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Supervising Veterinarians as Boundary-Spanning Agents:
Human–Animal Relations in Law-Science Interaction

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Abstract

Boundary-spanning agency is important for weaving together different ways of doing and knowing. This article examines boundary-spanning agency in the context of courtroom contestation of veterinary expertise. Analysing Finnish supreme administrative court judgments, we highlight how knowledge claims about animal welfare and about the process of supervisory inspections are deployed and contested by both veterinarians and animal owners in a bid to set down an authoritative interpretation about empirical actuality at the inspected sites. A central finding is that veterinarians, contrary to the implications of earlier studies, are in a potent position in their supervising role. Given the lack of intermediary soft law mechanisms such as inspection guidelines, the interpretative space left between animal protection law and veterinarians' inferences about the conditions at the inspected site leaves veterinarians with a wide mandate to make decisions about ending livelihoods and euthanising the inspected animals.

Keywords: Boundary-spanning agency, Expertise, Animal Welfare, Veterinary Practice, Law-Science Interaction, Judgment, Boundaries

Introduction

Veterinary expertise is situated in the intersections of different forms of knowledge. When dealing with these various "traditions for knowing and acting" (Law and Mol, 2010: 1), veterinarians are required to manage boundaries between traditions to maintain their mediating position concerning, for example, animal and public health (Enticott et al., 2011; Hobson-West and Jutel, 2020). In their *supervising* role, veterinarians are also engaged as experts in managing animal welfare in the contexts of law and regulation, which makes their task more complicated (Asdal and Druglitrø, 2017; Singleton, 2012).

Animal welfare inspections performed by supervising veterinarians are often highly charged situations. While the law can be a source of certainty, inspections also carry with them an element of uncertainty (Anneberg et al., 2012).

Inspections also often involve a breach of privacy and, in the case of animal production, the veterinarian's inspection report carries the potential of sanctions possibly influencing whether the owner is entitled to financial support from the state (cf. Andrade and Anneberg, 2014; Väärikkälä et al., 2020). In many cases, veterinary decisions are based on economic considerations alone. No money to treat one's animals often means euthanasia for the animals and loss of livelihood for the owner.

The fact that the supervising veterinarian is a threat to some animal owners is reflected in the abuse and threats veterinarians potentially encounter. In an anecdotal example, Finnish veterinarians in training have even been instructed to park their car in a way that allows for a fast escape from the farmyard if a situation escalates (Kivimäki, 2023). Whether the case is about companion animals or production and livelihood, veterinarians are also targeted in social media and often accused of *not* doing a better job of protecting animal welfare, with issues of confidentiality often making it difficult for veterinarians to defend their decision making (Vaarala & Siniauer, 2023). Adding to this load, some supervising veterinarians' decisions are contested in the courtroom. We discuss veterinary agency in the context of complaint cases in the Finnish supreme administrative court, where the legitimacy of veterinary decision making is disputed and eventually resolved.

Our aim is to understand and explain what we see as the core feature of the *supervising* veterinary practice: the fact that supervising veterinarians as both state officials and veterinary experts span the boundary between different ways of knowing and doing, that is, between the law and credentialed knowledge of animals and their (observed) welfare. We examine complaint cases featuring contested understandings about expert decision-making and accounts of animal welfare at the Finnish supreme administrative court. These provide an empirical vehicle to examine and conceptualise boundary-spanning agency in context. Thus, we complement the understanding of the veterinary profession and its position of power. In this, we draw on earlier studies about the veterinary profession and practice (Enticott, 2012; Hobson-West and Jutel, 2020). We also draw on STS literature on boundaries (Mol and Law, 2005; Law and Mol, 2010), law-science interaction understood as contestation and negotiation of knowledge (Edmond, 2001; 2004; Jasanoff, 2005; Taipale, 2019; Taipale and Hautamäki, 2021), as well as on studies of how expertise is deployed in disputes (Lynch, 2014; Wynne, 1996).

The empirical analysis we present below focuses on three aspects of epistemic contention in the court cases. First, who gets to set the authoritative interpretation of animal welfare and on what epistemic basis? The result of this contest between the supervising veterinarian and the animal owner is central to the ability of the supervising veterinarian to span the boundary between the law and veterinary expert accounts of the inspected site. Second, a prominent strategy for animal owners is to question the veterinarians' accounts by questioning the appropriateness of the inspection process as well as the motives underlying this inspection, thus trying to influence the credibility and authority of the supervising veterinarians and their inspection accounts. Third, we argue that by drawing on their experience and history of inspections, supervising veterinarians engage in a practice of creatively working their inspection accounts to meet the minimum level of animal welfare as specified in the animal protection law.

An important finding concerns the relative position of power the veterinarians inhabit: the veterinarians seem to be in possession of an extensive mandate marked by an unmediated interpretative space between the animal protection law and particular instances of animal welfare. The finding complements the conventional understanding according to which veterinarians have a relatively weak position of authority. Our results suggest that the veterinary jurisdiction is quite powerful in granting rights to override privacy and ownership rights and issuing immediate relocation or euthanasia of animals by drawing on Article 44 of the Animal Welfare Act, the decision being based on the veterinarians' trained judgment and interpretation.

The following section discusses earlier literature on veterinary expertise as mediating human –animal relations, as well as law-science interac-

tion and boundaries. It also outlines the conceptual framework for analysis and the central theoretical aims. The subsequent section presents the complaint cases at the supreme administrative court and explains the methodological rationale for focusing on a handful of these cases. The penultimate section then presents three themes for empirical analysis and further develops them in discussion of what we can learn about supervising veterinary expertise and boundary-spanning agency based on these court cases. The final section sets out the conclusions.

Veterinary expertise and human–animal relations

Veterinary expertise is a relatively understudied topic compared to the sociological study of human medicine and health and illness (Hobson-West and Jutel, 2020; Hobson-West and Timmons, 2016). According to Pru Hobson-West and Annemarie Jutel (2020: 393), veterinary practice operates as a "key site of human–animal relations," where veterinarians mediate between humans and animals in multiple situations, whether in the context of animal production, companion animals, or wild animals. Veterinarians also control boundaries between them. In relation to animals, veterinarians do not occupy just one position: drawing on the notion of multiplicity, veterinarians can occupy multiple positions and mediating roles that are not always compatible (cf. Law and Mol, 2010; Singleton, 2012). We contribute to this emerging line of study by examining contestations of veterinary practice, as well as how its legitimacy is maintained by the legal system.

The mediating work being done by veterinarians is also filled with multiple tensions. This is illustrated by Clinton Sanders's (1995: 199–200) comparison concerning the ways in which veterinary practice differs in multiple ways from the performance of human medicine. In the human setting, physicians are commonly in control, directing the interaction from an authoritative position. Physicians are also subjected to "extensive legal and ethical regulation" (Sanders, 1995: 199), and considerations of financial costs are of limited importance in conjunction with the health of human patients or saving human lives. In contrast to this, veterinarians are situated in a triadic relation, mediating between the animal patient and the human owner. Veterinary practice is client oriented, and considerations of costs are of high significance. Thus, euthanasia is an option in many such cases that in human medicine would be unthinkable. The result of these differences is that the legal regulation of veterinarians is much looser in comparison with human medicine, contributing to both flexibility and conflict in veterinary practice (Hobson-West and Timmons, 2016).

Animals are thus not patients in the way humans are. Instead, they have a dual status both as sentient beings and as economic objects. They warrant care and medical attention as living beings, but at the same time, the work veterinarians perform is also part of the 'maintenance' of animals used in production. As John Law (2010: 61) somewhat bluntly expresses it, the way veterinarians 'care' for animals can be seen to include killing them as well: "[T]his isn't cruelty, which is what a sentimental urban world might imagine. For caring for the calf is also, and crucially, a matter of a good death." However, emotional stress is not a quality of the 'sentimental urban world' alone, but subjects veterinarians to various tensions (e.g., Enticott, 2012). Furthermore, questions about what constitutes good care for animals are at the heart of animal welfare debates.

Veterinarians and veterinary expertise are part of the enactment of the "state-controlled killing" of animals, where this capacity is taken away from, for example, religious authorities, to ensure the 'rational' and 'humane' treatment of animals (Asdal and Druglitrø, 2017: 74). Veterinary practice is part of the processes of limiting the treatment of animals to certain controlled locations – such as the slaughterhouse or the laboratory – as well as controlling the movement of animals, for example in the international trade of production animals and agricultural markets (Enticott, 2012). This has also involved the gradual definition of animal health as a publicly relevant issue in which veterinary expertise is seen as a crucial solution for dealing with it (Enticott et al., 2011). Animal rights organisations have also demanded stricter regulation, limiting, for example, the performance of painful procedures only to veterinarians. These

demands have been countered by references to the specialist knowledge of producers who see themselves as equally qualified for such procedures. Such developments exemplify contestations about who is authorised to deal with animals and what kind of expertise is considered legitimate.

The economic status of animals as ownable objects conditions the work of veterinarians but is also related to the consequences of supervising veterinarians' work. Veterinarians can order sanctions, relocation, or, in extreme cases, the killing of animals that producers rely on for their livelihood (see Koskela, 2021; Väärikkälä et al., 2020). Supervising veterinarians are dealing with and, in some cases, severely interfering with, the property (i.e., the animals) of a citizen, and such actions require robust legitimation. This legitimacy is partly grounded on the inspected animals' health and wellbeing. Tensions between forms of knowledge can nevertheless form grounds for controversy, as different groups struggle to define what counts as acceptable or good care for animals. As Brian Wynne (1996: 61) notes, "the basis of lay public responses to expert knowledge is always potentially an epistemological conflict with science about the underlying assumed purposes of knowledge". Legitimisation based on veterinarians' expertise on animal welfare is often met with suspicion about underlying motives for interfering and controlling the relations between animals and their owners (Hobson-West and Jutel, 2020; Knights and Clarke, 2018). The suspicions are indicative of the status of veterinary expertise, which in comparison to a physician is a lower position of authority, and thus also more contestable. A successful performance of veterinary expertise, therefore, requires managing tensions between different stakeholders and the coordination of different forms of knowledge, and supervising veterinarians regularly encounter situations where this is not achieved.

The supervising veterinarians' assessments of animal welfare are connected to the enactment of animal welfare and animal protection law (Koskela, 2021; Valtonen et al., 2021; Väärikkälä et al., 2020). The Finnish Animal Welfare Act from 1996 (3§:1) states that animals should not be subjected to unnecessary pain and suffering, but the word *unnecessary* leaves considerable room for interpretation and has been contested by those advocating for animal rights or animal welfare.[1] The ambiguity is amplified by the different categorisations of animals and their dual/ambiguous status as sentient beings as well as economic objects in law (as discussed earlier). Even though the main purpose of the law is to prevent and remove unnecessary suffering – the main point in many legal court cases that we analyse here – production animals can still be kept in conditions that many perceive produces unnecessary suffering. Whether something is necessary or unnecessary is a question of what is considered justifiable. In terms of powers, Article 44 of the Finnish Animal Welfare Act (1996) confers extreme discretion to supervising veterinarians in cases in which the condition of the animals or the conditions in which they are kept are such that immediate action in relocating or euthanising the animals is necessary. This interpretative flexibility (Collins, 1981: 4) is underlined by the absence of a soft law instrument such as inspection guidelines mediating between the law and veterinary expertise, the consequences of which we discuss later.

Boundaries, law, and boundary-spanning agency

Supervising veterinarians are required to manage and maintain boundaries between the multiplicity of practices and forms of knowledge related to the care of animals, but also to cross such boundaries when making inspections. Central to our examination, supervising veterinarians also span boundaries between the abstract normativity of the law and the multiple forms of knowledge and practices related to animal welfare (Enticott et al., 2011; Law and Miele, 2011). Boundaries and their management have been a central topic in STS, ranging from the flexible demarcation of science from nonscience (Gieryn, 1983) to institutional ecologies and the coordination of action with boundary objects (Star and Griesemer, 1989). While displaying differences, both approaches focus on the coordination of heterogeneous collections of actors, knowledges and interests.

Annemarie Mol and John Law (2005) state that boundaries, the possibilities of crossing them, and the identity and fate of the objects and subjects crossing these boundaries, are highly varied and in complex relations with each other. To Mol and Law (2005), boundaries and their management are crucial to all ordering. However, the authors also highlight the potential transformations in the identity or perception of the object/subject that result from crossing boundaries, and the possible consequences for order. In some instances, to maintain order some things (or the identity of some things) might need to be preserved or affirmed in the crossing of the boundaries. This is because the power of some practices or techniques is derived from the perception that they apply everywhere or are true or produce true outcomes regardless of context. A prime example of such normative arrangement is the law, the legal order, and legally mandated agency, with the caveat discussed by Bruno Latour (2010: 247-249) that law is a plural and socio-culturally situated practice. Yet, in its situatedness the legal order spreads to the extent of its web of (socio-cultural) associations and provides a uniform means to verify social order (Latour, 2010: 254-277).

From the legal courts' fact-finding perspective, Sheila Jasanoff (2005: 50) argues that "the law develops knowledge as an aid to doing justice in a particular case; by contrast, science seeks truths that are, as far as possible, detachable from their context of production." We examine veterinary expertise as situated in-between these rationales for knowledge production. On the one hand, the authority of veterinary expertise is based on the scientific training of the veterinarian and the general and detached truths of veterinary science. On the other hand, veterinarians as supervising officers with a legal mandate are tied to reporting the specifics of the case and thus combine their trained expert perception with an evaluation of what animal welfare is in the context of a given inspection case. However, we emphasise that supervising veterinarians also need to connect the details of the case with the normative (both general and abstract) aspects of legal statutes on animal welfare (cf. Latour, 2010: 254-277).

In the complaint cases we analyse, the central actors include supervising veterinarians, the legal courts and their judges, and the complainants (and we should also add, the silent party of animals). The relations between these actors can be understood as involving jurisdictional and epistemic boundaries, understood (in general terms) as delineating any number of stabilised institutional values and epistemic stances and their logics and principles of action or operation (cf. Abbott, 1988). These "traditions for knowing and acting" (Law and Mol, 2010: 1) with their distinct rationales in this case context include law, rights, economics and veterinary expertise, but also the lived actuality of the complainants – the lay and specialist knowledge concerning, for example, animal husbandry, health, ownership and the animals owned.

These potentially complex relations point towards an agency capable of navigating and stitching together the different traditions of knowing and acting in institutional practices. The figure of the boundary-spanning agent and boundary spanning as agency has been discussed in management and organisational as well as governance and sustainability literature.[2] In our approach, boundary-spanning agency is something that is partly in-built in relations between institutional practices that also involve standards and guidelines (Timmermans and Berg, 1997) and partly constituted, affirmed and challenged in situated contexts such as legal courts. Boundary-spanning agency is not an actor's category (Lynch, 2014), and is (in our use) meant to capture a function of a socio-cultural practice that involves a struggle which leads into more or less temporary relations of power (order), the specifics of which depend on the context of inquiry.

What makes the cases we analyse interesting is that while complainants seek access to their rights, at the same time their questioning of the supervising veterinarians' decisions and practice can be interpreted as disruptive of the legitimacy of the system of enforcement and legal order in general. That is, what legal courts try to put together, complainants try to tear apart.

In conceptualising boundary-spanning agency, we note that by definition, the *supervising* veterinarians span the boundary between the abstract and highly general domain of law and the messy empirical reality, which in this case is a particular instance of practising animal husbandry or animal

ownership. Thus, veterinary expertise is the medium through which the veterinarians' authoritative representations and their interpretation of the facts on the ground are communicated to the law, and through which the boundaries between different ways of knowing and acting are both spanned and affirmed (Singleton, 2012). Put in different terms, the actual is transposed into the normative through the mediation work of veterinary expertise. This veterinary work presents the focus of contestation in the legal court cases we analyse.

Examining agency through legal court disputes

Empirically our focus is on the contestation and maintenance of veterinary expertise in courts, focusing on the Finnish supreme administrative court. We approached the topic with a preliminary interest in how the actors involved argued for their case in trying to bolster or detract from the parties' credibility and the credibility of their knowledge claims. We further examined how these credibility contests (Shapin, 1995) were connected to relations between veterinarians, the court, and the complainants as well as the animals they own.

The initial case data consist of 78 Finnish supreme administrative court judgments, dating from 2013 to 2022. All cases are complaints made by the animal owner against supervising veterinarians on grounds that are discussed later, but the character, context and substance of these cases is quite varied, ranging from industrial production to concerns related to companion animals. For this study of supervising veterinary expertise, we chose five court cases for in-depth analytical examination. The criteria for choosing these judgments are twofold. First, we chose these cases due to their character as particularly contested in comparison to other cases in the full dataset. The selected cases contain exceptionally pointed argumentation, and though this exceptionality might not be representative of the case type as a whole, these judgments by their exceptionality highlight well what is at stake and provide a suitable material for empirically motivated theorisation of practice. Exceptional instances challenge, add to and provide a reflective surface to theory and its development (cf. Timmermans and Tavory, 2012).

The second criterion for choosing these cases had to do with the variance of their substance. By including different types of human–animal relations, we provide both a more varied *and* context-independent understanding of how boundaries are negotiated, and justifications contested or affirmed. In a broad stroke, the cases we focus on are about animal husbandry (dairy and meat production) and companion animals, but they also involve breeding for profit as an economic motive. More specifically, the cases involving production animals are about wild boars and cattle, and the cases involving horses, cats and (wolf)dogs represent companion and hobby animals.

It is noteworthy that the judgments we focus on also contain the relevant parts of the lower administrative court judgment, because most (if not all) of the evidence was already filed in the lower court proceedings. Supreme administrative court proceedings are based on the previous case file and additional filed written statements by the parties, whereas oral hearings are rare. The judgments are representations of court case proceedings, filtered by the judicial and epistemic reasoning of the judge or a collegium of judges. While the judgments thus provide a one-sided perspective on these cases, the judgments as resolutions are what matters for the consequences of the legal disputes, and what matters for the authority and status of the supervising veterinarian. The judgments then bring closure on these contested cases, which is significant for affirming (or contesting) the status of the supervising veterinarians.

The analysis of the judgments is complemented by news material from selected media outlets in Finland, and especially by a handful of news items that discuss or have taken the first-person view of supervising veterinarians. The issues of animal welfare and its supervision have been topical in Finland lately, as the recent reform of the Animal Welfare Act has generated debate on the practice and extent of supervision. We have used these media texts to locate the figure of the supervising veterinarian in the Finnish cultural landscape of meaning (Reed, 2009: 89-171) and provide the analysis with additional insight.

We developed the data thematically, starting from coding the smaller sample of cases with Atlas.ti case by case. We then collapsed the case-specific quotations into general themes, while preserving the richness and individual characteristics of the cases in descriptions and select quotations. The aim here was to make more general inferences about boundaries, institutional logics and practices and their interlocution. The themes that emerged as most pertinent to our analytical interests were the contestations relating to the condition and characteristics of the animals, the contestation of the propriety of the inspection process, and the role of drawing on past inspections as an argumentative strategy.

Examining the production and contestation of boundary-spanning agency in Finnish supreme administrative court cases

Affirming and contesting veterinarians' inspection accounts

The central point of contestation in the analysed court judgments concerns the definitions and claims about whose assessment about animal welfare is considered legitimate and on what grounds. Both supervising veterinarians and complainants draw on their varying expertise and experience of animal welfare and husbandry, displaying the often-contradictory ways of defining animal welfare. The claims are fundamental in establishing the credibility and legitimacy of the contradicting positions, and thus consequential to the resolution of the court dispute.

Veterinary expertise appears mostly in a matter-of-fact way in the analysed court judgments. Claims in expert statements are represented as facts about animals in general, and the facts are then contrasted to the perceived mistreatment of animals observed at the inspection sites. Thus, in a case concerning wild boars (3372/1/15, 2016: 7), the court decision notes that wild boars generally reproduce rather easily. Since this had not occurred in the farm in consideration, the veterinarians and the court deduced that this was another indication of malpractice. In another case, the supreme administrative court discussed a case in which the veterinarian had ordered the castration of household cats that were breeding profusely. The court based its decision on the notion that there is reliable veterinary knowledge about the breeding of cat populations:

> The general understanding, also expressed in the previous decision [by the lower administrative court], is that [situations in which there are] uncastrated cats of opposite sexes who move freely outdoors lead to the uncontrollable growth of cat populations, which is harmful to the health, wellbeing, and security of the cats. (Case: 23579/03.04.04.04.24/2021: 5)[3]

Based on this general knowledge, the veterinarians did not have to inspect individual cats to make the decision, as the definition was seen to apply to all cats and cat populations. The way animals are enacted in these instances therefore relies on abstract and detached knowledge about the characteristics of the species in general, with not much room for individual or situational variation.

