be produced.

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[4] On this distinction between evaluation and valorization drawing on Dewey's theory of valuation, see Vatin 2013.

Metrics: studying economic valuations within work practices

Measurement, especially the development of metrics, is a normative and highly creative process. François Dagognet has highlighted its unifying and revelatory powers (1993). On the one hand, things are no longer autonomous once they have been measured, but are assigned to a homogeneous group of commensurately valued things that makes them prone to automatic processes of connection: incommensurables become commensurables. On the other hand, measurement frees things from the relationships we form with them, allowing us to seize and manipulate them in new ways. They open new avenues for action, as they "discard the useless, the encumbering," and project the measured thing "onto a substrate favourable to an operational language" (Dagognet 1993: 167). Measurement produces new entities and opens up unexpected or recalcitrant phenomena for investigation. This process is "involved in the cumulative growth of systematic knowledge" intrinsic to the logic of writing (Goody 1977: 150), which begins with taxonomy and the making of lists and tables (Bowker and Star 1999).

Metrics are bound to performativity issues, but also to dynamics of inquiry, which do not point only to the pursuit of objectivity (Porter 1995) but also to the continued transformation of the world. Representing and intervening through metrics transforms phone calls and telephone entities within the process. Applying any metric to optimizing service leads to a need for new valuations. Inquiry is therefore a two-phase process. Defined as "the controlled or directed transformation of an indeterminate situation into one that is so determinate in its constituent distinctions and relations as to convert the elements of the original situation into a unified whole" (Dewey 1938: 108), it includes both phases of doubt and phases of certainty or knowledge. Telephone engineers move between moments of inquiry, seeking and inventing metrics to grasp and define new phenomena, and moments of optimization, when they know what to count and how to measure it. Models guide their choices in the latter phase, whereas they search for ways to accommodate and measure new entities in the former. The analogy of life that is so common in the engineering literature at the time grants these entities a natural economy, calling for endless exploration since all natural organisms keep changing. The metaphor of life is explicit: engineers are seeking iconographic reductions of the "telephonic life."[5] In telephonic lines, circuits or other items, they see "mechanisms that, by their flexibility and the endless number of accumulating combinations they allow,

[5] Here and below, the quotation marks indicate a frequent expression.

become almost comparable to living organisms, and like them are in a permanent state of evolution."[6] This pattern sustains the engineers' quest for iconographic reductions, their multiple attempts to crystallize the "telephonic life" in a curve, number, table or other visualizations. They want to see it "at a glance," as in the image of the effect that a spoken word has on the current in Figure 1.

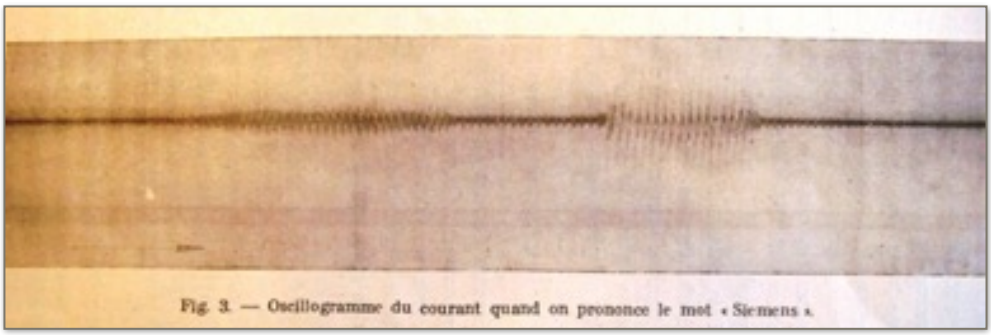

Figure 1. The primitive inscription of sound: the inscription foreshadows the ordering of a still-elusive phenomenon (caption reads "Oscillogram of the current when the word 'Siemens' is spoken").

The successive methods engineers invented for defining what should be sought and what makes the telephone valuable are part of its metamorphoses. Inventing a metric[7] is determining a frame which defines and prioritizes the various telephonic entities in a certain way, states their respective normativity (what they are worth, what they can claim or demand),[8] and requires that all choices be formulated within its optimization framework. To paraphrase Porter (1995), within each frame, engineers "trust in numbers," but between two frames they trust in experimentation, experienced judgment, and trial and error: their focus is less on accuracy than on the new phenomenon to be tackled.

A reminder of a few facts on early telephone technology: in the early days of the telephone, the voice was transmitted by an electric current running on a line. To improve this transmission, the focus was

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[6] "L'autonomie financière des PTT et les méthodes modernes de comptabilité," (by E. Julhiet, engineer from the École Nationale Supérieure des Mines de Paris), *Annales des Postes, Télégraphes et Téléphones*, 1925.

[7] In his "plan for a sociology of measurement," Jean-Yves Trépos (1998) had already called for wide acceptance of the concept of measurement, including all the cognitive operations linked to commensuration processes.

