# On Not Muddling Lunches and Flights: Narrating a Number, Qualculation, and Ontologising Troubles

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## Abstract

Calculating and making public carbon footprints is becoming self-evident for multinational corporations. Drawing on ethnographic data I narrate of the calculative routine practices involved in that process. The narration shows how routine yet sophisticated mathematical transformations are involved in retrieving salient information, and second that mathematical consistency is readily interrupted by 'dirty data'. Such interruptions call for opportunistic data management in devising work-arounds, which effect enough mathematical coherence for the number to hold together. Foregrounding an episode of calculative data retrieval, interruption and work-around contrivance, I employ it to make a comparative reading of two STS analytics, arguing: whereas Callon and Law's (2005) analytic technique of qualculation reveals the episode of data management and work around contrivance as a teleologically oriented process that manages to bridge mathematical inconsistency, Verran's technique of ontologising troubles enables us to recognise how a number-as-network configures its particular kind of certainty and coherence, how it sticks.

**Keywords**: calculation, number, ontics, ontology, qualculation, empirical philosophy

## Introduction

Number studies thrive in Science and Technology Studies (STS). STS has raised a range of questions challenging numbers and calculation. These include how chance got quantified and politically employed (Hacking, 1990; Desrosières, 2002), how accuracy gets constructed (MacKenzie, 1990), how trust in numbers is playing out in society, technology and economy (Porter, 1995) or how equivalences are achieved (Espeland and Stevens, 1998; MacKenzie, 2009a). The concerns here are not about numbers as output of some calculation, but rather about how numbers and calculations are employed in practices that constitute science, technology, economy—such as knowing epistemic objects (Knorr Cetina, 2002), distributing resources and accountabilities (Strathern, 2000), constructing economic agents (MacKenzie, 2009b), setting prices (Fourcade, 2011) or defining baselines (Ureta, 2017).

The field of actor-network theory (ANT) has been highly instrumental in STS for studying material and semiotic entities as relational networks (Latour and Woolgar, 1986; Latour, 1987; Law, 1992, 2009). ANT studies of numbers and calculations have opened up how accounting numbers configure action at a distance (Robson,

1992), how markets get materialised (Callon, 1998; Callon and Muniesa, 2005) or how collateral realities get enacted in presenting quantifications (Law, 2012). In the latter cases, numbers and calculations, too, are analysed as components of semiotic and materials relations that configure science, technology, economy. ANT's power to open up entities as relational networks, however, has not been deployed to open up specific numbers, numbering or calculations. Two notable exceptions are Verran's (2001) work on doing numbers in routinised practices and Callon and Law's (2005) proposal to study calculations as interwoven with judgement, using the neologism of qualculation.[1] Callon's (1986) concern with numbers can be traced back to his work on scallops and their conservation at St Brieuc Bay, Law readily shares how he learned it from Callon (personal communication), whilst Verran (2001), disconcerted by her experiences of learning and teaching numbers and basic concepts like length in Nigeria, set about delving to the insides of numbers.

The subfield which this paper operates in, then, is the use of ANT to open up the networks *within* numbers or calculations. How to use ANT to explore this opening? A number of ANT authors point us to ANT not as a consistent body of theory but rather as something akin to a toolkit (Latour, 1996, 1999, 2005; Law, 2009; Verran, 2007b). I wonder, then, whether the tools to open up numbers and calculations are equivalent, lend themselves to the same kind of work. And, I suppose, this concern and question is relevant to others who want to understand, master or even deploy the toolbox of ANT to open up numbers. The research question of this paper then is narrow and has a methodological form: how do the two analytical framings, qualculation and Verran's take on numbers, differ, complement or work against each other? This question matters not only for enriching our understanding of the ANT toolkit's inner compatibilities and frictions, but also to the larger task in STS of spelling out the nuances between some of its analytics.

The question, and the research to address it, is novel in that it positions the reader to engage in a comparative methodological exercise. This means that this paper focuses on studying how the two

analytics work, in analytic practice. In short, this paper presents a study of two ANT techniques. Both these techniques are key for ethnographic investigations of a number-as-network. To study number-as-network this paper employs a method of empirical philosophy, narrating a number.

What both analytical approaches share is that enumerated concepts, results of calculative and quantifying relations, have 'insides'. This follows from a core claim of the ontological commitment in ANT to the mattering of material, bodily and semiotic practices (Verran, 2001; Callon and Law, 2005; Law, 2009): doing numbers or calculations enacts not only the known but also the knowers.

The argument pursued here is that both analytics narrate and analyse numbers/calculations differently, foregrounding different relations, elements or effects of the insides. This means that the objective is to show that both approaches lend themselves easily to make different points. This does not rule out that both approaches could be mobilised to say what the respective other is saying, too. The point I want to draw out is that each approach makes some things easier and other things more difficult to explicate. And, unsurprisingly, both approaches have not been very explicit about what they tend to fore- or background. So, the contribution to STS which I pursue is to show how these two ANT approaches, though similar, are also different, and not easily substitutable against each other.

The empirical ethnographic material that I draw on in narrating a number deserves an introduction as much as the choice to use precisely this material. The domain in which the number/calculations I am interested in have been practiced, is the field of carbon numbers and economics (Callon, 2009; MacKenzie, 2009a; Lohmann, 2009; Lovell and MacKenzie, 2011; Ehrenstein and Muniesa, 2013; Vesty et al., 2015; Lippert, 2016). Specifically, I turn to carbon accounting and book-keeping, numbering and data practice. This ties in with an analytical trajectory that investigates how environments are known and come into being through data, information, algorithms, simulations, databases and reporting—configured into situated practices of environmental management and sustainability governance (Elichirigoity, 1999; Waterton, 2002; Fortun, 2004; Ellis et al.,

2007; Millerand and Bowker, 2009; Edwards, 2010; Gabrys, 2016; Lippert et al., 2015; Blok et al., 2016).

I studied carbon accounting in a financial service provider, one of the globally 50 largest companies (by revenue). This was an ethnography conducted across 20 months, studying the multinational's environmental management work with a focus on their material and semiotic practices through which they achieved their global carbon footprint.[2] Opening up numbers of carbon accounting involves addressing their indeterminacies and certainties.

To open up number-as-network, I tell a story of a number, which has been configured, *inter alia* by myself, the corporation's sustainability accounting database, a subsidiary's chief operations officer (COO) and a worker who put environmental numbers together for him. The worker, Nick, figures key in my narrating. Most relevant for the present paper, Nick was a novice—first-time user/practitioner—of doing environmental data for the company. Studying a novice promises to disclose the frictions and work involved in doing numbers (cf. Suchman, 2007: 122). Neither Nick nor his boss, the officer, were concerned with explaining or theorising numbers, data and calculations, not with experimentation for making carbon markets work (Callon, 2009). Still, my narration of the number includes a calculation. And this calculation was highly effective as a machine that made the corporate carbon accounting exercise proceed, a machine that made things work, enriching the voluntary carbon market, rather than standing in the way (on machines and their working, see also Lippert, 2011; Neyland, 2018, in this special issue).

Next, I offer some notes on methodology and transparency. Then I turn to the core: I narrate a number in a way such that the two analytics can be deployed; subsequently I introduce the qualculation analytics, putting it into practice by analysing a calculation. Then I present the Verranian analytics and use it to ontologise a number's troubles. Finally, I draw together my conclusions in terms of the two analytical approaches differently oriented capacities to foreground specific workings within numbers or calculations.