However, while such 'facts' are based on current veterinary knowledge, it should be noted that the question of what species-specific behaviour consists of and how it should be accounted for is a malleable issue and provides a possible opening for contestation. Production animals especially can be kept in conditions that limit their possibilities to, for example, move, take care of themselves, and socialise with others of their kind. Therefore, while indeed based in veterinary expertise and animal welfare science, it should be kept in mind that the definition of what counts as sufficient conditions is both flexible and contested (e.g., Lundmark et al., 2013).

The case concerning wild boars (3372/1/15) revolved around the question of what is and is not proper nutrition for the animals and provides another example about the flexibility of definitions. One of the main points of contention (the other being the conditions in which the animals were kept) in this case had to do with the type of feed provided to the wild boars, namely, pastries procured from a local bakery. The pastry the boars were fed with was considered appropriate nutrition by supervising veterinarians *if* the pastry was complemented with other more conventional and good quality fodder that is usually provided for farm animals. In a further twist, the pastries were found to be past their sell-by date, and if not mouldy or rotten, then they were at least stale, but

probably also somewhat tainted as food. Consider the following excerpt:

> The inspections have described the [state and quality of the] fodder found on the farm. The conclusions concerning the wild boars' feeding have additionally drawn on the account of [the animal owner, farmer] *A.* During the first inspections *A* has himself given the opinion that boars would rather eat stale rather than fresh pastry and hay, and that the nutrition wild boars naturally feed on is partly rotten, which also gives the wild boar meat its correct aroma. The [regional authority] states that providing partly tainted nutrition is just one of several problems related to the feeding [of the animals]. (Case: 3372/1/15: 12)

Thus, when the quality of the fodder was raised as evidence of the farmer's compromised practice of animal husbandry, the owner/farmer responded that is was characteristic of wild boars to scavenge and eat waste or garbage – claiming that this is what they feed on, and not only that: the typical or recognisable taste of wild boar meat is dependent on the animals scavenging and eating waste. This referral to the economic and related aesthetic rationale of the feeding practice was an attempt to counter the veterinarian's judgment by referring to alternative facts about the animals, which were importantly based on the practice-based knowledge of the farmer (cf. Lynch, 2014; Wynne, 1996). While these claims also operate on the level of species-specific qualities, the economic-aesthetic aspects also go beyond considerations that are strictly about animal welfare.

The contested issue was thus the species-specific needs of wild boars – what do such animals need to fulfil their 'wild-boarness'? From a veterinarian perspective, species-specific needs connect to the up-to-date requirements of animal husbandry as a target of governance, as defined by veterinarians: it is required for the farmer/owner to know what the animals husbanded need as a species. Both the supervising veterinarians and the owner of the animals claimed to have superior knowledge on where the boundary between nature and culture is located, and the issue boiled down to the quality of the pastry fed to the wild boars. In its resolution in favour of the veterinarian's position, the court signalled preference for expert authority based on veterinary science over the animal owner's practical experience and local knowledge of conditions (cf. Wynne, 1996).

The interpretative flexibility (Collins, 1981) of such boundaries, epistemic objects and the competing forms of knowledge were also apparent in a case judgment that concerned cattle. In this case, one cow – dubbed cow no. 107 by its number at the farm – exemplifies how both supervising veterinarians and complainants can qualify the situation in almost completely opposite ways.

First, in the account given by the supervising veterinarian, the cow in question was described as in very poor condition, which eventually led to the decision to put it down:

> The cow with earmark 107 was limping and practically three-legged. In the inspection that took place Dec 16, 2015, the supervising veterinarians had given an order to either treat or to put down this cow, among others. The cow was then put down at the end of this inspection to prevent further suffering. (Case: 1253/1/16: 12)

In this description of events, the veterinarians had inspected the cow several times, noting it to be in very poor condition and in need of treatment. As the complainant-producer had not acted as advised by the veterinarians, the cow was put down. However, in the complainant's account, the same cow was described as completely fine:

> The cows were milking well and therefore there could not have been any severe problems in their circumstances. For example, cow number 107, which was put down during the inspection that took place on Dec 16, 2015, was the best cow [the complainant] had based on milk production. It had milked a little under 50 kilograms per day, and according to a linear curve model its milk production would have been almost 16 thousand kilograms per year. [The complainant] had provided a report of milk production of his cows to the court. (Case: 1253/1/16: 14)

In this account, the wellbeing of the cow is based on assessing its productivity, which the complainant at another section of the judgment also supported with reference to the plans he had made in cooperation with the dairy. In addition to relying on the statistics of milk production as neutral evi-

dence for substantiating the complainant's case, the complainant had also consulted the services of other veterinarians. The purpose was to substantiate the complainant's claims with (competing) veterinary expertise:

> The animals had been inspected with [another veterinarian] and no problems were noticed. Of course, in a freestall barn and in a large herd there are always some problems to do with chance and circumstance. In the complainant's experience, such injuries heal in about a week. (Case: 1253/1/16: 14)

Hence, the claims are not just the complainant's own opinions or choices but are instead substantiated by other actors and facts as well – other veterinarians, the dairy, and the cow as a productive unit that was enacted through productivity calculations.

The complainant still admits that the animals are not completely fine, but these are chance events or part of the normal life of a barn. As evidenced by this quotation, allowing for such variance and openness can also indicate intimate knowledge of the local situation and thus can serve as a justifiable basis for making knowledge claims about the disputed issue. This could also be used to avoid responsibility. An example of such an evasion is the reference to a chance event in which a certain outcome is not a result of deliberate action. The discussed court case, in general, shows how the supervising veterinarians made claims about the animals' health and wellbeing based on their (expert) observation of the condition and behaviour of the animals, whereas the complainant-producer used arguments based on productivity and economic factors to demonstrate the animals' health.

Overall, many of the complainants stated that the evaluation of the owner's practice of taking care of animals should be based on the owner's situational consideration and judgment. Instead of making inferences based on the abstract rules of the Animal Welfare Act, external observers should trust the animal owners' personal expertise. In another example, the case concerning possible mistreatment of horses (20056/03.04.04.04.24/2020), the complainant referred precisely to this kind of solution. The police had received several complaints about the stable, as their horses were seen outside during harsh winter nights. The complainant, however, argued that if the weather was too harsh for the horses, the complainant could assess their condition situationally and then decide whether the animals needed to be brought in or not. In other words, the complainant would assess the horses' conditions and wellbeing first, and then decide what to do (instead of applying a categorical rule that the horses needed to be kept inside at a certain temperature and at certain times). Here confining judgment to the context of each situation is proposed to offer a basis for resolving the case.

In sum, in all the examined judgments, the veterinary 'facts' about animals and their relation to mistreatment of animals was explicitly contested. When mobilised successfully by the veterinarian, such facts affirmed the veterinarians' expert accounts of animal protection violations and enabled boundary-spanning agency between the abstract generality of law and particular conditions at the inspection sites, as represented in the expert inspection reports. The complainants, by comparison, sought to disrupt the spanning agency between the law and the veterinary expert account by declaring their superior knowledge of conditions on the ground at the site of inspection. This superiority was based on a different rationale of evaluating animal welfare: the intimacy or situatedness of knowledge about the animals and what their welfare requires and the economic aspect and productivity, supported by reference to the counter-expertise of contracted veterinarians.

Affirming and contesting the due process of inspection and appropriate practice of animal husbandry and ownership

In the cases we examined, a reoccurring way to challenge and undermine the credibility of the supervising veterinarians' inspection accounts was to claim that these accounts were somehow personally motivated. We interpret such claims as attempts to disrupt the boundary-spanning agency of the supervising veterinarians. In these instances, the supervising veterinarians are not portrayed as focused on the relation between

the characteristics of the case at hand and the law. Instead, their focus is claimed to be limited to the setting and the personal relations with the complainant.

The personal motives attributed to the supervising veterinarians were presented as examples of the incompetence of veterinarians, thus questioning their understanding of what it is to care for animals:

> The veterinarians who made the decisions do not have experience in practice [of animal husbandry], which has led to resolutions that are incorrect and not based on facts, and to deception and a witch hunt against [the complainant]. The supervising veterinarians always arrived at the farm without notice. (Case: 1253/1/16: 14)

The notion of "witch hunt" aims to reverse the veterinarians' account. Repeated visits to the farm and claims about recurring instances of mistreatment of animals are thus explained by a personal motive for the veterinarians' actions. That is, recurrence is claimed to be not a quality of persistent problems at the farm, but instead signifies repeated attempts by the supervising veterinarians to find proof for their personal agenda or vendetta against the complainant. Furthermore, arriving without notice could be considered a way to make sure that the inspection is focused on the actual conditions in the farm (i.e., the producer has not had time to hide mistakes), but here the complainant interprets it as a sign of deliberately attempting to find (in the sense of making up) violations of animal welfare standards. Claiming that supervising veterinarians are motivated, or their actions influenced by ulterior or personal motives, marks an attempt to undermine the supervising veterinarians' legitimacy and capacity to span the boundary between the expert inspection account and the abstract generality of law.

Another basis for contesting the veterinarians' decision making are the alleged violations in the way the inspections were carried out. The protocol for inspections deriving from the animal protection law states that the owner of animals must be given a chance to be heard and respond, unless the situation is such that relocating the animals or euthanising the animals immediately is a necessity and the owner cannot be heard for some reason (the mandate for this is set in Article 44 of the Animal Welfare Act). Consider this excerpt, detailing the complainant's position:

> The matter has not been handled impartially. To start with, the executive assistance the supervising veterinarian delivered to the police has jeopardised the supervising veterinarian's impartiality, and his/her actions in the animal protection matter cannot be seen as separate from the police investigation. The decision made by the [involved] authority regarding the legal conformity of the premises the animal was held in is based on subjective perceptions, for in [the related] regulation there are no objectively verifiable criteria [with which to evaluate the] premises. That the [veterinarian's] first contact with the case happens as part of a criminal [police] investigation is bound to guide the supervising veterinarian's interpretation of the law and the application of that law in a direction that is injurious to the [complainant]. (Case: 20821/03.04.04.04.24/2020: 8)

In this case, an animal protection and wildlife crime case involving a suspected wolf and a wolfdog, the presence of police officers during the inspection was argued by the complainant to violate the due process of inspection, since the neutrality of the supervising veterinarian was compromised. Due to suspected wildlife crime (keeping a wild wolf) the supervising veterinarian had entered the location with the police, and while the vet was questioning the owner about the canines' origin, the police were also present. This, according to the owner of the animals, made it impossible for the owner to give his/her account to the veterinarian, because his/her right to not incriminate him/herself was compromised. In addition to an inappropriate inspection process, the complainant suggested an ulterior motive for the inspection: a police action programme for combating wildlife crimes, with the programme allegedly in desperate need of cases to show successful implementation.

Concluding the inspection, one of the canines, presumed to be a wolf, was euthanised on the spot by the decision of the police present at the location. Because the veterinarian did not receive a sufficient background explanation about the other canine, suspected to be an unregistered wolfdog, the vet made the decision and instructed

the law enforcement officials present in the location to euthanise the animal. Both the lower and the supreme administrative court dismissed the owner's complaint and established that the procedure that was followed at the location was appropriate, thus also affirming the veterinarian's account and the legitimacy of her/his expert authority.

In the wild boar case, the complainant explicitly claimed that the objectivity of the supervising veterinarians had been compromised due to them having been offended by the complainant's behaviour and comments. This was further connected to the complainant's argument that the principles of equality and legal protection had been violated because the supervising veterinarians were women. Thus, objectivity and neutrality were compromised by what the complainant perceived as gendered prejudice. The reasons the supervising veterinarians offered for their decisions were therefore interpreted only as excuses, again hiding a personal agenda. In the wild boar case the court, however, resolved the issue by noting that differences in opinions or disagreement between the parties did not mean that the officials would be unable to carry out their professional task objectively.

While in the previous section we examined instances where competing forms of knowledge and interpretations were set against each other, in the situations discussed above the focus turns to the actors themselves. In such instances, the defendants did not aim to provide alternative interpretations but, instead, aimed to introduce possible hidden motives. The enactment of successful boundary-spanning requires that such personal elements are not present in the accounts and there is a connection between the detached accounts based on expert knowledge and the law. These personal elements are almost always a part of veterinary practice, as discussed above (cf. Koskela, 2021; Sanders, 1995), and provide possible fractures through which actors can try to undermine the supervising veterinarians' authoritative position.

Despite these attempts, discrediting the supervising veterinarians' inspection accounts by drawing on allegedly inappropriate inspection procedures and veterinarians' personal or ulterior motives were not a winning strategy for the animal owners. It is true that in considering the court judgments, most claims the animal owners made against the supervising veterinarians come across as dubious, even outlandish. However, as we work with court-produced document data only, we are also left to work solely with the perspective of the judges in evaluating such claims by the complainant. That the court overwhelmingly sided with the expert accounts reflects the default position judges often take in relation to experts speaking from the perceivably neutral position of a state (expert) functionary. It should be noted that, in comparison, expert witnesses brought in by the parties are considered much less credible in their claims (Taipale, 2019).

Adjusting the relation between law and actuality

To establish and affirm the supervising veterinarians' boundary-spanning agency, a relation between the law and the actuality represented by the inspection accounts must be established. In the last two sections we showed how notions of animal welfare and its basis in the nature of the animal were subject to contestation, and how the animal owners sought to diminish the credibility and authority of the inspection accounts by questioning the propriety and motives behind the inspection process.

In this third analysis section, we focus on a recurring element in the examined court judgments: the way in which the veterinarians bring up the history of inspections. The mention and discussion of continuous problems is an important reason why these cases are in court in the first place. Consider the following excerpt discussing the inspection at the wild boar farm:

> The issue at hand concerns long-term deficiencies and negligence in the conditions and nourishment of the wild boars. At least some of the animals have been observed to be skinny, but not starved, sick or injured. [The lower administrative court] evaluated that due to these serious long-term deficiencies and negligence having to do with the basic needs of the animals, such as proper fodder and its sufficiency, these deficiencies and negligence gave sufficient grounds [for the supervising veterinarians] to take appropriate action as defined

> in Article 44 of the animal protection law. (Case: 3372/1/15: 9)

Such referrals to orders that concern the same issues repeatedly construct an image of lasting problems that need to be addressed. The earlier history of inspections is a criterion for evaluating the animal keepers' ability to take care of the animals in a sensible way, which is apparent in the following excerpt:

> Considering that, despite numerous instances of advice and orders, [the complainant] has systematically *decided* to follow *his own* principles of animal husbandry, the issue is therefore not about a temporary condition that could be remedied by acquiring additional help and nutrition for the cattle. (Case: 1253/1/16: 25; emphases added)

The complainant had 'chosen' to apply his own principles and these principles are not generally accepted (according to the veterinarian). Attributing this to the personal choice of the complainant underlines that it is done by this person and is against the advice given by the veterinarians. But what is the broader relevance of veterinarians bringing up the history of inspections? In our contention, the key issue lies in something that a regional vet stated in a media interview in January 2023:

> The regional authority supervises the minimum level of the Animal Welfare Act - and sometimes that has nothing to do with the [good, in the sense of adequate] level of animal husbandry […] Coercive means can only be used in cases in which harm to the animals is very considerable and long-lasting. (Vaarala & Siniauer, 2023)

The vet continued:

> The lay public often reacts and questions the lack of intervention [before things get bad]. We do instruct and provide guidance to improve the conditions for the animals, but in the legal framework [we work with], we can only attempt to ensure that the minimum level [of animal welfare] is fulfilled. (Vaarala & Siniauer, 2023)

What we argue is that the strategy of making credible claims by indicating a case history expresses an important means — we might call it an 'epistemic device' — for the supervising veterinarians to span the boundaries of (or the interpretive gap between) the legal normative order and the actuality as represented by the supervising veterinarian's account or narrative.

Temporalisation, or bringing up the history of inspections, is important because it provides a means to adjust the relation or threshold between the minimum level expressed in the law and the 'greater good' of actual animal welfare, which for the most part – as evidenced by the veterinarian's interview excerpt – are a different thing (cf. Enticott et al., 2011). Bringing up past events can be understood as an argumentative strategy with which to ensure that, even though some of the animals might seem to be in good health and some experts might have expressed somewhat contrary or much less grave opinions about the current condition of the animals or the conditions in which the animals are kept, generally speaking and in the long run there are bound to be problems in the future as well, that is, according to the veterinarian's trained judgment and practice-sharpened gaze (cf. Daston and Galison, 2007).

What speaks on behalf of such considerations is that there is considerable public pressure upon the veterinarians to perform and succeed in their work. The possibility of such a practice of doing interpretive work (for the greater good) existing in our case study is also backed by earlier research. Gareth Enticott (2012) discusses bovine tuberculosis of cattle in Britain and follows the practice of testing conducted by veterinarians. The testing protocol stated that in the case of one animal in the herd testing positive, all the animals should be euthanised to prevent the disease from spreading. However, in the case of borderline test results (due in part to the very craft-like nature of the test procedure, leading to a variance in 'trained judgment' of determining infection), Enticott writes that veterinarians might interpret the results in a way that preserved the means of livelihood for the farmer/herder and preserved the lives of the animals. That is, some results were

interpreted in a certain way in support of the greater good.

Enticott (2012) based his observations on what Stefan Timmermans and Marc Berg (1997) call the local universality of protocols, which refers to the idea that for universal guidelines to work universally, they need to be interpreted and tinkered with in their local context. These interpretative spaces that are opened and what they enable across different scales of agency are very important to any large-scale coordinated action that is based on and seeks to uphold given principles and order. Guidelines mediate between general normative rules such as law and micro-level practice.

In the case of the Finnish supervising veterinarians the relevance of the veterinarians' broad discretion for attaining the greater good is pronounced. This is because there are no guidelines for inspection other than what is stated in the law. In other words, the lack of more accurately described guidelines or testing procedures (i.e., soft-law instruments) provides more autonomy for the veterinarians in providing them with an interpretive space as experts. Thus, the supervising veterinarians' mandate existing between law's normative perception and the observed actuality is quite extensive, with Article 44 of the animal protection law giving them powers to issue immediate action either relocating or euthanising the inspected animals, thus also overriding individual rights to conduct business, and terminating means to livelihood for some. This extremely extensive mandate is highly meaningful to the supervising veterinarians' practice of boundary-spanning agency between the extreme generality of law and the particularity of an animal welfare case.

Here we want to stress the issue of lack of inspection protocol for supervising veterinarians apart from what the law on animal protection states. Law, in its generality, is highly flexible to interpretations and thus also highly contestable. As earlier studies have shown, protocols can be very powerful as devices that are independent of human actors, affirming what for science counts as the generally accepted knowledge or the consensus, and the proper way to conduct one's business considering this knowledge (Taipale and Hautamäki, 2021). In a way, protocols can both diminish and reinforce boundary-spanning agency with a stronger coordinating mechanism, stronger or much more forceful because it has been negotiated into being by a group of experts or professionals representing the full field (cf. Berg et al., 2000). Thus, the lack of such protocol for the Finnish supervising veterinarians means that their autonomy to determine 'animal welfare' and 'unnecessary suffering' is quite expansive, but these interpretations are also highly contestable with, for example, counter expertise.

Conclusions

Animal welfare and its supervision has been topical in Finland at the time of writing due to the recent legal reform process and associated media attention. As our discussion of the cultural landscape and earlier literature on veterinary expertise shows, human–animal relations are a means to have a conversation about and also reflect upon core values that involve not only our moral stance towards non-human life but also the extent and limits of our entitlement with regard to medicine, economic activity and property rights in general (Hobson-West and Jutel, 2020; Law, 2010; Sanders, 1995).

In discussing complaint cases against supervising veterinarians' decisions in the Finnish supreme administrative court, we have sought to examine the making of legally mandated veterinary practice as boundary-spanning agency. As a theoretical construct, boundary-spanning agency provides a perspective on the general question of how transfer of knowledge (facts, legal principles) from one domain to another across their mutual boundaries is coordinated without loss of authority, and how the related tensions between different ways of knowing and doing are managed.