[8] The term "normative entities" highlights the legislative dimension of the activities of the humans and non-humans involved in the operation of a technical set (Dodier 1995).

at first on the transmitter in the phone handset: it had to be strong enough to overcome the line's "resistance." The telephone lines themselves were initially so neglected that an adage stated "anything's good enough for telephone lines." But this focus no longer worked when instances of "strong" yet inaudible telephone signals arose.[9] The growing heterogeneity of telephone amenities and the invention of amplifiers (to increase the signal's strength) indeed entailed unexpected sound quality problems. Although electrical metrics were still envisaged at the first International Conference of Technicians of Telegraph and Telephone Administrations in 1910, a new measure, "conversation trials," would eventually replace them. This auditory measurement, based on comparison between equivalent lengths in "standard line meters," consolidated a variety of electrical properties into a single dimension: *attenuation*.[10] "Listening quality" was then calculated by measuring the attenuation each component introduced along the chain of connections between two speakers, from the telephone cord to the telephone exchange. But the goal and metric remained the same: avoiding *unnecessary* friction that would dissipate energy along the lines. Engineers were then committed to minimizing this energy loss. This valuation frame, very common to nineteenth- and early twentieth-century engineers, can be described in terms of an "economy of force" (Grall 2003). It is imbued with the same notions that came later to be systematized under scientific management: both draw from knowledge in industrial mechanics. This "industrial science" was developed by applying to machinery the twin concepts of effort and product that were borrowed from an engineer's observation of human work. This interplay between human work and machine work, and back, has been discussed by Vatin (1993).

An initial frame for valuation: saving work

Developing industrial mechanics, in the 1820s French engineers conceptualized the *work* of machines by analogy with human *work*: as both an effort and a product. In this conceptualization, "work" stood as a "mechanical currency" (Vatin 1993: 58): a common metric and what had to be conserved. As François Vatin demonstrated, this physicists' formalization of work has an economic connotation from the outset. The initial formulation of the physical concept of work by Gaspard-Gustave de Coriolis promoted the aim of a useful effect and

[9] This ambiguity is specific to the physics of the era, which was preoccupied with the conservation of energy, while telecommunications techniques relied on the conservation of *variations* of energy.

[10] Meaning the relative decrease in the power of a signal during its transmission, it is the ratio between the effective value of the signal at the output and that at the input of the section under consideration.

an economic norm – the perfect transmission of work, without losses (heat, friction, waste, etc.): "[T]he faculty of working is limited for each time, for each place; it is not created at will. Machines only use and save work, without being able to increase it. Hence the faculty of working is sold, bought, and saved, like all useful things which are not in extreme abundance." On the one hand, the distinction between "lost" work and "usefully" used work is entirely subordinated to the economic purpose that is attributed to the mechanical device. On the other hand, the consideration of scarcity and opportunity cost appears to be at the heart of this optimization framework. Let us quote Coriolis himself: industrial mechanics elevate work – rare, since it tends to be lost – into a "mechanical currency" (according to the formula of the physicist Claude-Louis Navier), and it subsumes it to the principle of economic valuation.

This metric, by setting the perfect transmission of energy in machines as an economic ideal, casts mechanical phenomena as *imperfect transformations,* always entailing a certain *ratio* of losses. Telephone engineers proved to be the first committed to this *economy of losses*: maximizing the *ratio* of useful work to total work. They first tried to minimize the loss of energy in the telephone set, and then along the telephone lines. The domestication of various "telephone effects," necessary for putting the device into use, began by focusing on the transmitter's "power": "Every person who had a telephone at his disposal looked for a way to increase the instrument's power."[11] We have already presented the initial leap that would then shift engineers from analysing telephonic currents to an auditory measurement of line quality. Early telephone service had heavy line infrastructure costs. The new focus led engineers to create a space for potential arbitration between the cost of the line and its listening quality. Losses along telephonic lines were not merely seen as part of a natural economy to be studied; once lines had been made commensurable, losses became a problem to be fixed: difficult to solve, but acted upon. In a market setting, this could mean exploring demand in order to choose the level of quality with the best profit-cost ratio. Instead, telephone engineers aimed for a service quality standard that was both acceptable to the public and budget-compatible, or, put in another way, gave a "good transmission" at a "minimal price." The valuation of a "good transmission" was then the first conception of a *product* in this domain, since economic *value* was equated with minimizing losses along the lines.

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[11] "Le téléphone. Extrait du rapport de la commission spéciale chargée de l'étude du téléphone et des services qu'il peut rendre à l'exploitation télégraphique," *Annales des Postes, Télégraphes et Téléphones*, 1878.

Beyond optimizing telephone sets and telephone lines, this "economy of force" was also applied to the work of operators – the phone ladies (Bidet 2005b). As with the lines, engineers tried to establish a proportional relationship between the work to be done and the required workforce, with the aim to save work: "all shortening of the time needed for the establishment and even the termination of calls is a gain."[12] Concern for rationally organizing operators' work thus connected optimal productivity to the suppression of "useless movements and words" – those of the operators, but also those of the callers. The criteria of value were thereby related to the facilitation of service – with a focus on minimizing amounts of work. Thus, although the duration of communications was identified as a source of costs, it was not intended to provide a market response by charging for duration of communications. The primacy of a mechanistic framing of value over a market-based conception of cost is attested more generally by the systematic translation of the phenomena of congestion into a queue and into "dissatisfaction of the customers," but not in terms of a possible loss of profit. Duration was seen as a "useless" cost, and all the more so that it was not taken into account for the billing of long-distance calls, which was according to distance only.