## Methodology

This paper is grounded in an ethnography. The workers I studied knew I researched them; and I was employed to support the company in optimising their environmental accounting database. To protect informants, I render names anonymous, numbers imprecise and convert currencies into EUR.[3]

This paper's methodology takes the form of empirical philosophy, rather than of systematic qualitative data analysis. Following the purpose of the present special issue—interrogating recent innovations in STS analytics of numbers and numbering (Lippert and Verran, 2018)—for my analysis I have constructed an empirical story that serves to interrogate STS analytics. The narration, or story, here is not shaped to meet specific sociological and ethnographic criteria. Storytelling serves here to allow the reader relate and attend to key empirical detail, strengthening my ability to respond to the troubles I identify in and around Nick's calculation (on response-ability, see Haraway, 2016; on storytelling as relational practice Kenney, 2015: 758–759). The story is not narrated to privilege a particular explanation, attempting, drawing on Benjamin (2006), even to keep it free from explanation. This choice of methodology suffices to draw out the generativities and limitations of particular STS analytics.

The empirical story I present is bundled with inferences that draw out the significance of some of the relating that shaped the calculation or took place within the latter. To be able to analyse the practical, epistemic and ontological work in doing the calculation, I use the mathematical genre as a device: I employ mathematical denominations and equations that the numbering and calculation practice explicitly referenced or implicitly postulated. Using the mathematical genre stays true to some of the forms of rationality that I identify in Nick's practice.

A concern with accurate description or grounded theorising would shift the focus away from the kind of empirical philosophy I undertake. The evidence presented within the empirical story may be understood as serving a part-whole generalisation (Winthereik and Verran, 2012)—the kind of numbering and calculation I analyse is part of the company's global carbon footprint

and involved in relations to governments and investors, i.e. global political economy. One limitation of the kind of empirical philosophy I conduct is that this paper in isolation cannot make claims about the majority of calculations I have studied. The empirical story in this paper, if read in isolation, must be understood as an artefact of being written to serve the methodologically interested interrogation of the two ANT analytics.

For the purpose of comparative methodological analysis, I offer an interested presentation and deployment of both approaches, mediated by a partial reading of both, Verran (2001) and Callon and Law (2005). Whilst this constitutes another limitation of this methodology, an exhaustive review of the authors and their approaches is beyond the scope of this paper and not needed for the purpose of the comparative exercise. To respond to the research question, it suffices to identify differences between both approaches that are salient to the empirically grounded data and inferences that I narrate.

## Narrating a number

The multinational's accounting database, accessible as a Lotus-Notes based application in the corporate intranet, included forms, suitable called 'task forms', which subsidiary environmental agents were tasked to fill (as an illustration, view the form for reporting water consumption, Figure 1). I wanted to learn about the ways data gets constructed. My own boss at the headquarters (HQ) allowed me to travel to a Western Asian subsidiary, study their environmental data practices, and she tasked me to support subsidiary staff. So, off I went, arrived in the megacity, housing the multinational's regional sub-HQ. On my second day



**Figure 1**. 'Task': General form for environmental data entry (this screenshot documents Nick's form use to report 2008 drinking water consumption; for the respective analysis, see Lippert (2016); Source: Lippert, 2013: 81)

in the city, after a bus tour on a hot summer day, through the Eastern parts of the city, and then into the better neighbourhoods, finally I arrived at the modern steel-glass block. I entered the building, was asked whom I wanted to see, and after some back and forth was led to the subsidiary's COO. He occupied a large office, with a glossy wooden desk and several square metres of windows at the top of the building.

Early in our meeting Nick Xi joined us and presented a list of numbers to hiss boss, the COO. Later on I learned: Nick was the office site's head engineer, a novice in environmental accounting. Nick had been asked to retrospectively collect the 2008 environmental data that the HQ was seeking. Subsequently, Nick showed me around at the site, and, eventually, we went to his office, located in the building's windowless basement. His work space was neighbouring round six other desks. Nick and I soon got to work in depth, me doing participating observation and helping him out, clarifying things when he had questions, and Nick drawing together various environmental data. We worked, and worked, and, let me fast forward, to the next day of working with Nick, he sitting on his red chair, and me at his beige desk on this Friday afternoon, directly after lunch, between 2–4pm, in spring 2009. His desk was set up with two land line telephones, a computer screen, mouse and keyboard.

Nick picked up the phone to ask a colleague about the distances travelled by staff of his company. In the conversation he learned about the costs incurred in the prior year for domestic flights, 168,078 *EUR*. This phone conversation made him laugh and smile. His work equipment included a paper, to note the numbers and to conduct some simple calculations, like additions, multiplications and divisions. He next divided the flight cost number by 230 *EUR*, an average cost of each flight, and multiplied the result with 500 *kilometres*, an average distance crossed with domestic flights. With the result of this calculation ready, he turned to his computer and entered the result in the 'task' form for reporting the distances travelled on short-haul flights. At this point I intervened, suggesting to Nick to also briefly describe in the form's comment field how he had calculated the estimation. He hesitated, but then agreed.

Five inferences bring out the richness of Nick's calculating, mixing the ethnographic with the mathematical genre. Nick mobilised the total cost fact for the calculation. Where did this fact come from? Picking up the phone, Nick had called a colleague and received the cost fact on domestic flights for the subsidiary. This is not trivial. And this is the first inference. While for this particular case he managed to 'immediately' access such a cost fact for the totality of the subsidiary, with other environmental indicators he had to struggle more. For instance, Nick was also to report his subsidiary's water consumption data. Yet, some of his subsidiary sites did (or could) neither fully report water costs nor the consumed amounts. So, Nick extrapolated the available site-specific consumption facts to the scale of the subsidiary, with calculations, materially supported by spreadsheets, pen and paper. Luckily, for calculating flight distances, Nick was equipped with an already complete fact; no need to extrapolate towards the total costs at subsidiary level: at the end of his phone call, thus, he laughed and smiled.

Knowing that the organisation had paid 168,078 *EUR* for domestic flights did not tell him how many kilometres have been bridged, however. Nick reconstructed the cost fact corresponding to a particular mathematical form, my second inference: as the *sum* of several individual flights, totalling *n* flights, each with a cost, $c_n$. He effectively exploded one number into many.

$$\sum_{i=1}^{n} c_i = total\, costs$$
*Equation 1*

Unfortunately, Nick had not received information, at this point in time, about each flight's associated costs, $c_1$ to $c_n$; all the individual costs were as unknown to him as the number (*n*) of and distances ($d_1$ to $d_n$) travelled with flights. From observing Nick exploding the total cost fact and transforming it into the cognitive form, shown in Equation 1, I infer, thirdly, that this cognitive understanding inspired Nick to use a mathematical routine, well known to him, that would allow ignoring all these unknowns. Thus, Nick explicated assumptions about these individual flights, specifying each flight in two dimensions, in terms of estimated average values: one for the cost, $\bar{c}_i$

, and one of the distance of an individual flight, $\bar{d}_i$. For instance: 'I assume, on average a domestic flight bridges a distance of 500 kilometres and costs 230 *EUR*.' Mathematically, he postulated $\bar{c}_i$=230 *EUR* and $\bar{d}_i$=500 *km*. To be even more explicit, these assumptions implied:

$$\frac{\sum_{i=1}^{n} c_i}{n}=230\,EUR$$
*Equation 2*

as well as

$$\frac{\sum_{i=1}^{n} d_i}{n}=500\,km$$
*Equation 3*

And, Nick knew what he was searching for: the total distance travelled by short-haul flights, sum of all the flights' distances, $\sum_{i=1}^{n} d_i$. My fourth inference is then: making such assumptions, when equipped with the total cost and searching for the total distance travelled, presented Nick with a clean structure of statements (illustrated by Table 1), leaving only one unknown element, the quantifier *x* for the data type *total flight distance* in *km*.