The analysis explored how different forms of knowledge were used by supervising veterinarians and animal owners to enact animals and their welfare (Law, 2010; Law and Miele, 2011; Singleton, 2012). Establishing such accounts is crucial to the successful performance of veterinary expertise, while animal owners, for their part, aimed to undermine this by bringing in elements

that do not go together with the official position of the veterinarians. One element of these cases is then the dynamics between different forms of knowledge related to human–animal relations, and the tension between abstracted expertise and the situational messiness of the inspection arrangements (cf. Singleton, 2012). However, this situational messiness is not just an empirical observation, but a strategy used by complainants to undermine the status of veterinarians as experts. Our analysis further shows how this veterinarian knowledge is accredited or challenged during the process of its transferral, and how the multiple boundaries that are spanned are themselves generated during the very process.

We contend that the figure of a boundary-spanning agent is a useful conceptual device to explore and compare arrangements of transfer and transformation of knowledge, while the actual way this transfer occurs is case-specific and subject to empirical examination. In our case study of examining a process involving law, supervising veterinary expertise, and local and experience-based knowledge of animal husbandry, our study focuses on the contestation and affirmation of the verity or quality of the veterinarians' observations concerning the inspected animals and the premises they were kept in as well as about procedural propriety of the inspections.

The practice of carrying out inspections generates tensions between veterinarians and animal owners. There have been calls to incorporate law enforcement officials in inspection procedures as a rule (Valtonen et al., 2021). However, as the analysed case about wolfdogs highlighted, this might lead to contestations over the neutrality of inspections, given that the police presence likely influences the inspections and alters the balance of power, at least by the presence of police possibly raising associations with criminal investigations. If inspections are conceived as negotiations between the veterinarian and the animal owner and geared towards improving animal welfare instead of looking for punishable negligence, it is not self-evidently desirable to involve law enforcement officials. However, critical opinions about supervising veterinarians' inspections being too lenient might also warrant stricter action (Valtonen et al., 2021). Rather than law enforcement presence, this might also be achieved through establishing inspection guidelines for supervising veterinarians.

What is noteworthy is the extensive interpretative space that supervising veterinarians have at their disposal. There are no soft-law instruments such as robust inspection guidelines that would mediate between the animal protection law and the discretion of the veterinarian, or the veterinarian's trained judgment. On the one hand, the lack of guidelines might present problems, because the lack of authoritative inspection guidelines renders the veterinarian's decision more susceptible to contestation, possibly prolonging official actions in such cases (cf. Väärikkälä et al., 2020). On the other hand, the animal protection law's definition of unnecessary suffering or adequate level of well-being for animals is open to interpretation and is seen to set the minimum level of compliance. The minimum level, as we discussed, does not often correspond with adequate practice in what the veterinarians see on the ground while carrying out inspections. Here the flexibility of the law and the wide mandate of veterinary discretion enable the veterinarian to adjust the relation between the law and the actuality represented by their inspection statements and (possible) auxiliary statements given to the legal court.

The argumentative strategy that we discerned in the judgments was based on bringing up the inspection history of the given complainant, which seemed to function as a kind of 'epistemic device' for determining the threshold for improper and punishable practice of animal husbandry. Attaining such a threshold also justifies the supervising veterinarians' decisions to act immediately – the main point of contention in the case judgments we analyse – as defined in Article 44 of the animal protection law. Earlier studies on veterinary expertise have tended to highlight the relatively weak authority of veterinarians. However, when the extent of supervising veterinarians' discretionary power is tested in the legal domain, our results show that supervising veterinarians occupy a strong position of authority vis-a-vis animal owners. Our results thus complement earlier studies on veterinary expertise (e.g., Hobson-West and Jutel, 2020; Sanders, 1995).

Thus, supervising veterinarians can be interpreted to engage in epistemic work to attain what they perceive as the greater good of animal welfare that is left unserved by the low minimum level of animal welfare determined in the animal protection law. By doing this work, supervising veterinarians also span the boundaries between law and the actuality represented by their inspection account, enabling the transposition of factual and local observations into the normative and general fabric of law. Examined in the context of legal court contestation of veterinary practice, this is the core idea of what we have termed boundary-spanning agency.

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Notes

1 The debate about the term 'unnecessary' in this context was debated during the making of the Finnish Animal Protection Act in the early 1990s, as already then animal rights advocates demanded that it should be left out (Committee Report, 1993). The term was also debated during the law reform during the 2010s and 2020s. It is therefore a central point of contestation, both in the Finnish context and elsewhere, as it provides an opening for a justified infliction of pain (see Lundmark et al. 2013; Valtonen et al. 2021).

2 The contributions highlight boundary spanners in their varying roles and their impact in facilitating innovation in cross-sector partnerships (Ryan and O'Malley, 2016), and as a promoted quasi-professional actor category in the science–policy interface with specific skill sets (Goodrich et al., 2020), and as a necessity in network governance (Williams, 2012). Boundary spanning has also been described as a skill in managing organisation's systems to exert an influence over it (Beechler et al., 2017) or as a communicative solution or model for complex and highly divided organisations (Schotter et al., 2017), and it is also central to organisational learning (Hazy and Tivnan, 2003). Isabel Collien (2021) in her review compares discursive, structural and agential perspectives on boundary spanning by discussing the different conceptions of power related to these perspectives.

3 All case excerpts translated from Finnish by the authors.

Socio-Digital Co-Design Practices: A Case Study on Human-Computer Entanglements in Architecture

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Abstract

Studies of architectural design practices have shown that building projects take shape through the intricate interactions between human designers and various technological tools. In present-day's architectural practice, these interactions are increasingly being reconfigured by two major trends that are affecting the future of construction: digitalisation and the imperative to make building processes and the built environment sustainable. Against this backdrop, the paper presents insights from an ethnographic case study on socio-digital co-design practices in the planning and preconstruction phase of an ambitious building project. This research explores how digital tools reconfigure design practices and highlights the 'reverse salient' that has limited the realisation of the integrative potential of socio-digital design processes. Using a practice theory approach centred on 'socio-digital co-design', the study shows that digital tools reorganise, but do not take over, the coordination practices in early design necessary to achieve coherent results and sustainability outcomes.

Keywords: Design practices, Digitalisation, Co-design, Sustainability, Reverse salient, Practice theory

Introduction

New buildings are not created in a void, but require a multitude of co-design processes shaped by the interaction of humans, technologies, standards and models. Today, digital tools for calculation, simulation and visualisation are playing an increasingly important role in these co-design processes. They allow actors to synthetise different options, calculate new ones, flag out and address coordination issues and more. Alongside digital potentials and logics, however, social perspectives continue to inform socio-digital co-design practices in architecture and thus get embedded in them. We understand socio-digital co-design practices as the realisation of human-technology entanglements and distributed agency that involve embodied enactments

of skills, routines and aesthetic judgment in professional settings.

Planning a building typically involves complex networks of actors. Architectural firms collaborate with numerous companies in which professional teams of engineers, specialists and project managers plan, sketch, visualise, and calculate using their respective technical tools, sometimes separately, sometimes together. In addition, they are in regular contact with clients, project developers, investors, authorities and sometimes also a broader public, and they may even establish planning companies for larger projects. Later, additional construction, assembly and installation companies join in. Human participants in these interactions routinely draw on visual representations, two-dimensional plans and data, (three-dimensional) models and renderings of previous projects, and incorporate calculation software and models that represent their interactions and lend them coherence (Henderson, 1991; Houdart, 2008; Yaneva, 2009a; Yarrow, 2019). In the course of design, planning and construction processes which often take several years, not only participants and their relationships change, but also objectives, models and visualisations, construction materials, technologies and costs. The early design phase of building, therefore, can be described as a multi-layered and multi-staged sociotechnical system in which social and technical components dynamically interact and need to be related to each other.

The difficulties of coordinating these complex interactions are generally considered the main cause of time and cost overruns, efficiency problems, construction defects and sustainability deficiencies. Against this backdrop, there is a widespread view that data-based approaches and digital tools are key to improving coordination and integration (Miettinen and Paavola, 2014; Paavola and Miettinen, 2019). Governments, software companies and consultancies are promising that digitalisation will also contribute to solving the enormous sustainability problems in the construction sector by improving efficiency of material consumption, integrating information about CO_2-emissions and energy demand, providing more accurate, data-based estimates of object-specific requirements, interdependencies and opportunities and by improving data-based documentation for maintenance and reuse purposes (Braun and Kropp, 2023).

For digital design and construction to become a successfully stabilised system, all technical and social components would have to be mutually adjusted and, metaphorically speaking, aligned in the same direction towards a common goal. Research in science and technology studies (STS), however, has shown that the evolution of sociotechnical systems, particularly large, open, and fragmented systems, is vulnerable to centrifugal forces driven by the divergent interests and agendas of those involved in their development (Callon, 1986; Hughes, 1983). These forces can only partially be controlled by closing interpretative flexibility and partially lead to context-specific unequal or even dissident advancements. As a result, the system's growth is uneven and incoherent, it remains instable and unable to realise its full innovative potential. Thomas Hughes (1983: 79-80) coined the concept of 'reverse salient' to describe the dynamics of uneven growth in complex sociotechnical systems where social, material, technical, historical and other components and subsystems interact with each other. It denotes components whose evolution is falling behind in relation to others, similar to a fallen back section of an advancing battle line or military front, thereby impeding joint advancement of the system. Once these reverse salients are identified as 'critical problems', they become amenable to creative critical problem-solving activity bringing the system back in line with its innovation objectives.

Whether the use of digital technologies will generally lead to the promised efficiency gains and make economies more sustainable remains controversial (Santarius et al., 2020). STS-informed case studies on digital technologies' use in architecture and construction have shown that expecting improved coordination simply from applying digital models is unrealistic because it ignores the fact that these models act as 'intermediary' (Paavola and Miettinen, 2019) or 'partisan' (Whyte and Harty, 2012) objects that both require and cause changes in design collaboration. Research on technological change in design and architecture has demonstrated that

digital technologies have changed action repertoires, design intents, design options and distribution of agency in the design process over the past decades (Boeva and Kropp, 2024; Houdart, 2008; Paavola and Miettinen, 2019; Picon, 2010; Vertesi et al., 2019; Whyte and Harty, 2012; Yaneva and Guy, 2008). Therefore, we refer to design practices supported by digital tools as 'socio-digital co-design', meaning distributed interaction between designers, computational information, software and other digital tools. We use the term 'socio-digital' to describe a mode of socio-technical interaction where software and shared data link technical and social conditions and practices, resulting in socio-digital implications.

To assess digital and computational technologies' contribution to integrative sustainable design and construction, we argue, we need to better understand *how* they are used in architectural design practices. Therefore, we examine these practices through an ethnographic case study of the interplay between human actors and digital and computational tools and technologies in the planning of a future university building. For this research, we participated as silent observers in the regular meetings of a so-called planning group, consisting of architects, engineers, IT experts, and sometimes officials, industry partners and other professionals during the design and preconstruction phase of the building project. The building was devised as a showcase project to demonstrate the potential of *integrative* computational design and construction technologies to improve the sustainability and performance of architecture and construction.

Starting from a practice-theoretical understanding of socio-digitally enacted design practices informed by actor-network theory (ANT), we explored how digital tools, software and visualisations intervened in the design and planning of the building project. As digital tools are increasingly being integrated into planning practices and their arrangements, we were interested in the potential as well as the actual features of socio-digital co-design. In particular, our study aimed to examine *how* digital tools entangle the social and the digital in design projects, and how this impacts the sustainability imperative. While we have previously examined the techno-political implications of digital planning tools (Boeva et al., 2024; Braun et al., 2022), this ethnographic study focuses on their implications for design practices. The case study is organised in three vignettes to show how socio-digital co-design is enacted under specific regulatory, technological and economic conditions. The first vignette demonstrates how planning constraints, design intents and computational optimisation interact with and inform practices of socio-digital co-design in an iterative back and forth to create an initial viable building design. The second vignette highlights how the use of digital technologies enables and defines the integration of various social and technical actors of architectural design and their perspectives. The third vignette captures how the addition of another type of actor — the construction companies — substantiates the economic framing of socio-digital co-design.

In the next section, we first situate the study in relation to previous studies on digitally supported architectural design practices informed by practice-theoretical approaches and ANT. We then briefly introduce the challenges posed to design and construction by climate change and resource depletion and sketch out the introduction of digital technologies and their affordances into architecture as an envisioned solution to these challenges. In the fourth and fifth section, we explain our methodological framework followed by our three-part reconstruction of the uses of digital technologies in socio-digital design practices. On this basis, we then discuss how, in this case study, definitional authority translated into socio-digital co-design. In the final section, we draw a preliminary conclusion about increasingly digital design processes, describing the interweaving of social and technical perspectives and highlighting the role of unequal access to 3D models and computational explorations as a 'reverse salient' that causes critical problems for the definition of shared innovation objectives.

A practice-theoretical and ANT perspective on human-computer entanglements in architecture

Approaches from actor-network theory and practice theory have highlighted the part that

technologies, artefacts and materialities play in enacting sociotechnical arrangements without, however, treating technological tools and other artefacts as allegedly neutral, stable determining factors (Latour, 2005; Reckwitz, 2002; Schatzki, 2002). These works emphasise that, in these heterogeneous contexts, agency emerges from the fabric of *sociotechnical practices* interwoven in organisational principles (Kalthoff et al., 2016: 20) and that technologies and other objects intervene in these practises depending on the respective 'assemblages' (Latour, 2005). Accordingly, to understand the design practices of various actors as being embedded in material arrangements (Orlikowski, 2007; Schatzki, 2010), linked by a series of technological mediations (Latour and Yaneva, 2008), and determined by routinised performances (Reckwitz, 2002) is to see the different elements of these constellations as interrelated and the intentions and capacities for action as interdependently shifting. From this perspective, our investigation looks at the promises of digitally *supported* coordination of designs, design phases, tasks and interests. We ask, how computational technologies are *entwined* with design and planning activities, how they *afford* it and possibly *coordinate* or *steer* it towards a more robust integration of sustainability goals.

Previous studies have explored architectural practice from an ANT perspective to show the "different actor-networks that underpin buildings and the complex negotiations" (Yaneva and Guy, 2008: 1; also, Blok, 2013; Georg, 2015; Houdart, 2008; Picon, 2010; Yaneva 2008, 2009a). Latour and Yaneva have argued for investigating design and construction processes as "moving project[s]" in a "series of transformations" (Latour and Yaneva, 2008: 80) through which the social and the material are linked and modified step by step. In their view, doing ethnographic research along these lines is the only way to get at both the practices of co-production of spatial relations distributed among people and things and by which people, material and the built environment are set in relation to each other and the discarded spaces of possibility. In her ethnographic studies of an architectural firm and a building's renovation process, Yaneva (2008; 2009a) showed this co-evolutive sociotechnical back-and-forth between model and design, meetings and drawing techniques, archives, and various groups of people. In her case study on the architectural firm, only architects who had mastered various practices of perspectival, technical and digital drawing had agency. Yaneva (2009b) and Gieryn (2002) looked at the design and use of university buildings with a similar focus on sociotechnical networks and emphasised the limited connection between the design processes (*design in the making*) and the final building in use (*design made*). Houdart's (2008) ethnographic study of a Japanese architectural office highlighted that virtual perspective drawings and their production are an assemblage of digital practices ("copying", "cutting", "pasting images"), hand-drawn sketches, and architectural sensibilities, often only verbally articulated. In a historical perspective, Picon (2010) traced the role of digital design proposals and object libraries in determining the architectural construction of social reality in different technological periods. In a case study of sustainable urban development in Denmark, Georg (2015) employed the ANT-concept of 'translation' to investigate the significance of a digital tool for sustainability assessment as a mediator and translator in processes of urban development design. This study shows how the digital tool influenced and mediated the planning processes between the various planners. Above all, it shows that the overarching socio-economic constellations or 'assemblages' in which professionals in architectural competitions operate had a much greater impact on the outcome of the planning processes than the tools and technologies they were using (Georg, 2015: 339). Other sociological case studies (Whyte and Harty, 2012; Kropp and Boeva, 2021) have used the concept of 'translation' to work out how digital planning tools constitute and reconfigure definitional power in collaborative design processes. Each of these studies conceives of planning and the built environment not as expressions or results of architectural design ideas, urban planning constraints, political orientations or digital technologies, but as elements of a complex practice that is as much social as it is technical, and in which planners' agency depends on multiple translations needed to create a common ground for the contribution

of other professionals, technologies, materialities, and models.

Besides digital technologies, a significant role is played by professional, including administrative, know-how regarding procedures, norms, and technical possibilities. Theories of practice do not ignore intentions, but focus on how these are embedded in doings, entangled with the tools of knowledge production, and consider them as interconnected components in "routinized body/knowledge/things-patterns" (Reckwitz, 2002: 258). In practice, computers and software are not isolated instruments but always enmeshed in spatio-temporally specific socio-material arrangements that are ordered according to rules (Schatzki, 2002; Orlikowski, 2007). From these socio-material arrangements, a relational and situated socio-digital co-design agency emerges as a capacity to act, in which neither digital tools support humans, nor humans choose the most appropriate technology at will, but which depends on successful associations of all agents involved. Will this socio-digital co-design "question the previous interactions through which these processes of generating and materialising form and space have taken place since the Renaissance" (Knippers and Menges, 2021: 23) in favour of sustainability?

Sustainable development and digital transition as new challenges facing architectural practices

Across the world, architecture and construction are facing the challenge of becoming sustainable and resource efficient. In order for construction to still meet the 1.5-degree target, changes in energy and material consumption as well as legal and regulatory framework are required at national and international level. Additionally, the sector is confronted with an accumulation of crises, from a productivity crisis and a skills and material crisis to the overarching environmental and climate crisis. Whilst opinions differ about the extent, causes and effects of these crises, the general assumption is that the future of construction will and must be digital or else the sector will be unable to overcome these crises, particularly with regard to sustainability (Braun and Kropp, 2023). In fact, all major programmes for making construction more sustainable strongly rely on technical solutions, digital assessment tools and technological innovation. The European Commission (2022) has already proclaimed a "twin transition" that would link digital and sustainable transformation, with construction to act as a model sector for the New Green Deal.

In short, design and building practices emerge within social, cultural, technical and economic horizons in which architectural design intentions, building technologies, forms of housing, property relations and ways of knowing, ordering and living in the world mutually shape and co-produce each other. Against this backdrop, in design and construction as anywhere else, sustainability-oriented objectives must be 'translated' into concrete targets and strategies in order to become effective (Schroeder, 2018). Instruments used for this purpose influence building knowledge and practice, which, however, often goes unnoticed, as do the sociotechnical assemblages in which decisions are made. Yet, it is precisely these sociotechnical assemblages in and through which planning and building practices take place and sustainability is "thought" that determine outcomes (Georg, 2015; Blok, 2013).

The digital transition with its attendant promise to disruptively enhance the built environment by means of integrative planning tools, is often mistaken for a linear and uniform process. However, this discourse conceals very different paths, visions and assemblages which will result in correspondingly different outcomes (Braun and Kropp, 2023). Moreover, the use of software for design and planning is not entirely new but has been only very slowly changing architectural practice over several decades. It is, therefore, fair to ask why digital tools have not significantly improved the coordination and sustainability of construction projects yet.

However, most architectural firms managed without design software until into the 1990s and, if they used computers at all, did so mainly for invoicing and word processing while only today, computers, scanners, printers and plotters count as standard equipment (Picon, 2010: 8). There was a long lead-up to the introduction of digital planning tools in which the implemen-

tation of what were at first information-based and later data-based management strategies was linked to cybernetic concepts of control in the military sector and production processes in globally operating corporations (Picon, 2010; Cardoso Llach, 2015). First came applications for computer-aided design (CAD), then calculation software for computing material requirements and prices, and ICT-applications for coordination and communication, and finally algorithmic tools for parametric design (Cardoso Llach, 2015; Vrachliotis, 2012). Research in STS and architectural history has shown how design practices, organisational patterns and professional identities by and by started to change in response to these tools and arrangements. Initially, the most significant changes were in design, while fabrication and construction remained influenced by trade practices and craftsmanship. In the second phase, development was focused on digital 3D models, building information modelling (BIM), and sensor and robot technologies. Today, we are witnessing a 'second digital turn' in architectural design (Carpo, 2017), raising expectations of data-based linking of all elements and phases in the design, construction and maintenance of buildings. In addition, the 'second digital turn' opens up prospects of novel built worlds by means of increased computer performance, machine learning and construction robotics and inspires sociotechnical visions of better, digital built worlds (Braun and Kropp, 2023). Sometimes, the visions centre on the digital, data-based modelling, coordination and control of the construction value chain, sometimes on the automation of (pre-) construction processes analogous to automotive manufacturing; sometimes on constructing iconic buildings with parametric design technologies, and sometimes on 'greening' building systems by using more efficient procedures, new calculation techniques and digital material catalogues for recycling and reuse (Braun and Kropp, 2023).