From minimizing losses to *creating* value: shifting valuations

The development of the first intercity lines in underground cables, called "circuits,"[13] resulted from this continued search for minimizing losses along lines. But it also got engineers back into studying what to value, and how. Processes of valuation involve "exploring sites of dissonance" (Stark 2009; Berthoin Antal et al. 2015). Why did intercity operations upset the existing optimizing framework? Because new entities had popped up in the telephone landscape: "the length of auxiliary lines is no longer negligible," and "the scale of traffic between two localities does not justify the application of urban operation methods."[14] In other words, the cost of long circuits – the amortization of a "considerable immobilized capital" – prohibited their proliferation which would have offered callers a "chance of over 999 in 1000" to find one open.

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[12] Henri Milon, *La téléphonie automatique,* Gauthier-Villars, Paris, 1914. An engineer, he was in charge of the Telephone Operations Service (*Direction de l'exploitation téléphonique*, created in 1909) throughout the 1920s.

[13] The first French intercity connection (1885) ran between Paris, Rouen and Le Havre. By 1890 there were 11 intercity lines in France.

[14] Henri Milon, *Principes généraux d'exploitation téléphonique*, 1925.

A "long circuit" then came to be defined by the need to update the criteria and methods for evaluation, and not by its length. Within a set distance of 100 kilometres, engineers kept their valuation frame: "the main point is not avoiding the loss of time, but the cost of labour."[15] But beyond 100 kilometres, they decided to focus less on speeding up the phone ladies, than on increasing the circuit's use. Here work – still measured by time – changed sides. Instead of referring to the work of connecting two lines, the "cost of labour" now referred to the work of building circuits, meaning that the same economic norm – minimizing losses – shifted from operators to circuits. Thereafter operators only had "a very small number of circuits to service": to facilitate "the increase of yield that the operator may obtain thus compensating, and more than compensating for, the supplementary personnel and equipment costs." It is not formalized theory, but practical knowledge "that allows this determination by trial and error."[16] In 1910, experiments were conducted on the six circuits connecting Paris to Lille: the challenge was to reduce the number of circuits assigned to each operator at busy periods in order to increase the average number of calls per circuit, so long as "the gain in receipts" remained higher than the increase in personnel costs. The number of circuits per operator was not determined by the average time taken to establish a communication link, but by the circuit's productivity according to its workload: "the supplementary operational charges resulting from it are minimal compared to the lack of gain brought about by a defective service."[17]

Let us see now how this management of intercity lines freed engineers from thinking solely in terms of losses. According to Latour, a valuation frame evolves when applied to "another regime of inscriptions and traces" (Latour 1985: 15). Figure 2 traces the duration of conversations on each circuit. In this figure, each horizontal line represents the duration for which a line was occupied; each line corresponds to a call, with a number indicating its chronological order. The interval between two vertical lines represents five minutes. One can see empty spaces between two consecutives black lines. Trying to

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[15] "La préparation télégraphique des communications téléphoniques et le rendement des grands circuits interurbains." *Annales des Postes, Télégraphes et Téléphones*, 1926.

[16] In the absence of graphic representation or formulae, the optimum balancing cost and a marginal gain remains implicit. "Moyens d'augmenter le rendement financier des grandes lignes téléphoniques," *Annales des Postes, Télégraphes et Téléphones*, 1922.

[17] "Le rendement des lignes téléphoniques en Allemagne," *Annales des Postes, Télégraphes et Téléphones*, 1913.

fill this space meant discovering a shortfall: engineers became *de facto* committed to get more instead of less. Of course, losses and gains are two sides of the same coin, but the concrete effort of the engineers shifted towards value to be created, and not only what could be saved.

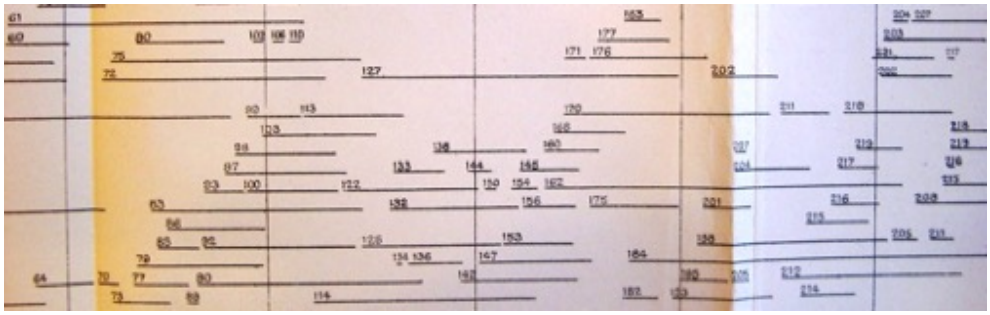

Figure 2. Detail. Graphic recording of the durations that lines in a group of auxiliary lines were occupied (reproduction of a 1918 AT&T document in the Annales des Postes, Télégraphes et Téléphones, 1921).[18]

The materiality of this managerial artefact makes it particularly effective (Bayart 1995), naturalizing a certain number of choices. The graph exposes an implicit valuation of circuits: successive calls were initiated one after the other and handled by a single operator. Put differently, calls were not addressed at the moment of demand. To improve availability, so that operators could increase circuit yields, they needed several pending calls lined up while they waited for an opening. Yet demand for calls only had these properties because of the reigning operational mode, and more specifically its particular constraint, waiting time, which regularly lasted several hours for intercity lines in the 1920s. We can see how a new object of optimization appeared from this observed fact: "the average waiting time depends on the excess demand which may occur at a given period on the circuits' flow capacity." There was consequently a need to "call back" people wishing to place a call and "take note" of their requests to establish a "chronological order" for the waiting list *(ibid.)*. Engineers went on to make this so-called "technical constraint" into an object of optimization, and thus management. Subjected to explicit organizational work, the *average waiting time* became a norm, maximizing the value produced by filling circuits based on the management and measurability of the calls on the waiting list.