Nick treated this frame of triples with only one unknown as mathematically exploitable, my fifth inference. He identified the two repeating units, *km* and *EUR*. Dividing the average distance travelled per flight by the the average cost of a flight, and multiplying the result with the total cost fact, Nick could cancel out the two *EUR* units, resulting in a data point with the unit *km*.

$$\frac{EUR}{EUR}\times km=km$$
*Equation 4*

This is the corresponding mathematical form:

$$x=\frac{\sum_{i=1}^{n} c_i}{\bar{c}_i}\times\bar{d}_i=\sum_{i=1}^{n} d_i$$
*Equation 5*

In a differently plain language, for the qualitative STS scholar:

$$x=\frac{total\,costs}{average\,costs}\times average\,distance=total\,distance$$
*Equation 6*

And this is the calculation:

$$x=\frac{168,078\,EUR}{230\,EUR}\times500\,km=365,387\,km$$
*Equation 7*

Despite the more or less overwhelming mathematical richness, Nick swiftly and seemingly routinely solved the problem of the missing data point and entered it in the short-haul flight accounting form.

Entering data into the environmental database was part of a routine of what the headquarters (HQ) called 'environmental data collection' in the company. The collected data was reviewed at the HQ, checked for inconsistences or obvious errors, followed by possible corrections. All the unique data points, indicating the consumption of water, electricity and paper as well as the distances travelled and the amounts of waste disposed, were multiplied with specific factors that converted each data point into the amount of carbon emissions ($CO_2$e) resulting from the respective consumption.[4] For example, according to standard conversion factors, short-haul flights cause higher emissions, per kilometre, than long-

**Table 1.** Structure of statements.

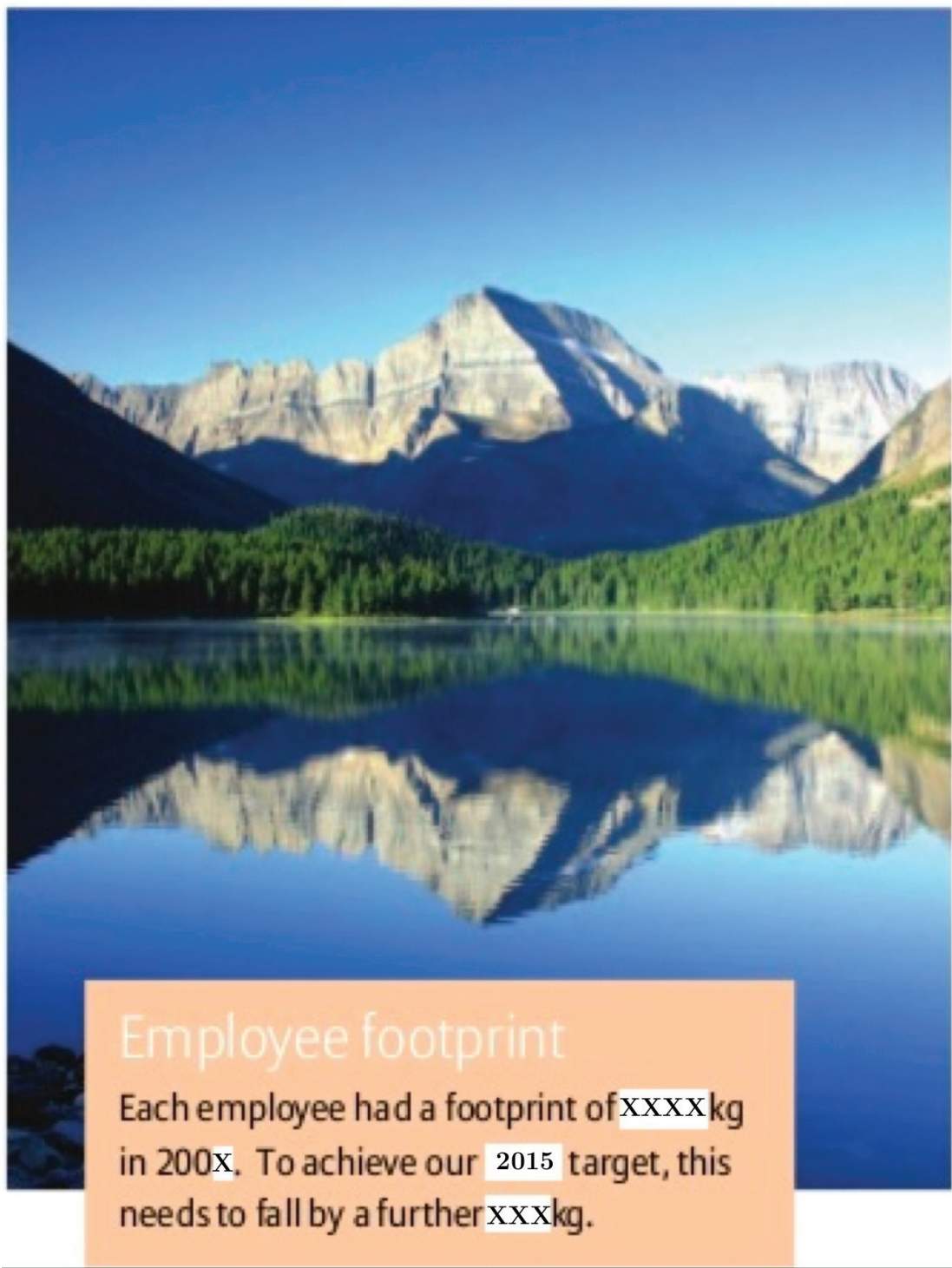| Knowledge status | Framed triples of data | | | Math. |
|---|---|---|---|---|
| | **Quantifier** | **Unit** | **Data type** | |
| **Partial** | x | km | total flight distance | $\sum_{i=1}^{n} d_i$ |
| **Complete** | 500 | km | *average flight distance* | $\bar{d}_i$ |
| | 168,078 | EUR | total flight costs | $\sum_{i=1}^{n} c_i$ |
| | 230 | EUR | average flight costs | $\bar{c}_i$ |

**Figure 2**. 'Employee footprint', extract from the corporation's Sustainable Development Report (Source: Lippert, 2013: 206).

distance flights.[5] The amounts of emissions were then summed up into a carbon footprint reported on a balance-sheet, for each subsidiary as well as for the global operations of the multinational. This footprint was communicated to stakeholders, including auditors, partners, investors govern-ments and civil society organisations, for instance in the form of relating last year's (2008) average carbon footprint per employee to the target of emission reduction in the future (2015), as illustrated in Figure 2.

Later the afternoon, Nick received an email that contained a spreadsheet. The latter detailed which cost items have been part of the account for domestic flights. The list included diverse items such as flights, restaurant visits, trips by boat and taxi and visa fees. He called out: The list includes lunch! Despite the skilled mathematical routine, it seemed clear the data could not be used. And so it proved.

Before the workday ended, Nick and I went to see Nick's boss. In this meeting we talked through a range of uncertain issues (that are not at the centre of this story), which Nick and I had encountered. In his reaction, the boss made one point very clear: he demanded Nick to only report facts; no insecure estimations! A few days later the comment Nick had originally added to the flight data had disappeared; and the distance itself had decreased to 60 percent of the distance Nick had calculated earlier.

What has happened, to summarise, is that Nick was tasked to report short-haul flight data. This data did not exist. So he contrived a work around, employing mathematical routines to retrieve the data he was to report. This work around contrivance drew on domestic flights' cost data and Nick used his calculation's output as input to the short-haul flight reporting form. Yet, later, Nick realised that his mathematical 'trick' for recovering distances from the domestic flight data would not work well because the cost figures included other costs that go along with staff taking flights—like buying lunch during the journey! The data was dirty! Eventually, Nick's subsidiary had reported a lower figure. I was not there to observe how precisely this has been derived but I suppose that Nick withdrew the 'non-flight' cost items from the total cost fact of the domestic flights sum (data cleaning). And I know that Nick's subsidiary did not posses distance data. Thus I infer he was otherwise going through the same series of mathematical assumptions and calculations. Closing off, as instructed he did neither draw attention to this 'internal adjustment' nor the assumptions in the short-haul flight reporting form. For the purposes of this paper, I end my narration here—though of course the story continues, elsewhere. It is this episode in the 'doing of this number' that serves the purpose of comparing STS number

analytics. And, thus, I turn now to analysing this episode.