But the different horizons of digitalisation are not just a backdrop to the prevailing relationships among actors in the building sector and the respective processes and goals. Rather, they change the latter and are themselves being changed in a reciprocal way. Uses of 3D digital building information models (short BIM), which are increasingly replacing paper blueprints and cardboard models, are shifting the ways how architecture and construction professionals cooperate by reconfiguring planning and coordination processes (Whyte and Harty, 2012; Paavola and Miettinen, 2019; Kropp and Boeva, 2021; Yarrow, 2019). And algorithms aiming to optimise the use of space or light and energy conditions have the potential to re-define, in the course of machine learning, agency and design contributions but also the built environment and options for action (Boeva et al., 2022; Kropp et al., 2022).

However, it is only by being used that any of these digital technologies acquire their significance, especially in routinised practices as part of infrastructures that are taken for granted (Boeva and Kropp, 2024). Their use must therefore be analysed in the context of distributed practices, in which actors take up standards, calculations and techniques of drawing and building and realise their designs with the help of countless instruments and models (Latour and Yaneva, 2008). At this confluence of factors, design practices depend on the skilful orchestration of possibilities and power relations that cannot be considered in isolation from materialities, economies and technologies, as the following case study shows.

Methods

All architectural planning, even that of conventional buildings, is the result of an interplay of many people, things and techniques. To better understand this interplay, we joined the ongoing planning process of a German building during the design and preconstruction stage. The project is a showcase project with the explicit objective of demonstrating how computational design and construction technologies can improve the sustainability performance of building. The study is based on observations logged during two stages: (1) the approximately bi-weekly meetings of the planning group that took place from August 2021 to July 2022 (*design stage*), augmented with qualitative interviews; and (2) the weekly meetings of the planning group with three different construction companies and, on occasions, the client that took place from November 2022 to February 2023 (*preconstruction planning stage*).

All authors took turns participating as observers in the meetings. Due to the Covid 19 pandemic, some meetings were held as virtual conferences while others took place in a hybrid format in the various offices of the participants. Typically, these meetings involved about ten physically present persons and a few digitally connected participants, the former sitting across from a large monitor that alternated between showing 2D-cross-sections, the current agenda, 3D-detail views, the virtually present members of the planning group, and calculations and simulations from at least six different software applications. Although meetings are often considered by professionals as uneventful, in reality, "they are central to the process by which designs acquire more details and greater focus, through a range of interlinked processes" (Yarrow, 2019: 176), as we illustrate in our case study.

This type of silent observation, where the social scientists are present in the meetings but do not actively engage in the ongoing discussion, draws on Goffman's approach to exploring the organising principles of social practices in an open-ended way, asking "What is it that's going on here?" (Goffman, 1974: 25), a method that is also used in design ethnography. It integrates various data collection techniques in which notes on researchers' sensory perceptions in unfamiliar realities play just as significant a role as the evaluation of meeting minutes, in-depth interviews, supplementary documents, situational arrangements and photos. Once the design and preconstruction planning phases were completed, we had at our disposal forty-six protocols of meetings, four in-depth interviews of approximately one hour each with active planners, ten documents from all project stages and numerous photos of intermediate planning stages.

Socio-digital co-designing in action – a case study

Our ethnographic investigation of the complex planning process is at once focused and data-intensive demanding that data be exploratorily objectified in a (re)constructed second-order account (Müller, 2021: 88) – which is what we did through the three vignettes below. In the first vignette, we introduce key moments in building design with a focus on the tension between planning constraints and design freedom. In the second, we take a closer look at the use of digital planning tools, and in third, we trace the relevance of needs and constraints that construction companies bring into socio-digital co-design in the preconstruction stage.

Co-design between design intentions, planning constraints, and digital integration

A building project rarely starts with an idea that is then converted into ground plans, building forms, material selections and structural calculations. In general, before the actual design planning begins, a set procedure of basic evaluation and preliminary planning identifies where the building can be located. Like any new building, our project had to be situated in an already built environment, which is ordered according to a land use plan at the municipal level and "precisely by parcel" (architect) at the level of individual plots in the development plan. Furthermore, there was a masterplan for the densification of the entire area, in which the location of new buildings, the provision of parking spaces and the handling of existing trees were already roughly defined. These specifications entailed numerous planning stipulations bearing on building height and use, clearances, open spaces and traffic areas, specifications regarding façade design, and the development policies of urban planners. In addition, a "users requirement definition" prescribed by the state building law was "duly" drawn up by a subcontractor; it specified the structural-organisational input variables and the functional programme of the building as a basis for determining a suitable site and eligible space allocation plan "accurate down to the number of wall sockets", as one of the architects lamented. Feasibility studies were conducted examining the intended site, the potential means of realising the building and the economic parameters in various scenarios, already using Excel spreadsheets that converted user needs into numbers and digital design software converting future options into design horizons; these were backed up with cost–performance analyses and recommendations. Based on these results, only

two building sites with their respective potentials to meet the demands of the functional space allocation plan, that is, the arrangement of the various office, laboratory, recreational, operational and circulation areas were still up for discussion, and they both specified either a more or less rectangular or a more or less square building outline. Moreover, the planned timber structure could only comply with fire regulations if the number of storeys was restricted to a specific building class: "And just like that you fall back to the (pause) long, rectangular block of a building", as another interviewed architect summarised the rather disillusioning preliminary design results.

Up to this moment one and a half years in ground plans had repeatedly been plotted to precise scale and presented. Whether they were presented digitally or printed out, since these plans lacked a discernible building shape, they did not have much to say to the future users to whom they were presented, even as the architects were already drawing inferences about the "building cubature", a loose reference to the building's geometry. In the subsequent twelve months of design planning, we were often unable to discern from the visual models and cross-sections the merits or problems of the individual design stages, which, however, sometimes galvanised our planning colleagues, who dealt with them successively in a series of micro-decisions.

Thus, the "building block", its site, height, orientation, and space allocation plan were already in place when design planning commenced. That said, there were still many decisions to make. While the views on the screens gained in detail and presentations divided the building into functions and areas, there was talk of development objectives and intentions, needs for meeting individual area requirements were solicited, staircases were discussed with regard to various uses, trees and shrubs spring up alongside cross-sections, photos and plans of other buildings in other regions of the world illustrated what is possible or to be avoided, digitally visualised interior views suggested lightness and sunsets, Excel spreadsheets served as a reminder of the users requirement definition, and square metre specifications and models became a basis for discussing perspectives, options and implications. As the co-design practices continued, ever new visualisations of design options appeared in the form of partial digital models. Ideas and drafts were commented upon, digitally supplemented with freehand drawings, altered, discarded, or later improved. While some significant decisions crystallised early on in this iterative process, others long remained open questions.

An illustration of how conflicts were negotiated between demands for sustainability, climate adaptation, user comfort, architectural ambition, and administrative regulations is provided by the problem of room temperature. The regulations stipulate a maximum room temperature of 25.5 to 28 degrees [Celsius], which may exceptionally be exceeded up to 30 degrees for 50 hours per year. But the planners were more ambitious:

> Architect A: We don't just want to comply with the standard, we want comfort. The user workshop concluded that 'room comfort' is a top priority.
>
> Architect B: We have to take into account that it will become even warmer and more humid in the next decades.

For the sake of environmental sustainability, the building had been planned as a lightweight construction in order to reduce the consumption of building materials. But lightweight construction has a temperature problem, as one of the building physicists involved pointed out: "There is always this problem when we build without thermal mass. The solutions for lightweight construction are often very specific". A wide array of such specific possible solutions was then discussed, including central ceiling fans. But these were rejected; they were felt to be too contrary the design intent, as architect A commented: "We don't want to hang a forest of fans over a large open area; it's contrary to the idea of this space." Fan-equipped drones were discussed as an alternative, along with different options for adding thermal mass to the building, for example, by means of loam in the ceiling, granite slabs, a loam parapet, or a concrete table. Finally, an agreement was reached to pursue various options, especially the use of loam.

Further additions, such as partitions, balustrades, façade posts and emergency staircases were debated as necessary responses to user

demands and building permit requirements. "Conflicts" like interfering tension bands and steel girders, which were often first discovered in the presentations and models, had to be resolved: "Have you checked what's there under the support head?" New assessments based on material requirements, calculations and problematic joints reacted to recalcitrant intermediate results that refused to comply with design intentions, echoing Schön's characterisation of design as a "conversation with the materials of a situation" (Schön, 1983: 78). Designers take a step in the design process that brings about changes, such that the situation "talks back" (Schön, 1983: 79), triggering a response, a "reflection-in-action", on the part of the designers.

Special attention is garnered by the roof, a free-floating "shell roof" with an enormous surface area formed "of seven double-curved partial shells that span the short distance" without obstructive interior supports. The structure can neither be named nor its merit grasped without recourse to technical terminology. The team supplemented this distinctive architectural feature with solar panels that cover the entire area to ensure that future energy demands are met with renewable energy, making the new building — among many other innovative solutions — into one more showpiece of the award-winning design team. The photorealistic renderings of the roof from within recall a tent ceiling grown from wooden tissue; those of the exterior resemble a giant armoured worm. The roof is the result neither of an individual act of imagination nor of a technical calculation. It came to be – with reference to an undulating, prestressed concrete shell roof that is listed and well-known in building design theory – from countless variations generated by parametric modelling. The latter permitted the designers to draw on their previous experience with free-span roofs and plan the building not directly according to its geometry but by controlling individual parameters in interrelationships. Right from the initial studies for the roof, feedback was obtained through structural simulations. These simulations allowed considerations of architectural aesthetics, structural performance and digital fabrication capabilities to be aligned in such a way that highly efficient structural forms could be achieved through intensive computational co-design, so that the material requirements for the roof — even if bio-based — could be reduced maximally and the material properties and their variability could be optimally utilised for the design. The computational approaches taken here reflect the research objectives of the design team and go far beyond design routines typically used today. Many months passed between the first, hand-drawn sketch (Fig. 1), which only roughly conveyed the design intention and the design

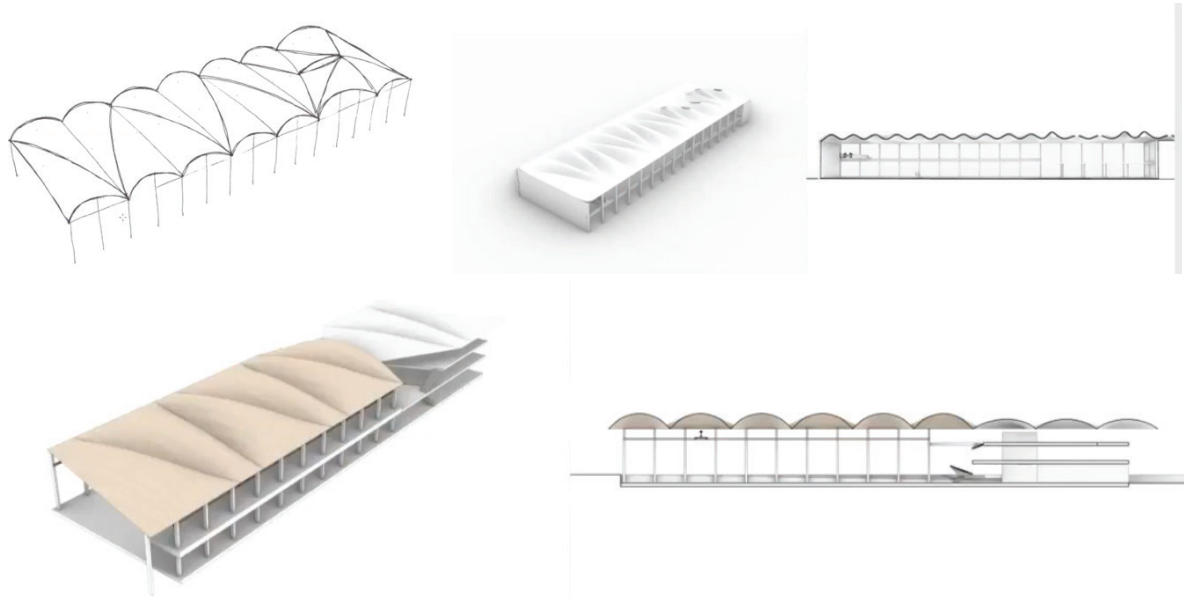

Figure 1. Hand sketch and parametric explorations for design planning. Permission to reproduce granted by: ICD/ITKE, University of Stuttgart.

that was submitted at the end of the design stage, during which the parametric model was configured and intermediate models were produced in hundreds of varying iterations.

The model was operated by a computational design expert who, while balancing the expectations of the lead architects with his own design intent, produced new versions and visualised them, compared them, brought them into discussion and edited them further. Another expert took up these results and computed, through many loops of agent-based modelling, the optimal segmentation of the roof shells "as seen from the perspective of the wooden coffers", he explains, "so they [i.e. the coffers] decide how they want to be arranged in the space: by size, for example, or to be as planar as possible." Without these computational methods, the expert said, it would be impossible to generate a form-fitting cover for a double-curved surface without gaps. Computational design tools, here, afford agency to the roof shells, inviting the shells to communicate their arrangement requirements to the planners and the planners to comply with them.

In our observations, the building project emerged from a complex, but consensual combination of mutually influential models, conceptual designs, ambitious designers, specifications, construction methods, material requirements, and external and internal desires — of users as well as of wooden coffers — all digitally represented in software, presentations, video conferences, documentation, data, and spreadsheets. The digital applications also provided information about material requirements and costs and allowed for comparisons with specifications and with internal and external objectives, such as those relating to building operations. These specifications did not include sustainability requirements. To the extent that these were taken into account at all, it was only on the deliberate initiative of the planners. The episodes discussed in this vignette make it clear that only socio-digital co-design practices in an iterative back and forth between building standards, professional expertise, data generation, computational optimisation and calculated evaluation could translate the tension between planning constraints and design freedom into an initial viable design. In retrospect, our analysis shows that, with the help of this internal socio-digital co-design, the planning group was largely successful in translating the externally defined regulations and economic conditions, set out in Excel spreadsheets, into a first consensual architectural design. Let us now take a closer look at this socio-digital integration and coordination.

Co-design between software and coordination

National and international governmental actors, policy-makers, professional associations and business consultancies are pushing the use of digital 3D models using building information modelling, in short, BIM (Braun et al., 2022; Leviäkangas et al., 2017). Countless documents and position papers by industry actors have promoted the use of BIM models, promising increases in speed, productivity, quality and, above all, coordination, and many governments have mandated the use of BIM for public building projects (Braun et al., 2022; Braun and Kropp, 2023). At the centre of BIM is an object-oriented 3D model linked to a database, which is supposed to make the planning and construction processes, along with all relevant information, accessible to those involved. Ideally, geometric, technical, material, economic, ecological and use-specific parameters are all included. One promise of BIM is to integrate all building component data into the 3D models in the form of shared specifications and material datasheets in order to better achieve sustainability goals by reducing design mismatches, material consumption and waste. Yet, precise details and their model representation require decisions early-on that can constrain the distributed socio-digital co-design, as we observed and show in this vignette. As we will explain, such a coordinating and all-encompassing 3D BIM model was not available in the design process under study here.

Although BIM models do require inputting all planning data, the more than twenty organisations involved in the design process in our case study made only unequal use of the model for the various – operational, scheduling and technical – purposes. An architectural firm operated the model and regularly extracted some views and information for external parties in the form of PDFs. This firm did not use Revit, the world's

most widely used BIM software, marketed by the US-based company Autodesk. Instead, the 3D models were created with the comparable product ArchiCAD, marketed by the German software company Nemetschek, a BIM pioneer.[1] The software choice followed from the architectural firm's tradition, which had been using BIM models for almost five years — "mostly for specific parts or phases" (architect), and not as a generalised intermediary object. "We use ArchiCAD because we work with Macs," one of them pointed out. This architect, in dialogue with a colleague from the planning group, added that everything is built up geometrically in ArchiCAD. In other words, everything is drawn "the way designers are used to". The Autodesk programmes, on the other hand, were originally a tool "for infrastructure planners who don't draw but insert objects, a motorway, for example. […] for us, it opens up a whole new way of working." The colleague went on: "Now it is no longer a matter of thinking, what do I want there, how should it be? But rather, is this what I want? […] and you always have to consider: Is that really the way I want it? Standards are permanently at issue. You have to consider what they mean, what else would be possible." This explanation by the architect demonstrates how digital driven and social, that is, professional logics merge into socio-digital co-design practices.

Both agreed that BIM software comes with a risk of standardisation due to stored object libraries. For a long time, for instance, the roof mentioned above could not be represented in the BIM model because there was no corresponding pre-defined element. "Now we've put something in there" (architects): The roof geometry was "loaded" via the interface of a freeform surface 3D modelling software (Rhino3D) "when we got it", ultimately as an IFC-file, a non-proprietary standard that facilitates data exchange in design and construction processes. This file format is also used to deliver the PDF files to contributing planners and building authorities, "who also need some way to access the information" — a quote that highlights how those without design software (access) are significantly cut off from the design process. As it grew, the BIM model thus gathered information 'under one roof' while imports and exports facilitated changes and review, but the integration was neither strictly cooperative nor dialogical. Yaneva (2009a) showed for analogous models a scaled knowledge production: Smaller models remained undefined in many respects, while large models had a greater impact on decision-making because they were "meticulous and enriched with more data and concrete details" (Yaneva, 2009a: 145) in order to attract more observers to the construction project and to augment it with more information. Today, this function is taken over by BIM models. BIM coordinators, a new professional profile, are to assume a decisive role in the management of building projects.

BIM models and the way they do integration thus involve exchange processes, uneven actor relationships, and introduce new hierarchies in design teams. The architects in our study viewed them with suspicion and did not use them as a standard intermediary model, but rather sought to "keep them at a distance", as they told us. The 3D building model was only fed data once a preliminary consensus was reached. Though it can display a planning history, it does so selectively – and thus reveals the "partisan nature" of models "bridging boundaries between some groups while creating and sustaining others" (Whyte and Harty, 2012: 201). In short, the 3D BIM model was not at the centre of the co-design process, let alone organising it.

Instead, in our case study, the group used additional software for coordination. Microsoft Teams provided for the involvement of physically absent team members for shifting quickly between views, planning stages, models and even the agenda of the respective meeting. In addition, plans were stored in a Miroboard so that those attending the meetings could quickly draw in their ideas for others to see and understand them. A dialogue from this design phase illustrates how this digitally mediated interaction worked:

> Planner A: "Come on, don't plan in elements. More like a ship: a full deck! We cut in there with scissors and push this down and then it's the stairs."
>
> Planner B: "I'll give it a try (draws around in the sketch). Make it parallel to the glass wall."

The presentation software PowerPoint was used to prepare the agenda and to display renderings

and models, some supplemented with explanations. These images took up a lot of meeting time because consensuses were recorded in them. The planners used Rhino Renderer, a visualisation tool that, with the help of numerous plug-ins, provides working views of interiors and exteriors, of sections and technical problem areas, and even views of the greenery outside the window, by day or night. It was likewise present at the meetings and received praise for its suggestive views, but could be operated by only one expert on the team. This expert prepared renderings — preferably always from the same angle, to enable comparisons with whatever elements were at issue — but this was not all. During meetings, he was constantly prompted to rotate the view, switch to street perspective or view the building from above, go up and down the stairs, zoom in, or display the former solution one more time. Rhino3D and Rhino Renderer are not architecture-specific software applications; they are also used in the development of other products, from ships to jewellery design. With their help, designs can be "cloned", views "pimped", partial plans "replaced". The question of the role played by their suggestive visualisations for the various participants in socio-digital co-design — gleaming staircases, shimmering roofs, lush green spaces in sunshine and at sunset — can only be answered by further research (cf. Christmann et al., 2020).