Circuit yield thus illustrates the *practical* origins of what came to be valued and optimized, which emerged from *exploring* telephonic activity's constraints and components. From this perspective, it is not constraints as such that are interesting for engineers, but their

[18] "Mission de fonctionnaires des Postes et Télégraphes aux États-Unis," *Annales des Postes, Télégraphes et Téléphones*, 1921.

potential link with a product, their potential effects, and the correlate possibility of deriving optimization from their exploitation. In turn, in this optimization the technical "data" stand as pre-existing constraints, no longer suffered *ex post* but posed *ex ante*. Turning necessity into a virtue is thus the hallmark of an inquiry grounded in practice. The service came to rely on the possibility of calculating waiting times, which dictated the operators' load as well as indicating *a probable waiting time* to the callers.

In Figure 2, we can see an unexpected consequence of this new metric: all the conversations are short, rarely filling (and never exceeding) the space between two vertical lines – that is, five minutes. This is the result of operators' work ensuring that the standard call duration of six minutes was respected and "cutting" conversations when other callers were waiting. Without this *standard conversation length*, any "indication of the probable waiting time would be illusory": the average waiting time would not be calculable in advance. Engineers' new valuation frame thus required operators to "[*cut*] conversations off." Operators also saw the paradox of such an optimizing method that involved "cutting" calls: "this condition is not favourable to yields, because the more a subscriber talks at length on a circuit, the better the circuit is occupied."

This choice was adopted partly because it was nearly impossible to object to it at the time: calls were considered simple exchanges of messages, with no value attached to their duration.[19] In addition, long calls went against the principle of *public order,* born of an economy of penury: "from a general point of view, it is impossible to let a subscriber monopolize a circuit over a certain time; the limitation [*of conversation length*] allows for the satisfaction of the largest number of subscribers and avoidance of excessive displeasure for the clientele."

Consequently, with pricing remaining per unit,[20] "cutting" calls made the rate correspond to the *duration* a circuit was occupied, in turn making it profitable to optimize circuit use. Establishing a rate or an operating mode always has unintended effects – externalities. As Callon's "overflowing mechanisms" (1998) revealed, all framing, being

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[19] Duration is introduced in France only in 1985 in the billing of local calls.

[20] The unitary fee ("taxed conversations") replaced the flat-rate subscription from 1924 onwards in France. The flat rate subscription was supposed to cover an average use and understood as the price of access to the service. Until 1924 it allowed an unlimited number of conversations within the local network. However, the rationality of unitary taxation was unquestionable for engineers: a rational price should cover the cost price, identified then with the direct human work of putting callers into conversation. But the cost of counting calls was hitherto an obstacle to the unitary fee.

imperfect and incomplete by definition, is also "its own inescapable source of the threat of overflows" (Çalışkan and Callon 2009, 2010: 8). Here we see the relationship between metrics and valuations: a metric, being the product of a way of assessing value and cost, when established, brings to the fore new entities that may create dissonance and require new valuations. Although in this case it was initially cost that justified the revenue (rare and expensive circuits should "pay"), the rationalization of their use shifted engineers' thinking to "gain." And with the change in billing practices for calls over 100 km, long-distance calls started to "pay," contributing to the gradual disappearance of competing costs from equations. As the "revenue depends on the number of calls made,"[21] the extent of the use of circuits, especially "some big circuits with a lot of traffic" and a high per-unit rate, became subject to "minute by minute" attention, so "that the conversations follow each other almost without interruption" to "increase the lines' income" and "the circuits' paid occupied time."[22] In thinking of the rate as the remuneration of capital investment, engineers opened a new field of monetary *ratios*.[23] Their analyses began to dissociate usefulness from a *modulation of the useless*: "productive minutes" are distinct from "lost minutes" *by nature*. Monetary valuations then went on to give weight to this new figure of created gain or value. They increased and highlighted the specificity of "productive minutes": they "pay." Those operating the nascent system thus came to associate the circuits with the production of utility and revenue which would increase with the duration of the calls, and in doing so also the service's worth increased.

This process does not mean the emergence of a commercial focus, however. Making an issue of "financial yield" did not lead engineers to anticipate a *commercial* response to telephony's condition of chronic penury. The possibility was nonetheless raised as early as 1887, in the *Annales des Postes, Télégraphes et Téléphones*' first contribution to intercity telephony, when an engineer, echoing a debate over a rate change opposed by railway engineers, set out to dissipate the "mirage" of a low fee. Only a high fee could chase "off the callers who only have an insignificant reason to place a call, [*and*] would allow the acquisition of regular service" that would be favourable for "truly

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[21] "Méthode d'exploitation des lignes téléphoniques interurbaines," *Annales des Postes, Télégraphes et Téléphones*, 1916.

[22] *Ibid.*; and "La contribution des ingénieurs français à la téléphonie à grande distance par câbles souterrains," *Annales des Postes, Télégraphes et Téléphones*, 1917.