## Qualculation

This section re-presents the qualculation approach, deploys it to re-narrate numbers, mathematical forms and a calculation and, at the end, draws out what I discern from this deployment about the qualculation approach in practice. I argue that the qualculation approach lends itself to foregrounding how a calculation achieves a form that effects connection, in this case securing quantitative calculability despite mathematical inconsistencies.

Borrowing the notion qualculation from Frank Cochoy,[6] Callon and Law (2005: 718, 722) argue for dismantling the dichotomy between the calculative and the noncalculative, instead positing both as mutually constitutive: the very distinction dissolves when we consider a boundary as achieving both, one side and its Other. Positively speaking, they use the notion qualculation to suggest that calculation and judgment are interwoven. This interwoven character comes to the foreground in their thinking of calculation as a 'three-stage process'. This process can be read and deployed as a robust instrument, as evidenced in this special issue by Gorur (2018), Holtrop (2018) and Neyland (2018). In this section I primarily focus on this qualculation process as an analytic instrument and deploy it, subsequently analysing what the instrument foregrounds.

> First, the relevant entities are sorted out, detached, and displayed within a single space. Note that the space may come in a wide variety of forms or shapes: a sheet of paper, a spreadsheet, a supermarket shelf, or a court of law—all of these and many more are possibilities. Second, those entities are manipulated and transformed. Relations are created between them, again in a range of forms and shapes: movements up and down lines; from one place to another; scrolling; pushing a trolley; summing up the evidence. And, third, a result is extracted. A new entity is produced. A ranking, a sum, a decision. A judgment. A calculation. And this new entity corresponds precisely to—is nothing other than—the relations and manipulations that have been performed along the way. (Callon and Law, 2005: 719)

My partial reading of Callon and Law elaborates this three-stage process. Core to the first stage is the existence of entities that are disentangled from other relations, rearranged and by that ordered to fit a space. In that respect, the first stage needs to be considered as performing a relational and categorical shift: the entities' connections are severed and they come to fit into the boxes of specific sorts. Within this space, in the second stage, these entities are rearranged by positioning them into new relationships between each other. The authors address these relational changes as manipulations and transformations of the entities themselves. In the final stage, out of these rearranged entities, a statement is drawn ('the result'). They plausibilise their generalisation by referring to several versions of such spaces and transformations: For the supermarket and the trolley, consider Lave (1988) and Cochoy (2008), for the court of law Latour (2009) and for sheets of paper and spreadsheets Lippert (2015).

Callon and Law (2005) specify their model in several ways. I identify two larger points. First, they clarify that the entities, 'objects', are manipulated 'within a single spatiotemporal frame' (Callon and Law, 2005: 719). True to post-ANT considerations, they suggest that the entities do not preexist their framing. The framing shapes the object; making entities fit the box, the order, constitutes new entities. In short, with Mol (2002), the framing enacts its objects. And framing comes with overflows, all that which does not fit in (Callon 1998). Qualculation as enacting new entities means also that the practice of qualculating is both, material and semiotic. For that they point to, *inter alia*, 'paper and pencil; the benches in a court of law; a system for tallying arrivals and departures' (Callon and Law, 2005: 719). Each of these frames and framings comes with specific spatiality and temporality; their shapes and topologies are potentially indefinite. Enacting any particular form takes time, is work, is an achievement. The effort consists of disentangling entities from others, removing and adding relations.

Second, I propose, Callon and Law (2005) model qualculation as intentional action—between the lines. In a summarising sentence, they suggest that qualculations "are all about arraying and manipulating entities in a space *in order* to achieve an outcome, a conclusion" (Callon and Law, 2005:

719, emphasis added). Thus, qualculations come with a purpose, i.e. a *telos*; they are practices for the purpose of producing their result. When the two authors turn to addressing the modes and practices of achieving non-qualculability,[7] they engage with Quaker worship and agapè as "strateg[ies] of *calculative rarefaction*" (Callon and Law, 2005: 723). Common to both are intentional practices of being passionate. "The Quakers have a set of material and discursive practices *for* disentangling from qualculability. *For* losing themselves in the passionate" (Callon and Law, 2005: 722, emphasis added). The disentanglement is purposefully produced in material and discursive practices. This analysis of resisting qualculability resonates, for the authors, with Power's (1999) take on accountability in 'audit society'. Making accountability is work, and so is making unaccountability (Callon and Law 2005, 725; see also Gorur, 2018, in this special issue). Achieving unaccountability is tough. I read their model of (non) qualculation, then, as purposeful action, in which actors or strategies are directed towards results, using resources to achieve these results. Whilst their analysis is not limiting qualculation to intentional action, all their cases involve intentional actors, trying to achieve particular (un)accountabilities and (non)qualculabilities.

To put the instrument of qualculation into action, I distil from the prior discussion the following questions: by which configuration of material and discursive practices do actors achieve what kind of simultaneously qualculative and non-qualculative space? How has Nick actually managed to produce this agencement which we tend to refer to as calculation? What do we grasp by analysing this as a mathematical operation? Conceptualising this set of relations, this movement of signs, as a mathematical office operation suggests that all the entities involved in it are unproblematic; we grasp it as a rule-following method, an implementation of the rules of multiplication and division. This understanding misses the practical point of the operation: it was not about solving a mathematical problem but about bringing into reality an entity that before had not existed. Thus, Nick's practice had a transformative character: it altered the form of how these entities existed; he assembled them in a shared plane in

which he conducted the operation. This transformative movement deserves spelling out.

In what follow, I map the three stages by Callon and Law onto my narration of Nick's calculation and numbers. According to qualculation's first stage, Nick had to initially sort out and detach some entities that he could work with. The total cost fact, which he had received, was already of a sort that he could employ well. This, however, was not self-evident. In the cases of several other environmental key performance indicators, Nick had not received total cost facts, but had to construct those.

Yet, whilst Nick was able to employ the total cost fact, in isolation the fact did not suffice. Nick next created further statements that effectively reconstructed the total cost fact via a mathematical form: as the *sum* of several individual flights. This reconceptualisation expanded the possibility for calculability. He could now make assumptions about these individual flights—he defined the average cost and distance travelled per flight. The postulations depicted in Equation 2 and Equation 3 mean that Nick judged his assumption of the two averages, $\bar{c}_i$ and $\bar{d}_i$, to be sufficiently equivalent with the real flights costs and distances (textbook mathematics, in contrast, would require some form of signifier like standard deviation to specify the degree of equivalence). Nick's judgement was relevant to bridge the gap between the different sources of information, the phone call's provision of the total costs versus his own experience of flights. In this moment he used situated judgement about these relations, I presume his local knowledge of distances and flight costs in the subsidiary's region of operations, rather than documented traces that might have established a link between the averages and the individual flights' distance/cost facts. These interwoven judgements, bridging the gap across the two different kinds of sources, are by no means self-evident. Politics and economics, in particular cost-benefit analysis, recognise the significance of this kind of treatment, calling it commensuration (see Adorno and Horkheimer, 2006: 13–14; Porter, 1995: Ch. 4; Patterson, 1998): "Commensuration transforms qualities into quantities, difference into magnitude." (Espeland and Stevens, 1998: 316)

And the accounting database form made clear what he was working towards: the total distance travelled, in km, for which he lacked the quantifier. Thus, at the outset, here, we can identify four statements (one given fact, two assumptions and one searched for result, the partial statement). He had, thus, disentangled the total cost fact and the body of flights these costs represented into four statements and drew all these statements together. With Callon and Law (2005: 719) we can think of his practices as sorting out and detaching these statements from the wide range of data held by financial accountants and of the possible assumptions he could have made. They call this process *qualculation*, underlining the involvement of judgment and qualification with quantification and calculation. The qualification here consists precisely in performing these statements and relations as appropriate rather than others. Not only could the assumptions have been different (such as specifying the average distance or costs with other quantifiers) but also could have the statement structure been alternatively configured (in fact, below, I introduce how Nick later challenged the structure himself). The selection, thus, of precisely these statements created and prefigured a space in which the subsequent calculation had to take place.