Moreover, additional specialised digital technologies were running in the background. SoFiSTic, for example, was involved in the structural design; Grasshopper, a visual programming language, allowed for the simplified coding of optimisations in Rhino3D. There were other programmable plug-ins for everything from ecological assessment to scripts that would empower the wooden coffers to make positioning decisions. These tools enhanced architects' means of exploration but also came with their own selectivities and requirements. Their preliminary results served in a visualised form as the basis for coordination among members of the planning group. Under the conditions of digital interconnectedness, the building project thus became a virtual product across various renderings. Cardboard and wooden models, more labour-intensive variants of materialisation, were being displaced due to the digital ease with which multiple design variations were generated. In socio-digital co-design, we were told, there is no such thing as a single design creator. In fact, the various software tools make it possible to integrate the various architectural and technical concerns and to coordinate joints and troubleshooting between the various professionals involved. However, the tools included some previous designs and excluded others, and they were not equally accessible to all parties. We now want to see how external, economic issues are added to the internal co-design.

Co-design between calculations, standards and materials

The complexity of building design and construction requires more than the coordination of human and non-human designers through digital models and software. One approach to organise this is preconstruction planning, which takes place before contractors' bidding and actual construction. Preconstruction planning combines costing and calculations, constructability reviews, risk assessments, regulatory compliance, and project planning and management, and is typically offered as a service by large general contractors and construction managers. Therefore, preconstruction planning not only advises building design regarding its technical and economic feasibility but also co-designs it between costs, standards and construction companies' interests and needs, as we will illustrate in this vignette.

As a showcase project for computational design and construction, our case study's building-in-the-making included a five-month-long phase of preconstruction planning. It involved multiple and occasionally intersecting stakeholders: three construction companies, each responsible for one of the building systems and sections, several computational design and construction experts, the planning group for overall project coordination, the lead architects, and the project's client. The additional preconstruction planning stage was also a response to the widespread reluctance to implement design and construction innovations in new buildings and to concerns about cost explosion. Therefore, the idea was that the construction companies would step in, provide an initial price range with an upper and lower price

limit and then use the preconstruction planning to optimise their calculation, ideally towards the lower one.

In order to give an initial offer, each company received a functional specification reference for their respective building system based on the "design freeze" of the previous design stage. While typically, a design freeze in product design, where the term originates, refers to an approved final design, its translation to architecture marks the end of a design planning stage. Hence, a design freeze in this case means further changes can be made to the design if needed or that changes are only made after specific decisions. The building's design was being revised, even if it was minor details, while the construction companies worked with an already outdated design. The functional specifications, however, were considered to be detailed and precise enough to draw out information for cost estimations as well as construction planning. Yet, it was precisely these potential uncertainties that influenced the calculation according to the construction companies' needs and interests.

For the first month, each company met with the respective computational design experts in a series of workshops to gain an understanding of the design and construction innovations developed with the computational approach. In reverse, computational designers gained insight into construction realities. The intensive workshops resulted in further optimised computational design and construction models to meet construction companies' experience, operations, materials, and standards. For instance, during one of the workshops for the timber roof, one computational design expert presented the segmentation of wooden coffers described in the first vignette. The construction company's task was to verify the roof segmentation's constructability by providing practical knowledge, fabrication details, and different quantities based on the available standard materials and their size specifications. Through the constructability check and material specifications, the overall material use should be diminished, and thus, the price estimate be closer to the lower threshold. However, as part of typical practices of valuation, the observed practices of "probing" the novel computational design processes included qualitative dimensions of "tasting" — in the sense of liking it — next to quantitative aspects of "testing" — in the sense of its feasibility (Hutter and Farías, 2017: 9f.). As any probing exposes novelties "to the judgment of acknowledged arbiters" and of "those who have gone through enough experience to make reliable comparison with earlier events" (Hutter and Farías, 2017: 9f.), it cannot be separated from either the physical perception of the design being tasted or the standards being tested. As Pinch (1993) observed, testing is about making connections between actual and imagined performance – and as Yaneva (2009a: 144) shows, this leads to judging the new against parameters that are already known. In the course of this process, some of the internally successful translations are abandoned in order to return to the established standards.

The preconstruction aimed to enable cooperation and knowledge exchange between the construction companies and computational design and construction researchers to co-produce construction specifications for bidding and fabrication and, ultimately deliver an updated cost estimation closer to the client's expectations. Yet, what seemed to be a collaborative and constructive exchange among professionals was, in the first place, a strategy for the client to save costs and for the construction companies to legitimise their expertise and established construction practices and standards. The computational optimisation of the roof's design reduced the amount of material needed by twenty percent. However, due to calculation constraints such as assembly and installation costs, this did not translate into a commensurate cost reduction and therefore fell short of the client's expectations. During a meeting, the disappointment about the lower-than-expected savings became apparent, when the seemingly exhausted and overworked planning coordinator voiced their regret that "200.000 saved Euros are not the goal we have set." The discrepancy in the interpretations of the preconstruction planning goal was partly due to the different sociotechnical approaches to calculating 'optimisation' and cost reduction. From a sustainability perspective, the material and thus environmental savings achieved through compu-

tational optimisation were first translated into an economic sustainability that then fell short of the prevailing construction market logic. In other words, the novel design and fabrication approach and its sustainability potential were forfeited by arguments about higher or uncertain labour and production facility costs on the side of the construction companies.

What we began to observe in the remainder of the preconstruction planning became a strategy of assembling and visualising elements. During and between the meetings, construction companies and designers exchanged, coordinated, and presented their results again in arrangements with multiple non-human digital actors such as Miroboards, PDFs of functional specifications, Excel spreadsheets with calculations, PowerPoint presentations, computational design, 3D modelling software, and occasionally forgotten to be updated servers and materials. Both sides strategically enrolled these technologies to provide as much argumentative ammunition as possible to make their case. For example, the font and size of a table in a presentation of optimisation results and costs were either scaled down to near illegibility or coloured in green to highlight an improvement.

The struggles resulted in delays in the updated calculation and addition of new aspects, such as budgetary and technical risks involved in integrating a robotic fabrication setup into the companies' existent facilities. Risk is a virulent concept within language and practices of contemporary building design and construction. Risks are invoked to legitimise costs by translating uncertainties and liability issues into calculation or to stay within the standards manufacturers and clients are familiar with. A considerable uncertainty, from the construction company's point of view, was the new glue for the coffers, which still needed to be certified and approved for the market. The absence of details about the glue's behaviour, which the designers had to provide, allowed the company to work with lump sums or cost estimates based on standard material they had experience with. The novelty of building materials and components compared to standard ones, as well as the lack of experience in utilising them, were considered as a cost factor. Towards the end of one meeting, the stakeholders joked wryly that they could as well replace all timber ceilings with conventional ones for the sake of saving money — which would of course have absurdised the whole point of the project. This little scene shows that the team was well aware that they were at risk to sacrifice sustainability for economic efficiency. Other construction companies also lacked experience with the innovations developed by the computational designers and incorporated them as imprecisely defined costs in their calculations, such as certification fees for robotic fabrication or lump sums for its setup.

In our case study, while computational and material optimisation was considered to have the potential for cost and resource optimisation, and thus contribute to the larger sustainability imperative of the project, interests, market standards, and conventions of practice — of construction companies and clients — co-designed the building mostly from an economic perspective, which is often absent in digital design models. The discrepancies between expectations, responsibilities and precise specifications were regularly used as a rationale to legitimise or challenge proposed costs. In his observations of designer and contractor interactions, Yarrow reconfirms that: "Where architects are concerned to highlight problems in the building, contractors are concerned to find shortcomings and inconsistencies in the plan. […] Money is made by exploiting the gap between what is specified and what will be needed" (Yarrow, 2019: 200). Indeed, one of the companies' managers commented that without precise specifications for one of the building walls, they had to calculate to the maximum in order to be on the safe side.

Discussion: The place of power in socio-digital co-design practices

At the early design stage, expertise, authorship, decision-making power and assertiveness are variably distributed among members of the planning group. During preconstruction planning, responsibilities are expanded to include the construction companies but also the client. Differences certainly reflect organisational structures

and individual responsibilities. We noticed that the decision-makers in all meetings primarily ask questions and make remarks on presented developments. Conversely, the experts provide details, variations, views, costs for individual elements, or search for solutions until the next meeting. They are constantly looking back and forth from their own laptops to the presentation monitor while participating in the discussion and recording last-minute adjustments and wishes, whereas the lead architects focus on the face-to-face planning interaction. At this point, they comment, explain, ask questions, or go up to the large monitor to point out conflicts or remaining open positions in the current planning. Yarrow's ethnographic study of an architectural office similarly reveals that lead architects "spend much of their time circulating among the others, [who are] perched on desks, gesturing at screens, or sketching over plans" (Yarrow, 2019: 28-29). Sometimes one of the lead architects in our study used his tablet to draw in alternatives in green colour, which then team members elaborate further. In response to the question of why the decision-makers do not bring any hardware, he answers: "Because we are concentrating on the matter at hand" — suggesting to us that at some points, the close socio-digital connection is consciously interrupted. Similarly, the construction companies in the preconstruction planning rarely used computers in the meetings. Still, they provided calculations and numbers in advance or verbally for the planning company to document. How are we to interpret this occasional return to analogous exchange without digital support? Although distributed sociotechnical co-design during the design set-up phase contributed to translating different actor expectations into a viable design, this way was abandoned at particular decisive external interfaces. We can identify a reverse salient in the sense of Hughes (1983: 79ff.) here insofar as digital design models were available, in principle, but they were not structured coherently nor could they be used for dialogue and co-design practices. Therefore, their unequal availability impeded the achievement of the shared objective.

The new building in our case study can only be planned within the iteration of socio-digital co-design practices. However, the capacity to act is distributed unevenly across the planning team: The generation of alternatives and their presentation as design options rested on the power and skills of individuals. All decisions in the design team were made by consensus. The gradual process of reaching consensus was driven by functional, architectural and administrative perspectives, which were mainly contributed verbally. Those persons who were responsible for the overall project success avoided the use of digital tools. They communicated their wishes in the form of hand drawings, partly in digital media, and making decisions in such a way as to consciously distance their creations from those provided by digital objects.

A powerful influence is also exerted by administrative and economic guidelines, which in this case mainly served to foster compliance with maximum square meters and costs, comparability with similar projects and safety specifications. Represented by authorised persons, these guidelines, which were quoted in every meeting, influenced calculations and visualisations. They played a major role in decision-making situations since the design team was always careful to comply with the guidelines so as not to jeopardise the project.

In our study, as in Georg's (2015) on the role of digital sustainability assessment tools in multi-actor urban design planning, sustainability requirements were not anchored in the overarching institutional arrangements, unlike clearances, maximum surface square meters, and investment amounts. This meant, that it did not constitute a planning requirement. Therefore, it had to be constantly defined and defended by the planners themselves. To be sure, the building project's countless design options were processed and reduced by standards, guidelines, technical and regulatory requirements as well as architectural routines and digital options. Yet while spatial and economic factors constantly appeared on the agenda in the course of the socio-digital practices, consideration of sustainability aspects such as resource and energy consumption depended entirely on the situational definition and ambitions of the designers or the client, and thus were much more dependent on social representation than on technical representation.

The detailed examination of the case study in three vignettes demonstrates that the socio-digital co-design practices in the preliminary design phase, with multiple socio-digital entanglements, significantly supported the necessary work of translation, which was required to create common ground by integrating the various issues and expectations into a viable design. However, this was not achieved simply by a digital tool such as the BIM model taking over the coordination, but by successfully linking several distinctive socio-digital practices. Sustainability was not a necessary objective, but an additional one and was seen more as a challenge, for example with regard to the thermal and structural restrictions imposed by the use of bio-based materials. At the early design phase, the efforts of integrative computational co-design for a sustainable building were intensified and the observation made it increasingly clear to us that the constant back and forth between individual planning tools, their results and their integration into one project (design) is extremely challenging. There is no digital planning centre, no 'neutral' intermediary boundary object, but decision-making authority is primarily established and defended verbally. Those digital objects which are promoted for better coordination, especially BIM, were enrolled by deliberation, as their implicit ordering authority over the design process was suspected of causing premature commitments and decisions. Different from large architectural firms with their established and settling BIM-based coordination models, however, many project structures like the one we observed include multiple and diverse actors, lack experience with such socio-digital approaches and the needed time to reorganize accordingly. At the prefabrication stage, the critical problems associated with the unequal distribution of distributed socio-digital co-design tools became abundantly obvious: The complex, painstakingly put-together design was now trialled and tested from perspectives that were previously insufficiently involved and had no souverain access to the co-design practices during the evaluation.

From the perspective of Callon's (1986) model of translation, the translations achieved through socio-digital co-design thus lacked shared moments of problematisation, interessement and enrolment in order to be successfully mobilised for the final building. The circularity made possible by socio-digital co-design, through which later building materials and construction details can already be taken into account in the design stage (Knippers et al., 2021), is not flanked by an institutionally secured participation of the relevant stakeholders. Instead, administrative processes define sequential participation, for which the necessary co-design tools are not equally available. Yet, that the critical problems can be identified doesn't mean they are easy to solve.

Conclusion

The interweaving of the social and the digital emerged clearly in this case study. We have shown that design intentions and their implementation only took shape through interaction with models, comments, calculations and visualisations. At the same time, we saw that the degrees to which socio-digital co-design agency penetrated the situated design interactions varied greatly. As a result, socio-digital co-design practices took place against a backdrop of uneven involvement of different actors; representatives of authorities and contractors could only react on the basis of viewer documents rather than proactively engage in co-design. Their internal socio-digital agency had not developed coherently enough to meaningfully contribute to defining shared objectives, and ultimately these actors slipped into the role of veto players. The uneven socio-digital development within the interdependent subsystems and, in particular, the restricted access for some stakeholders to actively contribute to socio-digital co-design practices, proved to be a reverse salient that limited the performance and output of the overarching system.

And yet, on a less observable level, the building project was co-determined by the planners' far-reaching claims and aspirations. These were partly specified in steering the course of socio-digital co-design through their selection of processes, and partly defended by verbal comments. Their aim was to make the building project a showcase for their research, demonstrating both potential and practicality of computational, integrative and sustainable building methods (Knippers et

al., 2021). Making architecture and construction sustainable through building differently is the whole point. This surplus of meaning, as the case study illustrated, was partly negotiated, changed and shaped through socio-digital co-design practices, eventually abandoned by some actors for different reasons. Design and decision, visualisation and calculation, material and culture – architectural practice emerges from co-design practices within which intentions and know-how, specifications and possibilities, materials and technologies coalesce object-specifically in virtual worlds. Yet, agency is not restricted to human actors, as the case of the roof shells has shown. It arises from the entanglement of digital and human design capacities and must be linked to organisational principles and to the collaborative project.

In this process, a future building as anticipated realisation of the design project comes into being and must later stand the test of realisation. Discussing ethnographic studies by Schön (1983) and Yaneva (2009a), Ammon (2017) has asked whether design practices can be understood as scientific experiments. With regard to practices that are explorative, but also co-productive of novelty, she answers in the negative, for several reasons. One of them is that experiments are tested in reality as their "counterpart" (Ammon, 2017: 511), whereas, in design processes, *possible* realities are projectively interrelated and coordinated but there are no (technical) means for evaluation by an external other. Put simply, design ontologically lacks the standard of an external truth: "truth does not help in the case of designing" (Ammon, 2017: 513). Digital data and 3D models do not change this, nor do conventional calculations and analogue models. The selection of specific design options from the spectrum of infinite possibilities is ultimately determined only by the mobilised requirements of the concrete situation; the result depends in principle on the planning group's "arbitrary" judgement in this situation (Ammon, 2017: 514). In our case study, the building project seems to be restricted to realise only those selected aspects, that can be judged against established parameters, while others are in danger of falling by the wayside. Sustainability, in the end, remains dependent on strong spokespersons, while economic goals are enforced with power, even retrospectively in planning.

We do not see our analysis as conclusive when it comes to discussing the potential of socio-digital co-design practices. Rather, it should be considered in the context of the case studies discussed above, which also found that the use of digital tools does not automatically lead to improved integration. Our in-depth research suggests that the reason for this finding lies in the uneven engagement of the relevant stakeholders in the socio-digital co-design practices due to uneven access to related digital technologies and skills from which socio-digital agency emerges. As previous studies on design and innovation but also prominent project examples demonstrate, which actor-constellations work well and how so, in relation to the digital tools, depend on projects' ambitions, social preferences and organisational structure. Any analysis would require looking closely and carefully at the context of distributed design practices and under consideration of materialities, economies, technologies, and the power relations behind them. Thus, a conclusive answer to the evolving digital and sustainable transformation of design and construction practice is far from reach.

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Notes

1 Initially developed by Hungarian company Graphisoft, ArchiCAD and the company were acquired by Nemetschek in 2006. Nemetschek markets different BIM software along their in-house developed product Allplan.

From STI Policy Objectives to Infrastructures: Understanding the Implementation of Directed Challenge-Driven Research Funding

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Abstract

Science, technology and innovation (STI) policy is shaped by the policy instruments used. However, we know relatively little about the work practices of policy actors implementing them. This article investigates how policy objectives are translated into governance by drawing on a case study of the implementation of a 'Strategic Research' funding instrument in Finland. The instrument is expected to fulfil a plurality of objectives, calling for solutions to various societal challenges through broad collaboration on research themes that require government approval. I examine the articulation work of the policy actors implementing the funding scheme and identify anticipatory tailoring and the repurposing of templates as central dimensions of this work. I show how the translation of policy objectives into a funding instrument expected to satisfy social worlds from politics to science is historically contingent and challenging. The article contributes with empirical detail into how policy actors managed multiple social worlds while implementing the research funding scheme, and the consequences and tensions that ensued.

Keywords: Science Policy, Implementation, Research Funding Instruments, Articulation Work, Strategic Research

Introduction

In 2013, the Finnish government decided to establish a Strategic Research funding instrument as part of the reform of state research institutes in Finland. Through the instrument, the proportion of peer-reviewed research funding increased, but the government also gained more tools to influence peer-reviewed funding, while the core funding of state research institutes, the Academy of Finland's[1] (AF) programme-based funding and the Finnish Funding Agency for Technology and Innovation 'Tekes'[2] funding decreased. The instrument calls for answers to societal challenges and emphasises societal relevance and collaboration across organisational and disciplinary divides throughout the research process. This kind of funding emphasis has become common in many countries. Its emergence is part of a wider quest for accountability of science that has been increasingly expressed in science policy during the last 30 years (see Jacob and Jabrane, 2018; Martin, 2011). Characteristic of the quest is the expansion of evaluation and management of research to measure the impacts of science (see Bornmann, 2013; Molas-Gallart, 2015; Martin, 2011; Miettinen

et al., 2015). What these measures have in common is the aim to guide, assess, and legitimise research processes, as well as the value created by public research funding. Although the accountability requirements of challenge-driven funding settings are heterogeneous (see e.g., Parker and Crona, 2012: 267; Wehrens et al., 2014: 9–10; Jalas et al., 2019), they resemble the ideas of new knowledge production models, such as 'Mode 2' (Gibbons et al., 1994) and 'Triple Helix' (Etzkowitz and Leydesdorff, 1998). In close resemblance to the ideology presented in the new knowledge production literature, directed challenge-driven funding instruments have implemented peer review beyond academia, relevance requirements in addition to scientific quality criteria, and transdisciplinarity as a guiding principle for research with extra-academic actors as partners in knowledge creation (Möllers, 2016; Wehrens et al., 2014; Felt et al., 2016; Parker and Crona, 2012). Despite the similarities between the policy emphases and the ideas in the literature (e.g. Gibbons et al., 1994), case studies have demonstrated that within research projects, changes in knowledge production have not been as straightforward as proposed by the knowledge production models (see e.g. Möllers, 2017). Although scientists have gained wider access to networks and data, along with the perspectives of collaborating stakeholders on their research (Felt et al., 2016; Jacob and Jabrane, 2018), they have increasingly had to cope with the diverging and often conflicting demands of their stakeholders, funders and the academic community (Möllers, 2017; 2016; Jacob and Jabrane, 2018; Wehrens et al., 2014).