[23] The 1923 accounting and budgetary reform instituted amortization and introduced a distinction between the establishment's costs and income and those of its operations.

commercial usage."[24] The French economist-engineer Jules Dupuit inspired this rationale: since a call is not worth the same to all agents, fixing a price level selects those for whom calls are worth the given value. But this interpretation of Dupuit is paradoxical; the problem he presented was not, in fact, resource scarcity, but a desire to set differential rates so everyone would have access to a good at a price each could afford. On the contrary, as the quote shows, future price would determine the corresponding demand, since the supply is fixed. Resource distribution could thus be adjusted by price, not by waiting list. [25]

The development of a commercial rhetoric (clientele, income, profits and so on) supporting the valuation of circuits was more a reflection of the extent to which engineers (who trust in numbers) valued *calculation* itself than an indication of a commercial turn. Calculation and optimization were their standard routine, radically different from the "search for numbers" they returned to periodically when reaching the limits of a model or a metric that failed to contain its overflow. In this case, calculation has more to do with the "thought's tendency to rest"[26] than with the drive for gain or love of knowledge.

In this shift from evaluation to valorization, from value as being saved to value as being produced, engineers' valuation of circuits also led them to discover a "law of demand" and to value "clients."

Discovering a law of demand

This progressive shift in valuation frames was not led by a broader rationale guiding the development of telephone services (not envisioned as an economic tool until the 1960s) by the French State nor by technological changes. Valuations and techno-organizational changes were integral to the same mundane dynamic of inquiry. When inquiring, engineers modified simultaneously their valuations and their

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[24] The perspective is dynamic; receipts should allow new lines to be financed, which would then allow rates to be progressively lowered, which was "increasingly practical, because the multiplication of needs will be preceded by the multiplication of means for action."

[25] This system only works with one of the two dimensions of Dupuit's variation of utility: the hierarchy of needs, not the wealth pyramid.

[26] We know that Charles Sanders Peirce (1978) described this research as an attempt to escape the irritation of doubt, and to re-establish a state of belief within a "community of competent explorers."

environment (organization, technology, etc.).[27] And as they modified their environment, they were more likely to get back to inquiring again as new entities and unexpected side effects emerged. Maximizing circuit yield put engineers face to face with an unexpected observation: "The measurement [*of consequences from the increase in operators*] also highlighted a frequently observed economic phenomenon: since calls were connected more reliably with shorter waits, *demand grew,* and the daily average once again rose rapidly."[28] This was a side effect of the previous optimization, which created relative abundance after a phase of managing cost. As a result, engineers noticed that "putting a new line into service" prompted "an increase in traffic."[29] Such observations suggested the existence of a predictable and potentially valuable demand, not just a "nuisance." Financial objections to the development of underground cables could thus be mitigated:

> The sound is still good, and one can rely on calls that have been put through. The absence of parasite noise is so complete that understanding is greatly facilitated. Public confidence is increased, which leads to *a more frequent use* of the telephone, which greatly improves circuit use, and with that, receipts. It soon becomes necessary to use the reserve circuits, and the time they spend unused is of short duration. [30]

As a result, the valuation frame's specific operational mode focusing on circuit yield became obsolete. When aerial lines were replaced with underground multi-conductor cables, waiting times shortened and operators no longer needed to constantly prepare circuits to assure supply for a waiting list of pending calls. In losing its relevance, the previous valuation of circuits lost its performativity:

> It is illogical to impose an avoidable waiting time on the clientele with the sole aim of increasing the yields on the circuits in service, since alongside them there are also circuits with zero yield for which the amortization fees and upkeep are, with very few exceptions, equivalent.[31]

The expression "it is illogical" marks the effort needed to break free from an existing frame: what was once logical ceases to be so *when the frame is no longer relevant*. But the fact remains that with an

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[27] For more on this, see Bidet (2014), Bidet and Vatin (2008), as well as Schön (1983) and Bayart (2000).

[28] "Moyens d'augmenter le rendement financier des grandes lignes téléphoniques," *Annales des Postes, Télégraphes et Téléphones,* 1922 (emphasis added).

[29] "Le rendement des lignes téléphoniques en Allemagne," 1913.

[30] "Les lignes téléphoniques souterraines interurbaines," *Annales des Postes, Télégraphes et Téléphones*, 1916 (emphasis added).

[31] "Les nouvelles méthodes d'exploitation interurbaine. Le trafic direct," *Annales des Postes, Télégraphes et Téléphones*, 1930 (emphasis added).

abundance of circuits, their productivity "no longer [*has*] an appreciable influence on the amount of receipts, since no demand is at risk of cancelation because the lines are encumbered."

Since the drastically shortened waiting times made it impossible to anticipate a longer waiting list, engineers went on to build a new *optimum* corresponding to the vanishing waiting lists: "operational methods should, then, not only increase the circuits' yield, but reduce the waiting time in a more satisfactory way for the clientele and increase the number of demands."[32] The aim is no longer a stable "maximum yield" optimum, but dynamic growth in circuit yield due to increased *traffic*, which becomes the new variable to maximize. In the early 1930s, this preliminary intuition of a "law of demand" sparked the development of an operating mode called "direct traffic," modelled on American "no-relay service."[33]

Discrete management (call-by-call) was thus followed by continuous management (of flux): *traffic* no longer designated a given constraint to be coped with, but a *variable at hand to be optimized*. The service's worth was no longer set in *evaluating* the cost of operators' labour but in *valorizing* the "demand" for phone calls by increasing it. Its emergence as a central issue piqued engineers' interest in the behaviour and satisfaction of *those using the service*. Mastering traffic flow henceforth meant taking account of the public's learning curve, anticipating the consequences of growing "confidence" in the service, "the habit of being served rapidly," being able to hear well and so on. Advocates for the "receipts angle," then, did not merely appeal to subscribers for legitimacy; a "client" rendered measurable was needed to run their calculations.