Now that the relevant entities are enacted and detached from another, they need to be "displayed within a single space" (Callon and Law, 2005: 719) to conclude qualculation's first stage; the space of these four statements needed to be transformed to perform in two ways: first, the space needed to allow for calculation and, second, the calculation's results needed to fit the material structure of the company's environmental database, i.e. its data entry form (cf. Figure 1). Thus, again, the accounting form guided Nick in how he worked. This form required the total distance travelled by short-haul flights to be represented with specific qualifiers and quantifiers: these included, first, the quantitative 'value' of the flight distance (i.e. the number) and the 'unit' (kilometres), second a 'value' and a 'unit' of corresponding costs and, optionally, a qualitative 'comment' on this particular data set. A possible inscription structure that prepares this list for calculability is to reimagine/rewrite the statements as *triples*. The calculation which Nick eventually performed, thus, corresponded to a three-fold structured space, depictable as a table (illustrated by Table 1). This space is marked with

a boundary of in/exclusion: to be excluded were the traces of the statements' sources. The fact that some statements were assumptions got lost in the framing—Nick was focused on the numbers.

With this first stage of organising qualities and quantities, Nick achieved new entities: once in the table, flights and costs existed in the shape of numbers, units and categories. The table itself framed these shapes in particular ways. The qualities of framing extend from the design of the data entry form to Nick's preparation of data for that form. Thus, the entities drawn together by Nick were transformed and changed shape; the resulting objects did not preexist their framing. Those qualities that did not fit in, are the overflows that Callon (1998) addresses: making things calculable means framing them and that necessarily implies that some things do not fit the frame and flow over the frame.[8] The boundary-drawing performs a qualification of how numbers are present in this space. Nick's employment of the framed triples (in Table 1) shows that he is precisely not just dealing with hypothetical, in an undeconstructed sense, 'numbers' but with inter-woven qualities, categories and units. The triples do not prepare some 'calculation' (in an undeconstructed sense) but a much more specific qualculation.

This selection, positioning and framing allows for the second stage in the qualculation process model: to actually informationally treat the four statements in relation to each other. Nick related the costs of all flights to the average cost of a single flight. This means he treated these kinds of costs as being of an equivalent quality. And he handled the average distance of a single flight as qualitatively non-distinct from the sought for total distance travelled. In both relations, he treated the two statements related as quantitatively different, rather than qualitatively. Nick achieved quite simple arithmetic relating—an ongoing relation—that took the form presented in Equation 6. Stage two of the qualculation instrument, points us, thus, to the calculative machinery, the central component of the equation:

$$\frac{total\ costs}{average\ costs} \times average\ distance$$

*Equation 8*

Without structuring triples in this way the information would have been different. In this mathematical form, the entities of the table are rearranged so that they appear simultaneously qualitatively and quantitatively compatible, thus, calculatively relatable. Now, consider Nick's judgement that his structure of treatment was apt. This is a key qualification, underwriting the calculative machinery, a second commensurating move.

Finally, in the third stage of the qualculation process, the arithmetic practice mathematically related the three framed triples, shown in the middle column of Table 1. These three triples were solved for the one remaining unknown with Equation 7, producing a result, 365,387 *km*, effectively a fourth triple: a) the value/quantifier 365,387, b) the unit *km* and c) the category total flight distance. This result was, importantly, tech-nically compatible with the accounting short-haul flight reporting form's field for numeric input, and its option to select km as a unit, and this is a point I come back to. To summarise, Nick related the triples that he heaved into this space in a way that allowed him to produce a result for the unknown slot. With this calculation he produced the fact, the very data which he was to report. Nick, thus, reported through the database environmental data that he first had to bring into existence in a thoroughly qualculative performance.

This story of qualculation nearly gets slightly messed up when we consider the spreadsheet that Nick received in the afternoon. Some of its elements threatened to undermine the calcula-bility, which Nick had so routinely achieved and we have so painstakingly adumbrated. Nick made judgement about these troubling entities of the spreadsheet. I never did learn what precisely happened subsequently. I can only report that, eventually, this Western Asian subsidiary reported a smaller sum; the total distance crossed by means of short-haul flights was reduced. Nick effectively managed to avert the threat to calculability: he delivered a result to the headquarters. Yet, the spreadsheet did not detail the distances travelled by each domestic flight, $d_1$ to $d_n$.

Zooming out, one further calculative-quali-fying move comes in light. Lingering between the lines so far, Nick's task was to fill the form for the

indicator short-haul flights, *y*. Following Callon and Law (2005: 719) '[t]hings have to qualify before they can enter a process of qualculation'. Nick's qualculative practice performed the domestic flight cost data, *x*, which he received, and subsequently employed in his arithmetics, as qualifying for the short-haul flight travel account.

$$total\ distance_{domestic\ flight} = total\ distance_{short-haul\ flight}$$
*Equation 9*

$$x = y$$
*Equation 10*

Nick, practicing this qualculation, could be certain that his work of slipping and connecting was organisationally appreciated—contrasting with Coopmans' (2018) analysis of the trouble of workers who have not been managing to solve a disconnect through clever numbering. Nick employed his judgement and calculative routines making *x* fit the form of *y*, even if this final slippage in reference was collateral, a 'collateral reality' (Law, 2012) of inserting the quantifier for the domestic flight data in the form for short-haul flights.

The mathematical tension here did not concern Nick. Whilst multiple interpretations are possible, Nick situationally judged well, that his achievement of connecting sources to the data form would not generate organisational tensions but, rather, comfort (on comfort, see Pentland, 1993).

What do we learn about the instrument of qualculation? By way of rethinking Nick's work as qualculating, we overcome the misleading dichotomy between calculation and judgement. In actual practice they overlap. This is no news to accounting scholars (e.g. Pentland, 1993; Robson, 1992). The point was not only to demonstrate a case of qualculation. I am concerned with analysing the apparent ease of a calculation—of a class that was not at all exceptional, but was and is exercised, constantly, ubiquitously. Defamiliarising such a calculation is a hard case.

The qualculation approach is generative in that Callon and Law's (2005) take translates the hard defamiliarisation task into a quite simply procedure, consisting of the three stages. These were quite straight forward to apply. This

approach allowed us to identify the entities employed by Nick and helps us see their saturation with politics: at several moments other qualifiers and quantifiers, other structures and moves of relating them, could have been opted for. Qualculation, then, seemingly offers an instrument for analytically narrating; we get a well-tellable story in which even the challenge to calculability eventually disappears when the qualculation's *telos* is realised in the reporting of a result to the HQ.

Core to this style of qualculation analysis is that it generates a story of Nick as intentionally treating the data in a way to achieve a number that can be plugged into[9] the multinational's central environmental database. Nick had started out with one determinate entity, the total cost fact, and rapidly conjured up further claims that turned into certainties in their tabular formation and were enrolled in the equation form to solve for his target not-yet-determined number, the total distance travelled by short-haul flights. I applied the qualculation analytics and found it to guide me in narrating of progressively more determinacy along the stages towards the result that Nick achieved. Determination, then, characterises both what I analysed and how I analysed it. Indeterminacy is first solved, and when new indeterminacies cropped up in the form of unwelcome content of the spreadsheet, these were overcome. In sum, Callon and Law's (2005) approach is generative of a story of a directed chain of enactments with the clear target of dissolving indeterminacy: the solute of indeterminacy changes its visibility, rendered invisible in the fact delivered to the HQ.