While scholars have studied how research collaborations cope with the requirements of directed challenge-driven funding, the way in which funders manage the arrangements 'on the ground' has remained relatively unexplored (see also Shove, 2003; Wehrens et al., 2022). Wehrens and colleagues (2022) recently contributed to this research gap by examining the work of programme committees, showing how they also juggled with a plurality of stakeholder interests, which they managed through staging work. However, it remains unclear how the funding arrangements have initially been implemented. Understanding the construction of funding schemes is important since they shape research conditions not only in terms of funding allocation but increasingly by providing narratives and measures of what science and its interaction with society ought to be. As policy instruments, their role in structuring the research landscape has become ever more prevalent due to the decline in public research funding and increasing proportion of temporary research employment (Lave et al., 2010: 667), which has led scientists to devote substantial amounts of time and effort to preparing funding proposals (Gross and Bergstrom, 2019: 1). To address this research gap and to respond to the quest to examine the institutional context and work practices of policy actors (e.g. Henderson, 2019), I conducted a case study on the implementation of a Strategic Research instrument in Finland. Drawing on interviews and textual documents, I examined how the policy actors central to its construction managed the implementation of policy objectives to a funding scheme and the tensions and consequences that followed. To do this, I used the concept of articulation work (Fujimura, 1987; Strauss, 1985) and drew on related literature in organisational studies and political science to understand the characteristics of the invisible work and its relationship to institutional change.

The paper proceeds as follows. First, I present the existing literature on science policy development and introduce my research approach, followed by the context and objectives of the Strategic Research instrument. The paper continues with a presentation of the materials and methods. In the empirical sections, I examine the articulation work of the policy actors, particularly anticipatory tailoring and the repurposing of templates that were central dimensions of that work. The empirical sections analyse the preparation of the law, the formation of the Strategic Research Council (SRC), the creation of the research theme process, and the construction of the research assessment tools and representations. Throughout the sections, I demonstrate the contingent nature of implementation and the emerging tensions between different social worlds ranging from politics to science. The final section discusses my findings in connection with

previous case studies, as well as literature related to the invisible work of policy actors.

Theoretical discussions and conceptual framework

The emergence and development of science governance

Research investigating the emergence of science governance has provided insights into transnational and national debates and events (Nedeva, 2013), the strategies and positions of central Swedish policymakers (Persson, 2018), and the history (König, 2017) behind the establishment of the European Research Council (ERC). Authors have also examined the role of European Commission (EC) officials in the emergence of a security theme in the EU's Framework programme (Edler and James, 2015), and the development of a science diplomacy instrument (Epping, 2020). In the analysis of these empirical cases, the authors have employed conceptual frameworks from organisational studies, neo-institutional theory (Persson, 2018), political science (Edler and James, 2015), and policy instrumentation literature (Epping, 2020). Scholars have used the concepts of policy, normative and institutional entrepreneur to describe actors driving the science policy establishment processes. While the definitions of these concepts differ slightly, they commonly refer to actors with sufficient agency and interest to alter institutions and realise ideas that they value (e.g. Dimaggio, 1988; see Persson, 2018; Edler and James, 2015). The findings suggest that policy entrepreneurs can benefit from the ambiguity of policy framings (Edler and James, 2015; see also Mahoney and Thelen, 2010: 11) and actively build narratives around new institutions by mobilising resources and ideas (Persson, 2018; Edler and James, 2015). However, by assessing theories of policy entrepreneurship, authors have overall emphasised the need to pay more attention to the work practices of policy entrepreneurs, and the social contexts mediating their work (e.g. Henderson 2019; Bakir and Jarvis, 2017).

By using Finnish science policy as a case example, Lemola (2002) has suggested that international influences and organisations, such as the OECD have largely shaped national policies through 'convergence', namely the manner in which institutions become like one another (Dimaggio and Powell, 1983). Irwin and colleagues (2021) emphasise that while processes of 'convergence' or 'isomorphism' importantly characterise the cross-national recurrence of ideas and practices in science policy, the complexities and contradictions of science policymaking require as much attention to contextual influences and distinctiveness. Influenced by the organisational institutionalism literature (DiMaggio and Powell, 1983), they present regulatory standards, travelling concepts and ideas (see Flink and Kaldewey, 2018) such as 'National Innovation Systems' and 'Mode 2', and professionalisation through transnational networks and organisations such as the OECD (see also Lemola, 2002; 2003) as examples of 'isomorphic pressures'. Drawing on Science and Technology Studies (STS) approaches, the perspectives on difference that the authors discuss include the variety of actors, networks and the distinctiveness of policy cultures in different contexts. (Irwin et al. 2021:1-5.)

To contribute to the understanding of the standardising and contextualising forces shaping science policy, I employ the concept of 'articulation work' (Fujimura, 1987) to analyse the policy actors' work practices, and use research from organisation studies and political science to understand the characteristics of the work and its connection to institutional development and change. In the next section, I will further describe this approach.

Making science policy objectives 'doable'

As there is no predetermined way to actualise policy objectives, this study is interested in examining how the actors involved creatively combine the materials at hand to realise this goal. The concept of 'articulation work' originally introduced by Anselm Strauss (1985) and Joan Fujimura (1987) is particularly useful here, as it focuses on the coordination and integration of tasks not officially given in the job descriptions. The concept has been adapted to several contexts, but initially Fujimura developed the idea of this invisible work in relation to science, where it enabled the creation of 'doable' scientific problems (Fujimura, 1987). Moreover, scientists are continuously "plan-

ning, organising, monitoring, evaluating, adjusting, coordinating, and integrating activities" across social worlds to manage intellectual work, the site of production tasks (Fujimura, 1987: 258).

In the context of my study, the science policy actors practise articulation work to make the translation of science policy objectives into infrastructures 'doable'. Infrastructures, as a set of embedded rules, classifications, standards and technical systems (for a broader definition of infrastructure, see Star, 2010: 611–612), once constructed, often become invisible in the ways in which they govern practices (Bowker and Star, 1999). The implementation phase of science policy objectives therefore requires attention to the things that are intentionally or unintentionally excluded or included in the making of a governance instrument. The policy actors implementing the funding scheme work across several social worlds as they interact with political institutions, universities, state research institutes, and their work organisations, which can be expected to pose considerable demands for articulation. Attention to the social embeddedness brings the dependencies and conditions that shape policy actors' work to the forefront of the analysis.

I identified two forms of articulation work that were central to how the policy actors managed the different social worlds during the implementation of the instrument: *anticipatory tailoring* and the *repurposing of templates*. In the context of scientific work, Calvert (2006) has described tailoring as the ways in which scientists strategically adjust the appearance of their research to make it seem more applied to gain funding. Möllers (2017) extended Calvert's concept with forward and reverse tailoring, the latter of which captures the invisible work that scientists do to adjust problems that fit the needs of funders but fall short when it comes to fulfilling the interests of their scientific communities (see also Jalas et al., 2019). By investigating the development of weather forecasting models, Barley (2015) found that researchers practised 'anticipatory work' as they shaped their work practices in anticipation of their collaborators' representational needs. In this study, I will show how the policy actors tailored policy practices in anticipation of a range of communities' reactions, work requirements and legitimacy needs. The close proximity of politics was evident here, and in politics "actors must constantly adjust their behaviour in the light of how they expect others to act" (Pierson, 2000: 258). The productive nature of anticipation in policymaking has also been indicated by the 'law of anticipated reactions' (Friedrich, 1937), which describes how actors produce what they anticipate is the will and reactions of people with more power, even in the absence of explicit communication of the will of the powerful. The anticipatory acts by the science policy actors in my study sometimes required considerable prior knowledge of policy processes on their part, suggesting that they had skills that may be interpreted as those of policy entrepreneurs.

The invisible work of repurposing templates refers to the way in which science policy actors articulated alignment by using existing practices, conventions, and models as building blocks for the new practices. Research in political science and organisation studies has indicated that the resources, characteristics, and relationships of the founding stage of an institution often become imprinted on it (Stinchcombe, 1965) and reproduced (Aldrich and Ruef, 2006: 67). Moreover, it is common that "even where a policy initiative is new or novel, aspects of the rules of the game that surround it will be well established in layers of underlying values and understandings" (Dunlop, 2010: 349). In the case of the ERC, Persson (2018) showed that while the ideas that policymakers related to were ones generally known within transnational communities, their positions were anchored to national legacies and frameworks, which they transferred onto those of the organisation. Similarly, Epping (2020) found that national needs motivated the objectives of Science and Innovation Centres, and old practices were relabelled. Drawing on DiMaggio and Powell's mechanisms of isomorphism (1986), Beckert (2010: 155–159) has suggested that institutional entrepreneurs can use existing models as templates for designing institutions based on 'attraction', which is learned through socialisation and 'mimesis' in terms of imitation of solutions perceived as legitimate. In this study, I show how the science policy actors repurposed the existing models and practices as templates in developing the new

practices based on attraction, familiarity, understanding that their institutional backgrounds provided, and the legitimacy that the practices generated as existing solutions. This articulation work was also affected by external resource-related constraints and the institution in which the actors worked to build the new practices. The focus on the invisible work of policy actors increases understanding of the influences shaping STI policy (Irwin et al., 2021) by indicating how their work made the instrument converge with both national and global institutions and ideas, resulting in a hybrid of the familiar and the novel.

The Strategic Research funding scheme

Context of the reform

The decision to establish the Strategic Research funding scheme within the Academy of Finland (AF) was made as part of the wider reform of state research institutes in Finland by the Finnish government in 2013. As a reform, it affected the Finnish research environment widely. The organisations primarily targeted by the reform were state research institutes, universities, ministries, the government, and the main public research funding agencies in Finland, the AF, which funds peer-reviewed research, and Tekes[3], which funds innovation-oriented research and development projects. The AF has traditionally played the most prominent role in providing external research funding to universities, in addition to other funders such as Tekes, private foundations and the European Union (EU). Much of the external funding of state research institutes has been provided by ministries, the EU, Tekes and private companies. (Late and Puuska, 2014: 188.) Allocations in the state budget funding have provided a large share of the core funding of state research institutes, but it decreased by €66 million (25 per cent) from 2011 to 2021 due to the reform and additional funding cuts on institutes (Tulanet, 2023). The research priorities of the institutes are formulated in collaboration with a designated ministry, which also monitors their performance (Tula, 2023; Late and Puuska, 2014: 202). The institutes support different societal services and tasks, with one of their main missions being to support ministerial decision-making, but their research, performance management, publication and funding patterns vary considerably (VNK, 2012: 32, Late and Puuska, 2014: 188, 202).

Prior to the 2013 reform decision, for over 20 years several government-appointed groups had produced proposals on ways to reorganise Finland's national state research institutes to "enhance the efficacy of the sectoral-based state research system" and to increase coordination and collaboration between and within administrative levels (VNK/TIN, 2012: 36). Despite the continuous debate, no major changes were made before 2013. In 2011, the Research and Innovation Council[4] appointed a new group to prepare a proposal for a reform of the state research institute sector. The government asked Finnish STI organisations and networks to comment on the proposal and received 77 responses that presented support for and criticism of the proposed changes (VNK, 2012). In the case of Strategic Research, the decision text was slightly modified in light of the responses. For example, the instrument's budget was reduced from the proposed €200 million to €70 million[5]. Overall, however, the decision document on the instrument largely aligned with the proposal (VNK, 2012; 2013). To the surprise of the group preparing the decision, just before the decision was presented, additional funding cuts were made to some state research institutes on behalf of ministries, reducing their funding even before the reform took place (see also Haila et al., 2018: 19–20). The funding of the Strategic Research instrument was drawn mainly from the core funding of state research institutes (€52.5 million), the AF's programme-based funding (€7.5 million), and Tekes research and innovation funding (€10 million) (OECD, 2017: 36; VNK, 2013: 9). This change increased the share of peer-reviewed research funding, but at the same time gave the government more options to steer public research and peer-reviewed funding (see also HE 25/2014 vp: 12).

In addition to the establishment of the Strategic Research funding instrument, the reform reorganised research funding with the establishment of the VN TEAS instrument (competitive short-term funding to support government decision-making) drawn from the core funding of state research

institutes, and the gathering of funding for ministries' own reporting and research activities (OECD, 2017: 36; VNK, 2013). The reform also modified organisational structures by fusing state research institutes, merging the Centre for Consumer Society Research and the Institute of Criminology and Legal Policy at the University of Helsinki, and establishing networks between higher education institutions and state research institutes.

The objectives of the instrument

As the ministerial group (VNK, 2013) consulted various STI organisations when preparing the decision, the objectives were partly shaped by organisational responses, including the AF where the instrument was to be established. The Prime Minister's Office (PMO) and the AF's overseeing ministry, the Ministry of Education and Culture (MEC), were designated as the governing ministries of the instrument. The decision objectives stipulated that "the Strategic Research funding instrument funds longitudinal problem-oriented research, the purpose of which is to find solutions to significant societal challenges and problems" (VNK, 2013: 9), enabling the renewal of economic life and competitiveness, the development of working life, and the orientation of research towards changing knowledge needs, and to areas where no prior state research institute has conducted research (VNK, 2013: 9–10). According to the decision, with "a significant increase in competitive funding that serves societal needs and services", Strategic Research will become the third competitive public funding pillar alongside the innovation (Tekes) and scientific research funding (AF) (VNK, 2013: 9).

According to the decision, the Strategic Research Council (SRC) would be established within the AF, and its composition would be decided by the government. The SRC, comprising a chair and eight members, "independently decides on the programme structure of research activities, the financing of programmes, the selection of research projects, and the establishment of the necessary decision-making and other support structures" (VNK, 2013: 9). The SRC is composed of recognised researchers and research experts, representing research users with extensive experience in administrative, trade and other occupational and research-related transitions (VNK, 2013: 9). Projects are selected through open competition with an emphasis on "societal relevance, effectiveness and research quality. Research projects are fully funded on a multi-year basis" (VNK, 2013: 9). The objectives entailed that the government would decide on the selection of research themes for the research calls based on the proposal by the SRC. The government's decision on research themes is conducted in collaboration with ministries and coordinated by the PMO, with research experts and the Research and Innovation Council also being consulted. The government or its ministries do not participate in the allocation of funding to individual research projects or programmes. According to the decision, changes related to the AF entailed that the organisation's administration and research funding procedures "will be reformed to meet the special needs of the Scientific Research Council and Strategic Research Council" (VNK, 2013: 9.)

Methods and materials

In examining how the policy actors translated decision objectives into a funding scheme, I analysed the preparation of the law, the formation of the SRC, the creation of the research theme process, and the research assessment tools and representations. A case study design was employed for this purpose as it enables the combination of multiple data, and attention to contingency and causal relations (Ylikoski and Zahle, 2019; George and Bennet, 2005). I conducted interviews (N=22) with science policy actors who had been involved in the construction of the instrument or discussions related to it and gathered official documents on the case. The empirical analysis is primarily based on interviews with officials and senior management from the MEC and the AF, the SRC members and officials primarily responsible for managing the scheme, and officials from the PMO. The informants were either key actors in the construction of the instrument or had subsequently played a key role in its development. The data also includes interviews with researchers and organisational representatives who were not involved during the implementation but were later closely associated with the instrument. Temporal dimensions of the phenomenon are considered, as the

analysis sheds light on several stages of the implementation, as well as the tensions and consequences that followed.

The interviews were collected in 2019-2020 and were a combination of thematised semi-structured and open interviews, which I recorded and transcribed. The informants signed an informed consent form and received a copy of it. To preserve their anonymity, specific background information of informants is not presented in detail. As the transcriptions were all in Finnish, I translated the extracts presented in this article into idiomatic English. The primary textual documents analysed are the government's decision on the reform (VNK, 2013) and the AF law amendment (HE 25/2014 vp). I also used the reform proposal (VNK, 2012) and its organisational responses (VNK, 2012) to understand the government's decision, based on which the implementation got underway. I analysed the data using techniques such as open coding and memo writing (Corbin and Strauss, 2008; Strauss, 1987) to determine how the policy actors formed and explained their choices and actions. I was interested in the work they did to manage their involvement in the implementation of the instrument, how the objectives of the decision were developed in the legislative text and further in the AF, and the outcomes of these choices. The recurring dimensions of the invisible work that emerged from the data were subjected to several coding rounds, during which I systematically re-evaluated the extracts.

Anticipatory tailoring

> Although political decisions are not always realised in accordance with how officials have prepared them, our professionalism lies in preparing decisions so well that there is little opposition from political parties… (MEC official)

The extract above from a ministry official sheds light on the invisible work that frequently appeared during the implementation: how the policy actors tailored practices in anticipation of the reactions, work requirements and legitimacy needs of others. The policy actors held discussions with several parties (e.g., the government's research coordination group 'TEA', ministries, and research organisations). Hence, the officials learned the professionalism indicated in the extract, namely, how to shape materials so that they would be accepted as decisions, through discussions with various actors, including those outside political parties. The tailoring involved anticipation of acceptance by heterogeneous audiences and theorising on issues, such as how to mediate the interface between politics and science. Policy actors shaped practices in anticipation of the likelihood of ideas being adopted, of their suitability for the conventions of target audiences, better communication, or smoother work processes. Below I provide examples of this work during the implementation and the consequences and tensions that followed.

Preparation of the law

Following the government's decision to establish the instrument, the law on the AF (HE 25/2014) was amended to accommodate the decision objectives at the AF. The law was a significant document for the further specification and legal verification of the decision objectives. For example, details such as the appointment of SRC members for a maximum term of three years with a maximum extension of three years, and the schemes' project duration of 3–6 years (HE 25/2014: 24) were specified in the legislative text, ensuring the relatively longitudinal nature of the projects. The law was prepared by MEC officials, who consulted several organisational representatives to contribute to an earlier draft of the law (HE 25/2014 vp: 13). Since the MEC is the governing ministry of the AF, the two organisations closely collaborated in discussions on the details of the instrument. In drafting the law, MEC officials tailored it to respond to what they anticipated would fulfil the government's wishes, while preserving what they thought could ensure the autonomy of the scientific community:

> […] We were terribly careful when wording the memorandum or background text to the law. For example, we explicitly stated that ministries or politicians do not participate in decision-making on projects and that the research should be relevant. We included many statements to this effect, even though the legislative text is relatively short […] We considered very carefully what should be documented so that it would align with the will

> of the government... it provided a lot of guidance at the outset, and still does of course. (MEC official)

As a result of the tailoring of the legislative text, it was made legally binding that the ministries and Members of Parliament (MPs) had no direct role in decision-making on Strategic Research projects. One of the organisational representatives, who later became an SRC member, participated in the consultation with organisations on the new law and was satisfied that they were able to include many of their ideas in the preparation. The representative explained that they had much experience in similar policy processes and knew how to write proposals that would be relatively easy to include, implying policy entrepreneur skills in terms of mobilizing their ideas in the policy process. Moreover, they described that many organisations had criticised the law proposal without including specific and feasible counter-proposals, and that they could anticipate that merely criticising the proposal would not play any role in the final version. During the early stages of the SRC's work at the AF, the potential political pressures that MEC officials had anticipated when preparing the law became apparent. A politician was interested in influencing the choice of projects and the formation of programmes, and the SRC had to reject these suggestions. The details and arguments that the officials had incorporated in the law increased the doability of the SRC's work by clarifying the division of labour between the actors (Fujimura, 1987):

> The law is very good. It states very clearly that the government decides on research themes, but that it must not interfere in the selection of research projects or the formulation of programmes. When [a politician] showed an interest in acting against this idea, we made it very clear that it's not right according to the law. It was easier for everyone to understand it then. Legal argumentation is not only about what is said in the law but also about how it's argued. If the arguments are clear and precise enough on these issues, it's relatively easy to build one's own independent position, so to speak. (SRC member)

The carefully tailored law helped the SRC to manage emerging tensions between the social worlds of politics and science. It also made the selection process of projects in the Strategic Research funding scheme converge towards the way in which projects are selected in the programme-based funding at the AF. However, the SRC itself has a different kind of representation in comparison to the other funding schemes at the AF, the formation of which will be discussed in the following section.