Conclusion

Economic sociology has paid little attention to economic valuations beyond prices, as prices have long seemed to be the metrological index for value. Many sociologists, like Jens Beckert and Patrik Aspers (2011), continue to share with economists the postulate that sees the central place of revelation and/or formation of economic value in the marketplace. This study sought to illustrate another approach to the study of economic value. It avoided the aporias of the noun "value" by preferring the verb "to value" (Dewey 1939), which encourages us to describe *acts* of valuations: activities, practices, processes that value a

[32] Ibid.

[33] Ibid.

situation, an object, an event, a person or a way of doing things. Economic valuation, from this perspective, finds a broader meaning. Economizing is not limited to "framing" activities around the exchange, nor to "the ideas and instruments through which individuals, activities, organizations, nation states, regions, projects, and much else besides are constituted as economic actors and entities" (Kurunmäki et al. 2016: 395). Beyond market orientation *stricto sensu*, lies the mere interest in optimization. At the root of the notion of economy, we indeed find the act of management (Vatin 2008a, 2008b), that is to say, the relation of an action and its effects, that one can assess according to various criteria, various metrics. To inquire into economic valuations, we shall then also look within organizations, companies and work practices – these "black boxes" of economic theory (Bidet 2011, Favereau et al. 2016). Any place devoted to work and management is full of inquiries and standpoints, often of a performative nature, on how to produce useful effects.

To track these economic valuations, a metrological approach proves relevant. The issue of measurement does not only give here an analytical status to organizations, businesses, companies in economic sociology. It also asks us to consider these organizations through their concrete work activities. What is valuable? All actors at work are confronted with this issue. Explicitly or implicitly, they use, explore and create metrics aimed at valuation. Paying attention to these metrics that inhabit practices and devices deploys a new perspective on economizing. Let me emphasize two specificities. A first point is that, contrary to Michel Callon and Bruno Latour (1997), who were mostly interested in the moving partition between what counts and what does not count, the inside and outside of calculations, the commensurable and the incommensurable, as two complementary framings, I consider the very process of doing commensuration: how to count, and to make disparate elements commensurate? Especially: what to put in the denominator and the numerator? What should be considered as a product, as a cost, etc.? In this process, calculation and judgement do not draw distinct worlds. The very possibility of measurement, of calculation involves setting standards of value (Barraud et al. 2013; Bidet and Vatin 2013). The second point is that, contrary to many inspiring studies in accounting and management science, which have studied management and work practices for a long time, I emphasize the epistemic dimension of work: besides the classic problem of control or governing – the conformation of behaviours to norms – I also consider economizing as an epistemic process, through which managers, engineers and workers are exploring, representing and transforming the world. It necessitates that they not only try to articulate pre-existing and dissonant conceptions of worth (Stark 2009); they also inquire into what is valuable and these inquiries lead

them to create new metrics. They rework metrics already at work in society, and they contribute unintentionally to their shaping.

In this study, we saw during the interwar period French State phone engineers wondering whether phone lines or phone calls were only consuming value or if they could also create some. The latter idea appears gradually, through a dynamic of inquiries and shifting of economic valuations. From saving work and minimizing losses to creating value, engineers went from evaluating (telling what is worth, within an economy of force, optimizing the ratio of losses over total work) to valorizing (framing value as possibly produced and not only saved, the production of utility). This new concern for valorization in the phone industry points to the development of ideas on what could create economic value (and not only minimal losses or offset costs). In this process, the very acts of measuring, optimizing, calculating, appeared as both "subversive," in that they pushed those who conceive metrics to transform the phone organization, and "subverted," in that when they mobilize a metric they often also contribute to redefining and transforming it. Finally, studying economic valuations through metrics stresses an indefinite creation of commensurability. Thereby, economic sociologists have the opportunity to capture the creativity of social action – a dimension which the hegemony of the two rival models of rational action and normative action has long eclipsed.

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Appendix 1 Chronology

1792 The system of optical telegraphy invented by Chappe appears in France.

1820 Three physicists (Oersted, Ampère and Arago) develop the electromagnet: electricity can be used for communication.

1837 Law passed on the monopoly of telegraph lines. The American Samuel Morse invented the electrical telegraph: a simple code uses the variation of the pulse rhythm to convey a message.

1851 Opening of the electric telegraph to the public.

1855 Creation of the Telegraphic Annals.

1876 First telephone patents by Graham Bell and Elisha Gray in the United States: the vibrations communicated by the voice to the transmitter membrane cause a magnetic flux of a magnetic bar placed in front of it, causing electric currents induction.

1877 Arrival in France of the first prototypes of telephone. Invention of the microphone by the American Hughes.

1878 A first commercial telephone switchboard is put into service in Connecticut and serves 21 stations.

1879 The Postal and Telegraph (P&T) Administration authorizes the creation and operation of telephone networks. A first network is put into operation in Paris. The limit reached by the telephone tests is 150 km.

1880 Paris has 100 subscribers including 22 newspapers, 70 banks, stockbrokers, brokers. The three companies merge into the General Society of Telephones. It reorganizes the network of Paris and creates those of Bordeaux, Marseille, Nantes and Le Havre.