Callon and Law's (2005) qualculation approach configures a narration that conveys how (non) qualculability is achieved and secured. The qualculation instrument is generative of foregrounding how connections are made, relations established, in order—intentionally—to effect either qualculability or non-qualculability. Callon and Law are fittingly quite concerned with differentiating strategies to achieve these. This instruments' focus on strategies to achieve either, qualculability or non-qualculability, establishes simultaneously a dichotomy—collateral damage?

The approach does not encourage me to analyse and attend to the fascinating fastidiousness and assiduousness of Nick, his practices of

making things very clear, reading the spreadsheet in detail, cleaning up data, indicating how he got to his fact in a comment and deleting it, attending to some of the data troubles. Maybe because these are not central to his practices' telos, securing qualculability? But they seem to be important elements in shaping these calculations and the mode of qualculability. Yet, these are neither about (non)qualculability nor the measurable degrees thereof. Whilst the authors, Callon and Law, surely have capacity to engage with these elements, their three-stage approach of qualculation and the strategies for achieving (non)qualculability do not lend themselves to open up these elements. In fact, Callon and Law (2005: 724–725) position qualculation as Other to the space of (pre)trust, care and agapè.

How then did these elements matter? I suspect these are about qualities of relations of accountability and I am disconcerted about their (missing) relevance in the qualculation analytics' study of the incremental crystallisation of the reported data on short-haul flights as certain.

## Ontologising troubles

Nick did not voice troubles, but my narration does. Does it matter that Nick offered a comment, like in the centre section of Figure 1, deleted it and cleaned up the data? In introducing this section's deployment of Verranian analytics, and with Verran (2001), clearly, yes, it does. It does matter because the comments' explication of how Nick had calculated the result as well as the sorting out of inappropriate elements, i.e. data cleaning, involve commitments to, or explications of, what these data are. So Nick had faced ontological troubles which he engaged with by deleting the comment and cleaning data. Verran (2001) would point to *Science and an African Logic*, Mr. Ojo and herself, ontologising troubles in the classroom.

In turning to Verran's work, I am not renarrating what the qualculation analytics was able to scrutinise. Instead, I deploy her work to attend to how it comes that the mathematical inconsistency, troubles, in the work achieved did not shatter Nick's qualculation. I argue that Nick ontologically accomplished a calculation that achieved a configuration of certainties, in plural(!), that sufficiently

cohered, allowing the result to stick. Cohering elements contribute to amassing certainty, despite mathematical inconsistency. This section brings forward, and then alter-ontologises, the troubles in Nick's work. Ontologising, then, is the instrument I draw from Verran. To continue, I initially introduce Verran's take on ontology as practice and subsequently deploy it to analyse a subset of relations of the number-as-network.[10] I close this section with a reflection about the way Verranian (re)ontologising foregrounds elements and relations in enumerated entities.

Practicing a form of juxtapositioning that does not privilege Western or Scientific standards, Verran offers a form of empirical philosophy that draws on engagement with both indigenous community as well as western science and technoscience. To start in the middle, consider her book's end in which she calls for "telling of the rituals and the coparticipants, human and nonhuman, living and nonliving, in microworlds, as reliable ways of managing complexity" (Verran, 2001: 238). In order to narrate and ontologise Nick's, or my, troubles, we need a sense of her notions of microworlds and ritual.

I consider counting objects like books a repeated routine performance. Verran (2001) calls such performances microworlds, or micro-worlds (Verran, 2002), based on Rouse's (1987) work on laboratories. She specifies microworlds as materially and semiotically configured time-places featuring routinising practices of interrogation, naming and tracking, effecting the boundaries of stuff, rather than passively reading preexisting entities. In such a microworld, the exclusion of irrelevant complexity is similarly routine. Microworlds produce realness. She highlights the reoccurring character of microworlds, repeatedness, routine and ritual, with her concept of clotting. "An object clots when the repetitions and routines of its generating microworld become a ritual." (Verran, 2001: 162) The repetitions and re-performances in ritual-like ways pre-figure and pre-script and, thus, stabilise their objects, gradually and relationally coagulating the objects and its shape. Normally, the case of counting routines is safely ignored, leaving the material and semiotic processes of clotting specific numbers often invisible (Verran, 2007a: 37–38).

She develops these considerations in *Science and an African Logic* and proposes that in the very practices of counting an object not only is the number performed but the object too. Following her approach, the pure matter of, say, books when we count them is not antecedent to the action but is brought into reality in that very performance. Face your distributed bookshelves; any count is an outcome of relational practice involving nonliving participants, e.g. paper and digital entities, living like ourselves, counting some entities as books, a multi-volume work as 1 book, excluding others. Being certain of the count emerges within doing counting, that is in the acting within a relationally configured situation. The bookshelves in my study room surely can be assessed as complex; but more importantly, the narration of the number at the core of this paper clearly shows the simultaneous simplicity and complexity *within* Nick's qualculation.

More importantly than the degree of complexity—numbers, numbering and how certainty is embedded within them appears, in the Verranian approach, as an effect of particular situated relating. Drawing on her work amongst Yoruba children learning calculating, she proposes: "Certainty of numbers is an outcome of the routines by which they are constituted in collective acting" (Verran, 1999: 150).

Her approach does not limit itself to numbers, but explores more widely what, and how, things are. This she calls ontological investigation (Verran, 1998) or empirical ontology (Verran, 2005). Core to this approach is to "refuse any and all *a priori* separations" in relational practices, characterising Verran's (2005: 42, her emphases) take as monist, whilst narrating things, society and nature as effected in those practices.

Core to the instrument of ontologising is the analytical division of labour between two narrations:

- **Ontic narrations** refer to 'the level of entities' existence or being' (Verran, 2007a: 34), i.e. realness, where entities are to be understood as actor-networks, that are accomplished, performed in material-semiotic practices that include our practices' (not necessarily explicit) commitments to these entities being there.[11]

- **Ontologic narrations** are characterised by explicitly explaining, studying or theorising what is and the metaphysical commitments to what is; this ontology is materially-semiotically performed and, thus, may shape reality-making.[12] Ontologising, however, does not necessarily determine its object, the reality being enacted.

To deploy this instrument, I narrate two discon-certments that the qualculation instrument did not easily allow me to story. Firstly, I turn to cleaning data, and, secondly, to the comment.

Lunch! Whilst the qualculation approach was able to register that data cleaning took place, I sense a richness in the moment of Nick receiving the spreadsheet and recognising the range of non-flights inscribed into the domestic flights account. Nick calling out 'lunch!' only made sense in relation to the spreadsheet that included a line, implying that some lunch cost had been part of the accumulated flight costs. In this evocation, then, Nick indexes the spreadsheet's lunch line. This specific line troubled Nick. Lunch was out of place. This implies that Nick was committed to the sort of things that would be correctly listed in the spreadsheet. He was concerned about the wrong entity being in the list. This means, Nick was able to draw a border between different categories, marking some as not fitting with the category of flights. Lunch was easy. Taxi costs more difficult, because they were clearly part of the overarching key performance indicator 'travel', of which 'short-haul flights' have been part. Evidently Nick was exercising a logic of what flights are. Lunches *are* not flights.

With Verran we can call Nick's practice of storying lunch as not being a member of the category flight as doing ontology. Nick ontologised flights. Lunch in the flight account troubled his ontology. Interestingly, before Nick got the spreadsheet, he was not troubled by the lunch line yet. That is because he was enacting the flights differently then, with a different ontology, an untroubled one. The flight data, before the spreadsheet, were practiced as pure flights. Flight data after the spreadsheet was impure. His ontologising had shifted.