Formation of the council

According to the government's decision, the SRC was to be established at the AF, and the government's decision on the SRC would be made in collaboration with ministries. The members should be recognized researchers and research experts, representing research users, with extensive experience in administrative, trade and other occupational and research-related transitions. (VNK, 2013: 10.) MEC officials specified in the law that the MEC would prepare a proposal to the government in consultation with various stakeholders on the composition of the SRC. They also added that the SRC is required to have a double majority, meaning that a majority of members must be recognised researchers, and the other majority must be research experts representing the users of the research (HE 25/2014 vp: 16). The double majority statement justified the inclusion of several recognized researchers who are involved in scientific work, but at the same time, it justified the representation of research users, which diversifies the SRC structure in comparison to scientific committees. According to MEC officials, the criteria for recruiting SRC members stipulated that they would be experts covering a range of issues and sectors, referring to them as holistic individuals with a broad understanding of a wide range of developments and systems. Impartiality was considered an important quality. Many officials deemed that representatives from ministries were not suitable due to their potential interest in selectively promoting the lines of work at state research institutes with which they were associated prior to the reform. The importance of the composition of the SRC with its anticipated credibility and impartiality became apparent when, in the first round of the selection of SRC members, an MP wanted to deviate from the ministry's proposal:

> In the first round, it became wildly politicised. In other words, I wonder how many times the proposal was taken back to the government because there was one minister who always brought it to the table. (MEC official)

The MP wished to include a person in the SRC who had not been proposed by the ministry. Consequently, the ministry had to rearrange the composition of the SRC according to the MP's proposal by excluding the initial candidate with a similar profile and choosing the member proposed by the politician. The event presumably further strengthened the ministry officials' belief in the need to anticipate the reactions of political representatives and other stakeholders and demonstrated the significance of the specifications laid down in the law. Overall, several informants described the selected SRC members as credible due to their wide recognition and achievements in various social sectors. The involvement of members with perceived credibility in social sectors across science and politics was seen by many as a crucial factor in how different audiences received the institutional change in the initial stages of the instrument's implementation:

> It's certainly very significant for an appreciation of the whole issue that the first Council had two academics, [names of the members], who sort of counterbalanced the discussion that was prevalent in the scientific community at the time, especially at the planning stage. Namely that we're going to compromise the quality of science, and that we're now conducting the kind of research that politicians demand. Well, if it's chosen by two people who have been regarded by the Finnish scientific community as the brightest stars in terms of the quality of science, it certainly gives it a different tone. (SRC official)

The articulation work of officials underscores the centrality of anticipation in terms of them making choices that are likely to generate wide acceptance – a common feature in policymaking (see Pierson, 2000: 258; Dunlop, 2010: 358). These choices in turn affected the influences towards which the instrument converged, as will be shown in the sections that follow. Next, I turn to the development of the research theme process.

Creation of research themes

The government's decision outlined that the SRC would prepare a proposal on key research themes and focus areas, which would be decided by the government in collaboration with ministries. This process would be coordinated by the PMO (VNK, 2013: 10). In the legislative text, MEC officials specified that prior to the SRC's proposal, various STI organisations and research experts would be consulted (HE 25/2014 vp: 8). They also specified that based on the theme decision, the SRC would further decide on the programmatic structure of the scheme's research work, and that the themes and emphases would be determined on an annual basis [6](HE 25/2014 vp: 16). The objective of making research more relevant by increasing the government's role presented a challenge for MEC and AF officials in terms of how to keep politics close enough, but not so close as to interfere with the setting of scientific priorities. As shown below, according to AF and MEC officials, the practice was intentionally tailored to enhance the autonomy of the SRC in preparing themes:

> We certainly discussed how independent it is. It became very independent to the extent that during the process, the SRC forms the themes itself. Then they're adopted by the government. Not rubber-stamped, but largely prepared – no changes were desired or expected. […] The government's decision-making works according to a presentation procedure, so it's quite formal. They make a large number of decisions at every meeting... well-prepared presentations are delivered. Some members of the government could take up issues for discussion if they wanted to, as they get the agenda, but they probably consider that the preparation has been good. On the other hand, there's a fear that the instrument will be politicised… (MEC official)

In addition to the role structure between the SRC and the government, the articulation work of the officials made the research theme process converge with the existing policymaking conventions in Finland, according to which policies are prepared well by officials before they are presented to decision-makers. In principle, changing the themes is possible, as in other cases such as the recruitment of members. However, several offi-

cials believed MPs would be unlikely to make any major changes because it would signal distrust towards the SRC members and the preparation process. Several policy actors highlighted how there had been very few changes between the SRC's theme proposal and the government's decision on research themes during the annual theme selection process. Changes had included the addition of cross-cutting themes (e.g., immigration) or some word modifications (e.g., democracy replaced by community, and basic services added as a feature to the theme of equality). After receiving the SRC's proposal, PMO officials prepare a separate decision document for the government based on the proposal. Due to PMO officials' invisible work during this phase, some differences occur between the two text documents even before the presentation to the government. As PMO officials have prepared the decision for the government based on the proposal, they have simultaneously adhered to government conventions by shortening, deleting or adding details to the decision text in anticipation of its better alignment with the government's information dissemination styles:

> So, a snippet of the text that stated... or a research method was proposed in the SRC's text that could be used to address these issues. In a way, I think it would be odd to already be talking about research methods in the government's decision. I think it's illogical. Perhaps I might question a little why there is guidance on a particular research method in the SRC's initiative... although it's an example, but still… In the government's decision in particular, it's not logical to point it out there. (PMO official)

To satisfy diverse legitimacy needs, PMO officials used more general language when preparing theme decisions for the government and other non-academic audiences, while SRC officials drafted more specific research programme texts for researchers. The officials highlighted that these differences were merely textual and did not alter the substance of the themes. One SRC member discussed noticing that some of their texts had been condensed or slightly modified, and described one situation during the government led by Juha Sipilä in 2015–2019:

> Sipilä's cabinet put a lot of emphasis on the bioeconomy, and we had one theme related to the circular economy. Then they erased all mention of the circular economy from the text and we were, like, can't we use that? And then they asked, why don't you talk about the bioeconomy? It may be that government officials think that it sounds better if we cut parts, but then they also make a decision that affects the substance, which can orient the framing of the research. (SRC member)

The invisible work of tailoring the theme process structure and text formats affected the construction of relevance in research themes. The theme process rendered the alteration of themes by politicians more challenging and less probable. Textual modification by PMO officials in terms of omitting indicative research methods, made the research theme descriptions slightly vaguer in the government's decision compared with the SRC's proposal. The theme areas depend on the process structure and the extent to which theme descriptions and research programme texts become tailored. Once the instrument was running, tensions arose because the organisation of the theme process did not satisfy all parties. A couple of PMO officials talked about how the low frequency of change, and the overall vagueness of research themes were problematic. They explained that they and certain political representatives had hoped for more tangible results on a specific theme, but since proposals are already well prepared by the time politicians receive them, it decreases the likelihood of themes being altered. In November 2023, the government led by Petteri Orpo with representation by the National Coalition Party, the Finns Party, the Christian Democrats and the Swedish People's Party announced that they would not accept a research theme on immigration and would postpone it (Junkkari, 2023). This was the first time that a government had declined and postponed a theme in the history of the instrument. The Finns Party, known for its anti-immigration views, perceived that the proposed theme "Interactions between immigration, work and wellbeing in future Finland" (Strategic Research, 2023) did not sufficiently consider the negative effects of immigration (Junkkari, 2023).

The repurposing of templates

At several stages of implementation, existing examples (e.g., convention, practice, model) influenced actors' thinking, resulting in alternatives being turned into good enough or best practice, while structurally shaping the new institution. Actors repurposed existing institutions as templates based on attraction, familiarity, resource-related constraints, and legitimacy that the existing practices offered as solutions. The choices were heavily influenced by the institutional roles and backgrounds of the policy actors. Below, I provide examples of this articulation work during the implementation and the consequences and tensions that ensued.

Construction of assessment tools

The decision to significantly increase the proportion of competitive funding for problem-oriented research created a demand to extend and reform the assessment of the funding (VNK, 2013: 9). Establishing the scheme as part of the AF was already perceived as sensible in the proposal (VNK/TIN, 2012), which the AF favoured in its response to the proposal (VNK, 2012). MEC officials specified in the legislative text that the SRC's management would seek to use the AF's practices to ensure cost efficiency (HE 25/2014 vp: 9). This suited the AF as they were motivated to increase the share of peer-reviewed funding (interviews with the AF) in the system. The AF's infrastructure therefore became a template for developing Strategic Research from objectives to practice. The SRC and its unit officials were tasked with developing assessment tools for monitoring and evaluating the impact of research projects during and after their implementation (HE 25/2014 vp: 9, 16). There was a high demand for articulation (Fujimura, 1987) at the AF because SRC officials had to work to an extremely hectic implementation timetable. As a solution, SRC officials repurposed the AF's organisational practices as the basis for new ones:

> But at the civil service level, our timetables were extremely tight at the beginning. Of course, we had to make the most of what had been done at the AF. We couldn't just come up with something completely new... we didn't have the time. Instead, we looked at how our application cycles work, and what our legal or other aspects allow. The challenge was that we were proceeding so fast in these matters that our lawyers and business units (among others) had to keep up. They asked, 'Oh is this the application process for next autumn?' and I said 'No, it's for this January', and in September or October, we started talking about how we need it now. It was a big challenge, but miraculously people... complied, [*sighs and laughs a little*] so we were able to get it done. (SRC official)

When constructing a new societal impact reporting practice for funded projects, SRC officials repurposed the AF's existing quantitative formats of scientific impact. They extended these formats with their ideas and by asking researchers what the measures could be when they implemented a series of indicators[7] to represent the social impact of science. The established range of measurable activities outside research can be understood as part of the artefactual (artefacts and services through which societal impact is realised), and institutional-interactional dimensions of societal impact (forms of collaboration and science-society interaction) (Miettinen et al., 2015: 272). For example, the epistemic dimension of societal impact, the understanding gained of phenomena (Miettinen et al., 2015), could not be directly represented with the indicators. Since several manifestations of societal impact could not be assimilated into quantitative indicators, officials established a societal impact narrative to capture them. To this end, they used the UK's Research Excellence Framework (REF) conventions as a template for the narrative, which resulted in the assessment practice partly converging with the UK's assessment models, implying the influence of global examples (Irwin et al., 2021: 2; Lemola, 2002).

The implementation of a societal impact dimension, distinct from scientific impact, was operationalised further when officials established a separate societal review panel, which may have important implications for the classification of reviewers' expertise and the composition of evaluation committees. As a consequence of actors repurposing the AF's existing solutions as starting points for new solutions, many of the assessment practices within Strategic Research nevertheless

converged with existing funding instruments at the AF. The SRC functions similarly to the AF's scientific committees, which select scientists from the field to recommend projects for funding. International and national reviewers are invited to work with the SRC on the review panels, and the AF's disqualification rules apply to the SRC members. The SRC decides on funded projects and evaluates their societal significance, impact and research quality (HE 25/2014 vp: 16). Tensions emerged due to the constraints imposed on the SRC's work by the AF's disqualification rules. The institutional rule, designed to promote impartiality and guard against favouritism in decision-making, helped create an arrangement whereby an SRC member with wide scientific networks in particular was more likely to assess proposals outside their field of expertise:

> Well, first of all, I'm not allowed to apply for funding through these instruments during that time, and after all, as a member of the SRC, you can't have an influence on anything much at all. On the positive side, it was a good group and I learned a lot there, but I was disqualified from the things I knew about. On the one hand, that's good, but on the other hand, it's a bad thing. As a result, I think we made several decisions where a potentially worse project received funding instead of the one that I considered should have been funded. […] Individuals within their field or a related field are either unable to judge because they don't know the subject matter, or then the evaluators wonder why the applicants have not collaborated with them and give them less credit, so it immediately becomes an inverse disqualification problem. Moreover, they are not officially disqualified, but might actually be, due to competition or something else. (SRC member)

The extent to which disqualification rules restricted the ability of SRC members to apply their expertise to the proposals depended on their scientific networks. The eligibility of SRC members to assess and comment on proposals further affects how relevance and scientific quality are understood in the allocation of funding.

Using existing institutions as building blocks for new ones may later again direct the construction of new institutions:

> […] … Again, we can see the power of peer review, as we also held a separate peer review panel. We had learned from the Strategic Research instrument how they should be organized in terms of societal impact. We certainly know how to evaluate science, but for the Flagships we constructed an impact panel in line with the SRC doctrines. (AF's management)

The newly established societal impact assessment of Strategic Research provided the actors with a usable template for building a societal impact assessment for the AF's new Flagship instrument. The officials and management were aware of potential challenges in the process of reviewing applications and measuring impact in project assessment. Despite the scepticism, especially when resources are tight, an established practice may acquire a standard-like stance that guides how a practice could be organised in other contexts. In this way, an alternative may become a guiding principle, generating changes through which an institution or its adaptable components eventually become more dominant or standardised in the environment. The gradual repurposing of practices can thus lead to a broader organisational change.

Construction of representations for research

The government's decision objectives emphasised the importance of finding solutions to major societal problems through longitudinal, problem-oriented research (VNK, 2013: 9), but the articulation of these dimensions into funding scheme criteria, guidelines and narratives was left to SRC members and officials at the AF. In many instances, the SRC members drew upon their experiences of practices and conventions to understand the meanings of research interaction and impact within the funding scheme. They articulated alignment by repurposing conventions or practices that were attractive or familiar to them as templates for the new ones. As a consequence, parts of the new interaction practices converged with models of national funding organisations that fund applied or innovation-oriented research:

> One of the things I've probably influenced the most is the central role of interaction in the instrument.

> And that… that derives from my past experience. Of course, from a researcher's point of view, it's very understandable that you receive money, then you conduct research, and in the end, you produce some results. And then you say you need more money to get the next... solution. That's just the way it goes, that's the logic of research. But I know from experience [in organisation x] that it works well when the research is followed by those who have an interest in the outcome, also at the stage when the work is progressing. (SRC member)

The meaning that the SRC member attributed to the interaction emphasis, namely that stakeholders closely follow research results, was influenced by their organisational role and conventions. The influence of the SRC members' and officials' work settings was observable in examples against which they articulated the conception of relevance inherent in the instrument, although they highlighted that relevance has multiple meanings. They were also influenced by phenomena, people, ideas, and problems that required solutions. Among these were the climate crisis, the proliferation of disinformation, the lack of legitimacy and the utilisation value of research, and poorly informed decision-making. They often saw interaction and relevance as manifesting in connection with policy processes, or as research partnerships with extra-academic actors or various sciences throughout the research process, highlighting the aim of developing solutions to societal problems or using research to implement developments in practice. Additionally, they discussed interaction and impact emphases as activities such as communication, consultancy practices, and policy work– a variety of activities that can be understood as part of artefactual and institutional-interactional dimensions of societal impact (Miettinen et al., 2015: 272).

These understandings were developed into formal criteria according to which consortia members must come from a minimum of two separate organisations, three or more research groups, and three disciplines. The views were also turned into programme guidelines and recommendations according to which researchers are encouraged to co-produce knowledge and interact with various disciplines and stakeholders throughout the project and provide tangible solutions to real-world problems with the help of interaction coordinators and programme directors. The meanings closely resembled the new knowledge production literature's ideas (e.g., Gibbons et al., 1994), suggesting that traditional academic research resides in an ivory tower. A couple of SRC members and officials referred to the framing of grand challenges and EU societal challenges as providing inspiration for the scheme, the impact of which was already apparent in the proposal for the government's decision, implying a convergence with global ideas and frameworks (Irwin et al., 202: 2; Lemola, 2002). One member specifically referred to the innovation helix as the mode of interaction that the programme was aiming for. Otherwise, there was no mention of policy literature concepts, such as 'Mode 2' (Gibbons et al., 1994) or 'Responsible Research and Innovation' (RRI) (Owen et al., 2012) by the implementation group. However, as the scheme was implemented, programme leaders, coordinators and researchers funded by the scheme began to use concepts such as 'wicked problems' (Rittel and Weber, 1973) and 'RRI' (Owen et al., 2012) in the scheme's events, documents, and public descriptions of research, due to their familiarity and the resemblance between the discourses and the emphases of the scheme:

> The concepts may have come into use due to us. I hadn't seen discussions on transdisciplinarity anywhere in the AF's material before. In a way, transdisciplinarity is not a good term because there's no direct translation into Finnish. I just started using it… and 'wicked problems' is such a central concept in my [field of science], it's such a natural […], unifying thing for me that everyone is studying these wicked problems. (A researcher with different roles in the funding scheme)

In this way, at the initial stages of science policy implementation, policy actors may not necessarily adopt all policy discourses directly from global examples to national practice through isomorphism (Lemola, 2002). Once established, a funding instrument may provide a platform for other actors to start using older science policy discourses, or to strengthen the use of more recent discourses as tools for 'identity work' (Flink and Kaldewey, 2018: 20), among other purposes.

The implementation group's relations, roles, and composition also influenced how research practices and processes became represented. A couple of SRC members and officials stood out as being highly dedicated to the implementation. Members often highlighted their mutual sense of togetherness and mentioned that most of them knew each other and implicitly understood the instrument's core meanings similarly. Some of these understandings were challenged by a social scientist who was not involved in the implementation. Tensions arose as the representations of knowledge production that had become central to the instrument did not represent the diversity of disciplinary interaction patterns:

> Strategic Research puts an awful lot of emphasis on that stakeholder thing, which begs the question of why and whoever came up with such an idea [*slight laugh*]. Because first of all, in our field, we've always worked with other people. Social sciences are certainly not born in any kind of ivory tower, but in basic places, where basic humans exist… […] Co-research is such a challenging term, and in SRC programmes there's a lot of talk about co-creation, or about doing things together, but certainly, as researchers we don't actually give the decision-making power in most studies, at least in social science decisions, to the group we're researching. It's not equal, no matter how much we try to say it is. (A researcher with different roles in the funding scheme)

This researcher's approach and background, like others, provided a template for understanding the interaction and impact of research. However, according to the researcher, interacting with society is inherent in their research process, although a distance remains between the researcher and their informants, for example in the collection and analysis of data. The kind of distance in interaction, a specific interaction pattern, may be understood as part of their process of gaining an understanding of a research phenomenon, the epistemological dimension of societal impact (Miettinen et al., 2015: 272). In their SRC project, they examine why a phenomenon is commonly perceived the way it is. One of their patterns of interaction with the phenomenon appears to be 'disrupting' the mainstream assumptions related to the ontology of the societal problem and subsequent solutions developed. However, the researcher's views aligned with others on the favourability of interdisciplinary collaboration in research.

The section illustrates how the composition of the implementation group, attuned to the plurality of the funding instrument's objectives and subsequent legitimacy requirements across social worlds, led to ambiguous but selective representations of research interaction. These representations were later co-produced by others who employed discourses aligning with the initial representations but were unable to reflect the diversity of understandings regarding science-society interaction.

Discussion and conclusions

By drawing on a case study of the implementation of the Strategic Research funding instrument in Finland, the article provides an understanding of the translation of STI policy objectives into governance. How policy actors anticipated the reactions and legitimacy needs of heterogeneous audiences, and repurposed existing practices as templates, were central dimensions of the articulation work (Fujimura, 1987) through which they managed the implementation. Ambiguity has been indicated as a central feature in the mobilisation and framing of science policies (Edler and James, 2015), and their tailoring to several purposes (Calvert, 2006). This study suggests that on several occasions when turning policy objectives into practices, sufficient specificity was crucial for how the policy actors managed tensions at the interface of science and politics. This was evident in terms of how the details written into the legislative text significantly assisted in mediating the division of labour (Fujimura, 1987) between SRC members and MPs, or how SRC members with specific backgrounds were important for generating legitimacy across institutions. Although the legislative text was particularly important for specifying the objectives, the government's decision also had a considerable bearing on the implementation. The choice to establish the instrument as part of the AF as opposed to Tekes had further consequences for the repurposing of organisational practices. Moreover, the implementation

was influenced not only by the work of the SRC members and officials at the AF but also by what happened before, during and after their work. The MEC and AF officials in particular played an important role in shaping the conditions pertaining to the work of the SRC members and officials. The instrument's implementation can thus be understood as a profoundly interconnected and historically contingent process: the actors' choices were influenced by a range of stakeholders, external conditions, and constraints. This provides empirical support for the importance of looking at the social embeddedness of policy actors and their work (e.g., Henderson, 2019), since the process could not be reduced to the actions of a few policy entrepreneurs, although the actors' visions and skills played an important role in the process. Their anticipatory acts and the subsequent ability to mobilize ideas in policy processes can be interpreted as policy entrepreneur skills that they have gained by working closely in the policy environment.