1881 The Société Générale des Téléphones (SGT) has fewer than 2,000 subscribers. Paris has seven central offices and more than 300 lines. Seven provincial cities have a network.

1882 Beginning of the expansion of the telephone in France. The first "annunciator" boards serving small inland networks appear. The Minister of P&T obtains from the chambers a credit to test the operation of the telephone.

1883 Opening of the first telephone networks managed by the state in Reims and Roubaix. Ministries and large enterprises develop indoor facilities.

1884 Almost all major cities in France are equipped with a telephone network. Renewal of the concession for five years of telephone networks. SGT ceases to invest in networking and benefits from its monopoly.

1885 Opening to the public of the first intercity link between Paris, Rouen and Le Havre. The rate for a 5-minute conversation is 3 francs (the average daily wage of a worker is 5 francs).

1887 SGT has 7,666 subscribers in 11 networks; the state, 1,627 subscribers in 11 networks and 16 networks in creation.

1888 France has more than 10,000 subscribers, including 6,000 in Paris.

1889 Creation of the first subsidiary budget (applied only for the budgetary years 1891 and 1892). Nationalization of the telephone networks of SGT, which has 9,100 subscribers. The P&T engineers are responsible for their management. They join the Ministry of Trade and Industry. The development of the telephone is entrusted to the municipalities via the process of "repayable advances". The development of urban networks accelerated between 1890 and 1893.

1890 In France there are 11 intercity lines. Invention in the United States of the first electromechanical switching system: the "Strowger".

1891 A decree extends the system of repayable advances to intercity lines. Plan to reorganize the Paris network (creation of the first subsidiary networks). First submarine telephone cable (Dover-Calais).

1892 France has 220 central offices (telephone exchanges). The first automatic one is put into service in the United States.

1895 The law modifies in part the powers of the telegraph engineers, henceforth guarantors of the interests of the state with regard to the global electrical installations and the protection of the telegraph and telephone lines.

1899 A. Millerand, the new minister in charge of P&T, launches a plan of economy. The publication of the *Telegraphic Annals* is stopped.

1900 Millerand report on the phone. France has 56,000 main subscribers. Responsibility for the development of telephony passes from the communes to the departments. Invention of the "Pupin" load coils to reduce the weakening of underground cables.

1902 Creation by A. Millerand of a state body for the engineers of P&T. It includes only 37 engineers until the end of World War I.

1904 First use of the notion of "telecommunications," by E. Estaunié in his *Traité de télécommunication électrique*.

1905 Establishment of the Association of Telephone Subscribers.

1906 Invention of the tube amplifier, the triode of Lee De Forest, the origin of all electronics. Beginning of substitution of multiples to standards. Huge strikes of operatives until 1909.

1909 Intense public debate on the crisis of the telephone and its financing. The newspaper of the association of subscribers titles article "Telephone anarchy". The Materials and Construction Department, occupied by E. Estaunié, becomes the "Telephone Operations Directorate". There are 44,600 subscribers in Paris. The telephone share takes precedence over that of the telegraph in the total number of calls.

1910 France has one subscriber per 200 inhabitants. Plan for census of the French telephone lines. Very great weakness of interdepartmental links. First issue of the *Annals of Posts, Telegraphs and Telephones*. The number of posts per 100 inhabitants is 0.5 in France, 1.3 in England, 1.5 in Germany, 3.1 in Sweden, 3.7 in Canada and 7.6 in the United States.

1913 Inauguration of the first automatic exchange (Strowger) in Nice. France has more than 22,000 exchanges and 340,000 subscribers, 65,000 in Paris; telephone density is 0.77. Creation of the Association of Postal and Telegraph Engineers.

1920 Report by H. Fayol on the "Industrial incapacity of the State and the Post Telegraph Telephone (PTT)". Launch of renovation of the network, under the supervision of A. Millerand (President of the Republic).

1921 France has 474,000 subscribers, one-third of these in Paris. Commissioning of an automatic exchange in Orléans.

1922 Project for automation of the Paris network. First PBX commissioned in New York. Paris has 120,000 subscribers.

1923 Vote on 30 June of a "subsidiary budget" of the PTT and a ten-year turnaround plan. The average waiting time for a long distance call is five hours.

1924 First telephone cable (Paris-Strasbourg). The unit charge progressively replaces the flat fee. Creation of the Underground Lines Service at long distances. Control of the first long-distance cable (Paris-Strasbourg). Standardization of subscriber stations (150 types were in service).

1925 Start of the French network of long-distance cables; of the 25,000 networks in France, more than half have fewer than five subscribers; Of the main lines, 4 per cent are served automatically. Beginning of use of tube amplifiers. Taxation per duration is generalized.

1928 The Paris network has 159,000 subscribers, serviced by 6,480 operators. Commencement of 21 automatic central offices in Paris. Ten switches have been installed in the provinces. The French telephone density is 2.2. France has twenty times more central exchanges than the United States for eight times fewer lines per capita. Creation in Paris of the first teams specialized in the maintenance of long distance cables. Permanent service is provided in all networks with more than 200 subscribers.

1930 The economic crisis is jeopardizing the financing of the recovery plan.

1931 The Paris network has 189,000 subscribers (including 82,000 automatic) and 5,600 operators.

1932 Of the main lines, 25 per cent are connected to automatic exchanges (this rate is 48 per cent in Paris). Nearly a quarter of the

lines are concentrated in Paris. Out of 38,000 municipalities, there are 31,939 networks, 70 of which exceed 1,000 subscribers (average of 5.7 subscribers). First automatic zones are built around certain cities (Saint-Malo, Deauville).