Nick must have noted then that the flight data body he was working with was different from what

he felt committed to. He had been doing a reality all along, ritually, over the many steps I narrated above, an ontic practice, that was committed to including the original domestic flights' total costs in deriving the total distance travelled by short-haul flights. So, whilst his practices were committed to enacting short-haul flights all along, after reading the spreadsheet, he nuanced his allegiance, his commitment.

Cleaning data, eventually effecting a smaller total distance fact, was enacting then a different ontology, to which his practice was committed, a smaller *x* inserted into the form of short-haul flights. In this ontology lunches are not flights, and routinely *x* equals *y*, as an ontic effect, domestic flight data remains slipped into the account for short-haul flights.

In the microworld of Nick 'gathering' data and entering that into the central database's forms, numbers were part of clotting several data sets, just like the short-haul flights. These clots have been stabilised. That we assess the short-haul flight fact as being erroneous does not (seem to) affect that this subsidiary's 2008 data has been maintained and employed by the corporation for many years. To my knowledge, the multi-authored, with Nick as a core author, clot continues to be enacted as part of the historic, this subsidiary's baseline, data of environmental impacts.

Now, on to the second disconcertment. When Nick had first entered the result of his calculation I had asked him to enter a comment on his calculation in the data entry form. He then had described in the comment field how he had gotten to the total distance fact (to illustrate, see the comment section in the entry form, Figure 1). By offering this comment he offered a trace of what his fact meant, effectively telling a story about what his number was. Simultaneously, this established the fact as troubled because it was not a straightforward fact, speaking securely for itself. I suggest this kind of storying work can be considered an ontological practice because it explains what the number of the total distance crossed by means of short-haul flights consisted of.

In the conversation with Nick's boss, Nick was told to only report facts; no insecure estimations. In tension with this demand, his comment did point to the two estimations involved in the calcu-

lations, the average distances and costs, $\bar{c}_i$ and $\bar{d}_i$, qualifying the total distance fact as a calculated estimate, not securely signalling factishness. The explication of trouble got, thus, troubled, and troublingly the trouble got hidden: a few days later the comment was deleted. The numbers without comment showed no trace of their history anymore, no contingency, no trouble.

What did deleting the comment do to emissions? A data set that came with a comment was signalled to the database user at the headquarters and prompted them to review that data set. Trouble! This algorithmic function served to support the system in achieving accountability. It was considered necessary by the system designers because the company recognised that sometimes numbers required some explanation; numbers did not always tell all relevant stories on their own. Comments, thus, enriched the ontology of environmental data, by serving as unstructured metadata. Without comments, those data users who had no direct contact to the agent-entering-data had less chance to actually learn about some of the considerations around the numbers reported. Yet a different form of trouble. Simultaneously, no comments also meant that superiors were less likely getting back to the bookkeeper to inquire about the data reported. Less of this trouble, at last. Both effects altered accountability—however, in different ways. In a Strathernian/Harawaynian twist, we could voice: it matters what troubles trouble troubles.

I understand the information reportable in comments as a partial account of the modality of the numbers and units reported in a form. Such modality was co-constitutive of the numbers. Bookkeepers were responsible for the data they entered. For the bookkeeper, deleting the comment also implied that they alone carried the possibility for responding to questions on data. Providing a comment extended responsibility materially to the database. The data set could respond directly to questions. A response-*able* data set was also a risk, however, because it could answer to questions without the bookkeepers' control. Deleting a comment made the data less accountable and reciprocally reduced the risk of having taken the work situation out of the worker's control. No risk that the data set

would speak against the bookkeeper, no risk that the comment would raise undesired concerns or questions about the number's straightforward story.

This shows that offering the comment qualitatively enriched ontologising the commented data and the reality of flight distance; and second, that opening up the ontological shape of what the data supposedly represents emerges as a risk. Without comment, ontologising for actors (other than Nick) was much more speculative—definitively differently grounded, if not less grounded—for they only encountered a straightforward fact, no detour via uniquely authored metadata, con-text. No signifier of trouble.

This seemingly straightforward fact was enrolable with less friction in a range of ontologies. Precisely because the numbers were not accompanied by explicit stories, the numbers lost their ability to resist arbitrary stories that would refer to the fact. Whilst the straightforward fact appears intuitively more certain, it emerges in my analysis as rather indeterminising.

Verran's instrument of ontologising and attending to ontological practice helps foregrounding the range of potential stories about what is the case, the range of storying reality, how troubles trouble. This analysis in terms of ontologising troubles indexes a complicated space of responsibilities and accountabilities. I propose that Nick's data submission mattered in two key ways. (1) Nick seemed to care for giving a good (enough) account of the flights. For that he edited the data after having received the spreadsheet that had included, in his reading, non-flight costs, indexing his data sources 'better', cleaning up data. This qualification work involved ontological considerations by Nick about what was not to count as short-haul flight costs, such as lunch costs. However, his explicit ontologising did not range into reasoning how domestic flights mapped onto the company's definition of short-haul flights. Thus, his routine calculation approach to translating domestic into short-haul flights remained stable. Ontics does not determine ontology. (2) Further, he wanted to complete the data submission without problems—and his boss had troubled the friction caused by qualifying data as estimated. Correspondingly,

deleting modalities became a solution. These two ways were not overly coherently aligned to one another. None of the actants involved dominated the relations around the data submission with a singular strategy. Much rather, this work space needs to be understood as ordering in multiple ways—situated doings that were both materially-semiotically ordered and in which actants enacted a non-deterministic order of the flight fact. Precisely because the comment got deleted the resulting data was interpretable in more ways.

The matter of the reported total short-haul flight distance of Nick's subsidiary, thus, was not precise and stable. By way of staging the flight fact as simple, his 'simple' practice effected flight-matter with less stable meanings and as a less fixed reference point compared to to upholding his indexing comment. Indeterminacy multiplies. The simplicity allowed more readings of and, thus, workings with the numbers. Removing the grounding of ontologies multiplies the space of narrative possibilities. Thus, the configuration of bookkeepers, the central database and headquarter staff achieved a world of flight matter that was loose, connectable to all kinds of other entities, and not explicitly referring to the multiple material-semiotic doings in which practices and entities were ordered and performing order.

I turn now to analysing this narration of the ontological significance of providing and deleting the comment as well as of cleaning up data. It has deployed a Verranian attention to actors (re)doing and not-doing ontology, generating a space of multiple stories of how the comment-in-relation mattered. This instrument of re- and alter-ontologising foregrounds relations and configurations of accountabilities, certainties and indeterminacies.

Deploying Verran's ontology in this way performs ontologising ethnomethodologically. Using ontology involves a form of accounting. And these accounts can come with a range of temporal orientations. An ontological enactment may attempt to prefigure some practices; and in the very moment of ontic practice (e.g. Nick doing flight data, first-time-reading the spreadsheet), ontological reflection about these practices may take place (lunches are not flights); and doing ontology may as well relate back in time to offer a retrospective retelling about reality that, of

course, joins in shaping the present. With respect to versions of the past, I am reminded of the retrospective telling of plans, that always differs from situated actions, simultaneously offering a new account of reality-making joining in semiotic reconfigurations (Suchman, 2007). The realness effected in some material-semiotic practice may be reconfigured in material change and semiotic shifts over time—as in when a number sign that was accomplished to signify a specific reality is read differently, through another ontology. The ability for retrospective retelling and rereading allows the Verranian instrument of ontologising to account for members' storying of realness where members' own stories may gloss over, sidetrack from or even highlight relations between signs—such as categories, units, number words and rules—or logics of how these should relate. Ontologies of reality multiply because it is not an antecedent reality that determines how the reality is theorised, but ontologies are enacted in time-places, and tomorrow's ontology might be as different from the current as the ontology of a differently positioned actant in the present.