1933 The first suburban switches are in operation in Paris.

1934 Cancellation of credits stops automation of the Paris network for 20 years.

1935 Use of the carrier current technique to transmit several communications on the same line. The inter-urban central office of Paris generalizes the operation with direct traffic to all its connections.

1936 Development of semi-automatic rural central offices. Installation of the first long-distance coaxial cables in the United States and Great Britain. Creation of telephone districts, grouping together the networks of a canton, and benefiting from a simple tax.

1938 Of the main lines 55 per cent are still served by manual exchanges (16 per cent in Germany). The telephone density is 2.4 stations per 100 inhabitants. France reaches a million subscribers. First automatic intercity link between Nice, Cannes and Monaco.

1945 Long distance calls are charged directly to the meter and not by ticket.

1947 France is the first country in Europe to establish a coaxial cable link over a distance of more than 800 km (Paris-Toulouse).

1948 Article by C. Shannon in the *Bell System Technical Journal*, founder of the theory of information. France has 5.8 posts per 100 inhabitants (compared with 9.3 in Great Britain and 24.2 in the United States).

1949 The American Von Neumann develops the first computer: the birth of computers is linked to the digitization of information.

1951 France is the first country in the world to set up an automatic long-distance link (500 km) from subscriber to subscriber (Paris-Lyon, 50 circuits).

1955 Of long distance traffic 15 per cent is fully automated.

1957 The rate of automation of the French telephone network is 55 per cent. Introduction of a reduced tariff in fully automated connections.

1960 Nine telephone sets per 100 inhabitants (compared with 15 in Great Britain and 39.5 in the United States).

1963 5.4 telephone lines per 100 inhabitants (27.6 in the United States, 9.7 in Great Britain).

1964 The connection time is on average 3 years.

1966 The Fifth Plan (1966–70) began a modernization of the network: telecommunications are recognized as a major infrastructure and a factor of economic development. The number of main subscriptions is fewer than 3 million.

1967 France has 400,000 pending connection requests.

1968 Rate of telephone equipment of French households was 15 per cent.

1970 Telephone density was 7.8 main lines per 100 inhabitants in France, 15.3 in Great Britain and 33.3 in the United States. In 1968, the rate of telephone equipment in French households was 15 per cent.

1971 The Sixth Plan highlights the role of telecommunications in French economic life. It has credits three times higher than the Fifth Plan and its first objective is "the smooth flow of traffic".

1973 The Sixth Plan becomes the "Telephone Plan". Direction Générale des Télécommunications (DGT) becomes the largest French public investor. The Paris network represents one-third of subscribers and revenues. Official establishment of the Operational Directorates. Removal of the quantum of connection in the taxation of communications by automatic means.

1974 France has 6 million subscribers. Of households 23 per cent are equipped.

1976 The Seventh Plan makes the telephone the subject of a priority action programme.

1978 In the year, more than 10,000 new subscribers are connected per day (compared with 100,000 per year in the 1950s).

1980 Of French households 80 per cent are equipped. They represent 80 per cent of the number of lines.

1983 The telephone density is 37.6 main lines per 100 inhabitants in France (41 in the United States, 35.8 in Great Britain, 38.3 in Germany).

1984 France has 22 million subscribers. Of households 90 per cent are equipped. Implementation of a four-tiered hourly rate modulation system.

1985 Implementation of new telephone numbering. Introduction of duration into the taxation of local communications.

Appendix 2 Synopsis of valuation frames

VALUATION FRAME	Infra-structure	Uses	Tests	Problems	Purposes	Optimized object	Measures	Metrics	Graphs	Focus of attention	Pricing criteria
ECONOMY OF FORCE (evaluation)	Air phone lines	Domestic Local	Transmission of voice and current	Energy losses	Increase the work capacity of lines	**Energy**	Clarity and efficiency	Standard line	Electric graph	The request and voice of the subscriber	Prime cost of production
				Attenuation				Transmission standard	Transmission graph		
applied to lines				Audition	Reduce cost		Audition	Ear			Flat rate
	Underground cables	Shortage	Connecting caller and receiver	Unnecessary gestures	Maximize work performance	**Human work**	Workload	Perfect efficiency of operators	Timer: time measurement	A service to subscribers	Direct labour
							Operating time		Operations table		
applied to operators	Urban switching			Unnecessary words and call: abuses	Minimize work expenses		Service quality	Equalization and standardization of work	Counting		Unitary fee
				Call overload							
PRODUCTION OF UTILITY (valorization)	Under-ground cables	Shortage	Monitoring of circuits load	Immobilization of circuits	Increasing the gains circuits	**Circuit yields**	Circuit loads	Maximum efficiency of circuits	Table of level measures	Transmission capacities	Prime cost for production
	Intercity lines										
	Mechanization: semi-automatic				Minimize expenses		Law of call				Circuits
applied to circuits											Unitary fee
	Direct traffic	Industrial	Traffic flow	Disturbances	Gain	**Customers**	Traffic statistics	Constant traffic flow	Industrial accounting	Connection capacities and subscriber behaviour	*Ad valorem*: subjective utility
	Automation										
applied to traffic				Traffic loss	Maximum receipts	**Traffic**			Probabilities		
	Maintenance										Price according to duration