Following this consideration of troubles and multiplicity, I suggest that we can consider the use of this analytics as yielding several political troubles: in this analysis of narrating a number-as-network, I opened up the politics of undoing modalities of claims and the trickiness of what it means to get the job done. Contrasting the troubles with the punctualising (Law, 1992) characteristics of technologies of, say, policy recommendation bullet points for evidence-based governance, Verran's analytics is generative of stories of so rich realness that explodes punctualisation attempts, rendering her analytics rather compatible with anti-hierarchical politics, such as workplace resistance in the midst of global environmental accounting. Spelling out an ever-dynamic partial and situated realness-in-the-making is *unlikely* to travel well in the universe of evidence discourse—hegemonic policy circles.

My Verranian-inflected account of a number's metadata contrasts with the ease in which Nick's numbers could circulate within the company and plug into the multinational's global carbon accounting. Deleting the comment altered qualculability not in degrees but in kind, rendering

the carbon accounting machinery more smooth, removing merely a tiny obstacle to it running well. This Western Asian subsidiary's short-haul flight distance number became part of not-so-earthly machines of references in emission trading. Nick's practice did not only effect collateral realness, but collateral certainty, too. Above we had identified that Nick was positioned to be certain that his slippery commensuration of domestic flights with short-haul flights would be organisationally appreciated. By attending to the space of storying around the comment the Verranian analytics foregrounds how certainty that the reported fact is straightforward is conjured up.

The corporation, too, was positioned through the enactment of the total short-haul flight distance to be certain that these short-haul flights existed. Whilst conjuring up out of costs a quantity for short-haul flights, these flights are enacted along the way as much as the certainty that they exist at least in so far that they do not resist their enactment. And deleting the comment helped reduce resistance. For the user, whether in the corporation's HQ, its civil society or regulatory counterparts, the situation appears straightforward: "I read short-haul flights, I include them in my assessment, therefore I can be certain they exist." Certainly, we are encountering here the multiplicity of certainty.

## Conclusion

Narrating a number opens up possibilities for analysis that reveals worlds in the process of being made. This paper presented 'narrating a number' as a method of empirical philosophy. Narrating a number is generative of a narration that includes description and inferences. Here, the description is ethnographically derived. Description and inferences together ontologise the number. This method allows investigating the number-as-network. Narrating a number, then, shows what is inside the number, what it is made up of, how it coheres and relates.

This paper conducted a two-fold exercise. First, it narrated and analytically renarrated a number, and its constituting calculative practices, explicating worlds being made—the case here shaping the world presumed in environmental

economics—emissions. Assembling emissions secures the demand basic to carbon markets. Second, it analysed how two analytical approaches within the field of actor-network theory—Verran's (2001) take on ontology and Callon and Law's (2005) three-stage process of qualculation—differ, complement or work against each other.

With their shared commitment to reality emerging in material-semiotic relating, both analytics are well positioned to agree with, or complement, each other. Comparing them indicates three sets of results.

First, as analysing numbers and calculations is discursively positioned in relation to competing formalist discourse, such as mathematics, it is relevant to note that both qualculation as much as Verran's empirical ontology allow for inconsistency to be part of numbering and calculating. While in qualculation analytics inconsistency may be encountered, its mattering is second to the achievement of (non)qualculability and their respective securing of a result or the impossibility to draw out results. Verranian ontologising turns to how reals emerge, encourages attention to elements and practices, independently of how coherent they appear, and this may result in attending to entities and relations which the qualculation take does not need to generate a neat qualculation narration. Thus, whilst I find the commitment to material-semiotic relating shaping objects and worlds to be shared by both analytical approaches, what the approaches invite attention to is not equivalent.

Second, what these analytics foreground, is methodologically differently configured. In narrating a qualculation, I find myself positioned to reconstruct a quite linear temporality, prefigured by this analytics' three-stage process. Verran's ontologising invites narrating of ongoing relating. The latter can be quite disorienting, but also generative in turning to practices' multiple relations of accountability, backwards, forwards and sideways in time. The (non)qualculability attention appears as a focussing apparatus, singularising concern: which of either form of qualculability is achieved? Verranian ontologising, in contrast, appears as an instrument that guides puzzling, exploring troubling, maybe well described with Haraway's (2016) quest to 'stay with the trouble'.

This leads to the third point: While narrating a number through the qualculation analytics, I am repeatedly provoked (as some of the reviewers, too) to feel consternated: $x = y$, this can't be! This approach seems to invite a form of external critique, In contrast, in ontologising troubles, I identify a form of infracritique, attending to collective accomplishment, multispecies co-authoring and wonder. Verran might call this exploring disconcertment.

I conclude that these two analytics offer useful instruments, and that both of the analytics' instruments are not equivalent in that they do not foreground and guide attention equivalently. Thus, declaring the use of the ANT toolbox to open up numbers is not sufficiently specific, for it matters with which commitments the scholars prepares and analyses the material.

Venturing into prescriptive number analytics methodology, I suggest as criteria for narrating number: The narration needs to take a form such that a number's worlding, relating, ontic and ontological commitments can be analysed, as much as the frictions, gaps or disconnects between material, epistemic or logical entities or relations as well as the directedness of calculative processes or their meandering and swaying in social-material space.

Along this narrative analysis, a final point crystallises—on numbers. Narrating a number explodes the number, for the number's inside is relating in multiple ways to outsides. The inside/outside dichotomy starts to collapse. Instead of presuming where the boundary of a number is, it seems now apt to analyse the boundary-making of how numbers are made to, or seek to, be different to non-numberly space. We can also follow how numbers are enacted, singled out, or qualculative relations. Maybe provoked by qualculation's thesis that quantification and judgement are interwoven, and sensitised by Verranian attending to ongoing relations by heterogeneous co-participants, number is denaturalised as much as pushed to the analytic margin: relations of qualifying need as much as attention as relations of quantifying. Yet, even more focus needs to be redirected to the multiple relations of connecting and disconnecting, relations of account-abilities and response-abilities in networks that are

glossed with a shorthand as 'number'. Such redirection of concern in numbers studies might be called 'after numbers', for here we study what is within the number-as-network as much as, in a different topology, behind number signs.

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## Notes

1   Asdal's (2008) work, too, is relevant for ANT takes to open up numbers. However, in this paper, I want to focus on ethnographic, rather than historiographic, approaches.

2   The narration that I pursue here is not shaped to reconstruct a case of carbon management accounting. I do present such a case, explore it in the political and economic context, including relationships to stakeholders and standardisers—e.g., GRI reporting demands, the WBCSD, a global nature conservation NGO—elsewhere (see Lippert 2013, 2015, 2016).

3   Detailed methodological outlines of the study and its generalisations are available (Lippert 2014).

4   On the relations between the concepts of carbon, $CO_2$, and $CO_2e$, see Lippert (2012).

5   The conversion factors differ because in short-haul flights the emissions resulting from take-off and airport infrastructure relative to the emissions by a plane flying in 'parallel' to earth's surface is larger than in long-haul flights (326g versus 180g per kilometre) (see Lippert 2013: 101).

6   Cochoy introduced the notion in 2002, see Cochoy (2008).

7   Gorur's (2018) contribution to this issue further nuances and enriches Callon and Law's (2005) take on non-qualculability.

8   Economists refer to this move as externalisation. More specifically, however, I identify a form of internal externality: the project of internalising environmental consumption facts folds into itself the externalisation of the statuses of these particular environments (cf. Strathern 2005).

9   On plug-ins, see Latour (2005).

10  For a more elaborate re-reading and contextualisation of Verran's work, consider Kenney's (2015) contribution.

11  See Verran 1999: n.16; 2001: 116–118; 2005: 42; 2007a: 36.

12  See Verran 1999: n.16; 2001: 118; 2005: 42; 2007a: 34; 2009: 5, 17; Verran and Christie 2007.