The inherent tension between politics and science required careful negotiation by the policy actors as they translated policy objectives into 'doable' practices (Fujimura, 1987). The tensions that followed the implementation in terms of the research theme process, the formation of the council, disqualification rules constraining the SRC member's involvement in assessment, or the representations of research excluding patterns of science-society interaction, show how challenging it can be to construct funding instruments that satisfy several social worlds. Challenge-driven funding arrangements have subjected researchers to multiple and conflicting requests (Jacob and Jabrane, 2018; Möllers, 2017; Parker and Crona, 2012), which they have managed by "shifting in and out of different contexts" (Möllers, 2016: 369). This case study provides further evidence of how funding management also copes with a plurality of demands (see Wehrens et al., 2022) and indicates how this plurality directly influences the design of science policy practices. In the same way that Wehrens and colleagues (2022) characterise staging work as a way for committees to take care of the programme, concern for the success of the scheme was also reflected in the invisible work of the policy actors, as they made their choices in anticipation of achieving widespread acceptance (see also Pierson, 2000: 258) and legitimacy for the new institution. Although strategic thinking was inherent in their work, the invisible work should not be viewed as mere window dressing or deceitful in some way. It is noteworthy that the caring extended beyond the scheme, as through its construction, the actors sought to maintain the legitimacy and continuity of the institutions they cared about. Their work was also shaped by several organisational and resource-related constraints, leading to ad-hoc choices or trial and error.

The way in which the policy actors repurposed institutional structures that were familiar to them or embedded in their roles contributes to previous findings on how new policy instruments are produced in reference to existing structures and values (Dunlop, 2010; Stinchcombe, 1965; Aldrich and Ruef, 2006: 67), as in the case of the ERC, where Swedish policymakers transferred many of their national legacies onto the ERC's agenda (Persson, 2018; see also Epping, 2020). These findings highlight the relevance of the composition of groups implementing funding schemes, and their repurposing of templates based on attraction, mimesis (Beckert, 2010: 155–159), familiarity and resource-related constraints. The tensions that emerged due to representations of knowledge production within the scheme could be alleviated by using research-based understandings of interaction as templates. For example, prior research has indicated that understandings resembling Mode 2 and innovation helix models of scientific knowledge production do not represent the diversity of the interaction patterns of research with society (Ylijoki et al., 2011; Tuunainen and Knuuttila, 2009; Zierhover and Burger, 2007). This is also related to how the categorisation of scientific impact as external to societal impact can reproduce old distinctions in STI policy discourses (see Flink and Kaldewey, 2018) and enhance a conception according to which a better understanding of a phenomenon, which is a vital precondition for resolving societal problems, is not part of the third mission (see Miettinen et al., 2015: 258).

The instrument was not a reproduction of existing practices but rather gained features of

existing global and national institutions, which in combination also resulted in novel institutional practices, adding to our understanding of how contextualising and standardising forces take shape in science policy (see Irwin et al., 2021). For example, the SRC officials' repurposing of the AF's conventions as templates for the assessment tools of Strategic Research made the instrument converge with the AF's existing funding instruments, while the models used by SRC members resulted in the instrument also gaining influences of innovation-oriented funding. The repurposing of the UK's REF's impact narratives implies convergence of the scheme's societal impact assessment with the UK's assessment practices. There was also convergence between the research theme emphasis on societal challenges and the institutional conventions of policymaking in Finland, whereby the government receives the SRC's research theme proposal late in the decision-making process. In Finland, policy officials have a notable role in policy preparation (Murto, 2014), which mediates organisational interaction. In another country, the societal challenge- emphasis may mean something else. The articulation work identified in this case implies a more general prevalence, but the characteristics it generates in implemented institutions may vary based on the actors, policy cultures and institutions of the policy context and even within the same institution as the actors and institutions working in its surrounding environment undergo changes. For example, the audiences whose reactions are anticipated by policy actors may not be as heterogeneous in 'excellence' instruments (see Scholten et al., 2019) as in 'challenge-driven' instruments. Further empirical case studies of science policy management in different STI policy contexts are needed to investigate these connections, and also the extent to which established funding schemes change over time. The findings lead me to conclude that the manner in which STI policies are implemented undoubtedly matters.

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Notes

1 In 2023, the English name of the organisation changed into Research Council of Finland.

2 In 2018, Tekes was merged with Finpro and became Business Finland.

3 On the governing role of the Research and Innovation council (former Science and Technology Policy Council), see Pelkonen (2006).

4 However, only €55 million became allocated to the instrument.

5 The SRC and its officials decided to organise workshops annually on the research themes with the public as a basis of their work.

6 At first, SRC officials created a broad selection of societal impact indicators but later decreased their number to avoid generating an excessive reporting load.

What's Wrong with Misinformation?

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Abstract

Strangely, few recent studies of misinformation have given attention to the concept of misinformation itself. An examination of several studies of Covid misinformation shows them to be implicitly based on having unquestioned possession of the truth, so there is no attention to struggles over who decides what counts as misinformation and no mention of the possibility that views labelled misinformation might offer reasonable alternative perspectives. This has limitations, especially if understood in the context of research on public scientific controversies: ethical and political disagreements are obscured, and social analysts become de facto supporters of scientific orthodoxy.

Keywords: Misinformation, Positivism, Covid-19, Scientific Controversies

Introduction

In recent years, there has been a huge increase in the number of researchers and government officials expressing concern about misinformation, along with its cousin disinformation. Misinformation refers to sincerely held false claims whereas disinformation refers to intentional falsehoods; here, 'misinformation' will be used throughout. Much of the commentary sees misinformation as a serious social problem, causing many citizens to subscribe to incorrect views with potential dangers to public health and political decision-making.

Curiously, in the outpouring of scholarly research on misinformation there is very little attention to the concept of misinformation itself. Authors in this field seem to assume they, or authorities on whom they rely, can unambiguously distinguish between truth and falsity. They align themselves with the truth and hence turn their attention to the reasons why some people subscribe to false beliefs. Few misinformation researchers mention alternative epistemological frameworks such as constructivism, relativism, pragmatism or, more generally, postmodernism and poststructuralism. These perspectives problematise claims to truth in various ways, including by seeing them as tools in social struggles, by pointing to their positionality, and by rejecting the idea of a grand narrative for understanding the world.

Within science studies, a prominent framework has been the sociology of scientific knowledge or SSK (Barnes, 1974; Bloor, 1976; Mulkay, 1979). In what is called the strong program, SSK investigations adhere to four principles: causality, impartiality, symmetry and reflexivity. Impartiality and symmetry are most relevant here. Impartiality specifies that knowledge claims should be scrutinised regardless of whether they are judged right or wrong, while symmetry specifies that knowledge claims, whether judged right or wrong, should be explained using the same conceptual

tools. This is in contrast with an approach in which the social analyst accepts one perspective as correct and only studies why people believe otherwise, an approach called the sociology of error. Note that SSK is a methodological prescription: an analyst can seek to explain both successful and unsuccessful knowledge claims using the same conceptual tools while personally believing in objective truth. In other words, within science studies, relativism is commonly treated as a method rather than a belief system.

There are various ways to refer to the social-science approach to knowledge in which reasons are sought only for incorrect beliefs, in other words unsuccessful knowledge claims. It is sometimes called positivism, even though the term positivism historically has a range of meanings. From an SSK perspective, it might be called partiality and asymmetry. For the purposes here, these terms, along with the 'sociology of error,' will be used to refer to an approach to the study of knowledge in which the analyst assumes knowledge of the truth — at least as currently understood — and seeks only to study the reasons why people believe otherwise.

Outside of STS, to refer to truth might once have been deemed straightforward, but in 2016 two events triggered the rapid spread of the idea of 'post-truth': Brexit and the election of Donald Trump. 'Post-truth' was chosen by Oxford Dictionaries as the word of the year, with this definition: "relating to or denoting circumstances in which objective facts are less influential in shaping public opinion than appeals to emotion and personal belief" (https://languages.oup.com/word-of-the-year/2016/). There was an outpouring of informed commentary by journalists and philosophers (e.g., Ball, 2017; d'Ancona, 2017; Davis, 2017; McIntyre, 2017), including STS scholars (Sismondo, 2017). However, not all commentators used the Oxford definition, and they had different views about whether post-truth was a new development, whether it was a dangerous development, and much else. The most sophisticated STS-informed examination of post-truth, also the most unorthodox, was by Fuller (2018, 2020), who posited that post-truth involves questioning the assumptions underlying the "game" of searching for the truth. In other words, it was not about a disagreement about truth claims but rather a disagreement about the bases by which truth claims would be judged. Fuller argues there is little new about post-truth.

Post-truth concerns relate to studies of misinformation in at least two ways. The concept of misinformation assumes knowledge of the truth, and hence implicitly decries post-truth, at least in the sense of the Oxford definition. In addition, the concept of misinformation assumes agreement with the rules for seeking the truth, and hence is contrary to the perspective on post-truth presented by Fuller.

There is nothing inherently wrong with studying only the beliefs of one side of a controversial issue: it offers a way of understanding issues and offers insights. At the same time, it cuts off or obscures insights available from other perspectives. We might expect scholars adopting this approach to justify their choice, including by noting the availability of other analytic frameworks and discussing the strengths and weaknesses of different frameworks and the assumptions involved in choosing their own. Given that the term misinformation signals acceptance of currently dominant ideas, therefore, we might expect that studies would include a careful examination of the assumptions underlying the term.

Initially I inspected a diverse range of publications, from the natural and social sciences, dealing with misinformation and found they all accepted the current scientific orthodoxy uncritically. Rather than undertaking a comprehensive search, I chose to look more closely at a small selection of articles, and to make the choice I limited the search in several ways. First, I looked only at studies of Covid misinformation, given that disputes concerning Covid easily fit within the longstanding tradition of controversy studies, unlike disputes about political matters. I relied especially on Google Scholar with the search term "Covid misinformation," looking for articles that were about this topic generally rather than, for example, in a specific country. Second, I picked studies that had been highly cited, suggesting that other researchers considered them credible and relevant. Because older papers were likely to acquire more citations as the field

rapidly expanded, I chose one article published in 2020 (the most highly cited in that year, and overall, Roozenbeek et al.), one published in 2021 (the most highly cited in that year, Gabarron et al.) and one published in 2022 (Caceres et al.), adding one additional article from 2022 (van der Linden), a review article and therefore of special interest for understanding approaches to the topic. Note that citation figures will have changed since I selected these articles. Third, I selected only articles that were open access, making it easier for others to check the analysis.

In reading these articles, I looked for indications that the concept of misinformation was open to critical inquiry. Indications could include:

- attention to struggles over who gets to decide what counts as misinformation;
- recognition that aspects of views labelled misinformation, or associated with them, might represent a reasonable disagreement with mainstream views, or a viable alternative perspective;
- discussion of misinformation by governments, corporations and medical authorities (e.g., Bellos and Montagu, 2024: 273–281; Goldacre, 2012);
- mention of the possibility that people may have good reasons to distrust the views of authorities.

Studies of Covid misinformation are a subset of the wider attention to misinformation in a range of domains. Separate investigations are needed into assumptions in misinformation studies in these domains, as well as studies of fake news, conspiracy theories, and critiques of the misinformation agenda (e.g., Schmidt et al., 2023).

In the following three sections, the four chosen articles are discussed with special attention to indications, or lack thereof, that misinformation could be a questionable concept. The emphasis here is not on whether assertions claimed to be misinformation are false but on the concept of misinformation.

Roozenbeek et al.

"Susceptibility to misinformation about COVID-19 around the world," by Jon Roozenbeek et al., was published in *Royal Society Open Science* in 2020. The authors surveyed people in five countries — UK, Ireland, US, Spain and Mexico — with a total of 4400 respondents, asking questions about beliefs concerning Covid, personal health behaviours, numeracy skills, and trust in science, among others. The questions about Covid were chosen to reveal beliefs that were either right or wrong, in other words, either correct information or misinformation.

With this extensive data, the authors performed numerous statistical tests, looking for correlations between the beliefs and intentions of the respondents. For example, the authors found "increased susceptibility to misinformation negatively affects people's self-reported compliance with public health guidance about COVID-19, as well as people's willingness to get vaccinated against the virus and to recommend the vaccine to vulnerable friends and family." (Roozenbeek et al., 2020: 1)

The rationale for the study is given in the first sentence in the abstract: "Misinformation about COVID-19 is a major threat to public health." One innovative contribution of the paper is to use a sample covering five countries, given that most previous studies looked only at US populations. Another is the wide number of variables examined for correlations with beliefs in misinformation.

Roozenbeek et al.'s treatment of 'misinformation' in a positivist, asymmetrical manner is apparent in their failure to note that there could be a struggle over who decides what counts as misinformation. Another indication is their central object of study, "susceptibility to misinformation." They do not examine the reasons people believe in correct information; for them, it would be strange to talk about "susceptibility to information." This one-sided examination of reasons is an example of the sociology of error.

Respondents were asked about several claims concerning Covid, with some of them deemed misinformation. "The false claims were based on the World Health Organization's 'Mythbusters' page" (Roozenbeek et al., 2020: 4). Thus, the authors treated WHO views as true and contrary views as false, without any question. There is no indication that these WHO views could be subject to rational, sensible disagreement on any grounds. There is no mention of WHO or any other authorities ever being wrong.

Most of Roozenbeek et al.'s misinformation items are strongly deviant from conventional ideas, almost absurd. Nevertheless, some of them might be considered to be associated with plausible claims. One question was "The coronavirus was bioengineered in a military lab in Wuhan." This is not the same as what is now commonly referred to as the lab-leak theory of the origin of Covid, which posits that the coronavirus accidentally escaped from a civilian lab in Wuhan where gain-of-function research on bat coronaviruses was being carried out, but shares some features with the lab-leak theory, namely bioengineering of coronaviruses in a Wuhan virology lab. Since Roozenbeek's article appeared, there has been a growing body of writing giving credibility to the lab-leak hypothesis (Wade, 2024) and evidence of a covert, coordinated effort to deny and discredit this hypothesis (Gutentag et al., 2023).

Another statement used by Roozenbeek et al. to measure beliefs in misinformation was "Gargling salt water or lemon juice reduces the risk of infection from Coronavirus." Several years after their paper appeared, a study found that gargling and nasal washing with a solution of water and bicarbonate of soda greatly reduced the duration of Covid infection (Wang et al., 2023). This is different from gargling with salt water or lemon juice, but suggests that believing in a preventive treatment along these lines may not be as absurd as it might seem on the surface. The point here is that the authors do not raise the possibility that what, when they wrote, was deemed misinformation might contain elements that later gain credibility.

Gabarron et al.

In 2021, a paper by Elia Gabarron and two co-authors was published in the *Bulletin of the World Health Organization* titled "COVID-19-related misinformation on social media: a systematic review." As the title indicates, this was not a direct study of misinformation but rather a systematic review, in essence a study of studies. Gabarron et al. used several databases, such as Google Scholar, to identify primary empirical studies of misinformation on social media in the early months of the pandemic, and then examined the studies to find those of the highest quality, of which they found 22. They assessed these studies in various ways, for example for reported rates of misinformation on social media, concluding that "COVID-19-related misinformation on social media is an important issue, both in terms of the amount of misinformation in circulation and the consequences for people's behaviour and health." (Gabarron et al., 2021: 460).

Gabarron et al. do not mention struggles over who gets to determine truth, or that authorities might disseminate misinformation. A complication is that Gabarron et al.'s paper is a systematic review, so they are reporting on other studies of misinformation on social media, not their own. Nevertheless, a couple of findings are revealing. One is that half of the 22 studies they examined "did not categorize the specific type of COVID-19-related misinformation" (Gabarron et al., 2021: 456), indicating that many studies of misinformation applied the label without specifying the claims said to be wrong.

Gabarron et al. (2021: 459) say "little is known about the relative importance of the different reasons why people propagate misinformation". This focus on those who believe wrong information, without any mention of the reasons people believe correct information, is characteristic of the sociology of error, and is compatible with Gabarron et al. adopting a positivist, asymmetrical approach to knowledge.

Caceres et al.; van der Linden

In 2022, "The impact of misinformation on the COVID-19 pandemic" was published in *AIMS Public Health* (Caceres et al., 2022). It reviews studies of Covid misinformation and summarises themes in these studies, including the risk of vaccine misinformation, the influence of social media, the role of trusted sources of information, measures that can be taken against misinformation, and recommendations for dealing with misinformation. Throughout this review, there is no discussion of struggles over who gets to decide what counts as misinformation, and no mention that people subscribing to views said to be misinformation might have good reasons for their beliefs. In short, Caceres et al.'s review is

based on a positivist, asymmetrical approach to knowledge.

Also in 2022, "Misinformation: susceptibility, spread, and interventions to immunize the public" was published in *Nature Medicine*. Its author, Sander van der Linden, was a co-author of Roozenbeek et al. (2020). It is a review article covering susceptibility to misinformation, the spread of misinformation and how this spread can be limited by discrediting it before and/or after encountering it, called prebunking and debunking. The paper includes several paragraphs (van der Linden et al., 2022: 461) about the challenges of defining and operationalising the concept of misinformation, including that in some circumstances experts change their views fairly rapidly. However, this is treated as a problem for misinformation researchers, not a problem with the concept of misinformation. Overall, van der Linden seems to rely on a positivist framework, for example referring to susceptibility to misinformation (a sociology-of-error approach) and not mentioning vested interests, misinformation endorsed by authorities, people having good reasons for distrusting experts, or struggles over who gets to decide what is considered misinformation.

Controversy studies

Within science studies, there is a long-standing subfield commonly called controversy studies (Engelhardt and Caplan, 1987; Kleinman et al., 2005, 2008, 2010; Mazur, 1981; Nelkin, 1979). A wide variety of scientific controversies have been studied, some of them internal to the scientific community such as over gravitational waves (Collins, 2017) and many involving citizen campaigners, like nuclear power, pesticides, vaccination, microwaves and GMOs. Martin and Richards (1995) classified controversy studies into four approaches:

- positivist, in which "the social scientist accepts the orthodox scientific view and proceeds to analyze the issue from that standpoint" (Martin and Richards, 1995: 509)
- group politics, which "concentrates on the activities of various groups, such as government bodies, corporations, citizens' organizations, and expert panels" (Martin and Richards, 1995: 511)
- constructivist, in which "the social analysis is applied to scientific knowledge claims as well as to wider social dynamics" and "both sides in the controversy are examined using the same repertoire of conceptual tools" (Martin and Richards, 1995: 512)
- social structural, which "uses concepts of social structure, such as class, the state, and patriarchy, to analyze society and to provide insights into controversial issues." (Martin and Richards, 1995: 514)

Martin and Richards (1995) used examples from debates over fluoridation and over vitamin C and cancer, pointing out the strengths and limitations of each of these four approaches.

Disputes over knowledge about Covid can readily be studied as a public scientific controversy. Many of the features of earlier and long-standing public scientific controversies are readily recognisable in claims and counterclaims concerning Covid, including the presence of a dominant view backed by scientific authorities, the role of powerful vested interests (the pharmaceutical industry in this case), the existence of dissident doctors and scientists, and emotional contestation by members of the public. Contrary to the name "scientific controversy," an important feature of these sorts of controversies is that they are not just about science but also involve disagreements over ethics and decision-making. An example is the dispute over lockdowns, which involves not just "the science" but also judgements about the relative importance of preventing the spread of the coronavirus versus freedom to travel and interact with others, or the value to children of attending school. While many believed the danger from Covid was the overwhelming consideration, this was not strictly a scientific matter but involved human values. The implication is that referring to misinformation without acknowledging these non-scientific dimensions is to take a position on them, without acknowledgement. The very term misinformation, in the context of a public scientific controversy, thus builds in a set of unstated judgements.

None of the Covid-misinformation articles examined here mentions research on scientific controversies or notes that Covid issues involve more than scientific matters. This is not to say that

respondents' answers to questions are necessarily rational, well-informed or justifiable, only that social researchers into Covid misinformation have not provided a full picture of the social context of their investigations, but rather made implicit presumptions about the controversial issues they are studying.

Studies of misinformation can be related to the deficit model of science communication. According to Bucchi (1998), the canonical model of science communication is positivist, with scientific knowledge transmitted, in distorted and simplified form, to the public. In the deficit model, members of the public are assumed to lack scientific understanding and need to be provided with correct information provided by scientists, a process that will make people support "science," which in practice means to trust scientific authorities. However, studies show that providing more information, filling the supposed deficit, is not an effective way to change attitudes, nor to build trust in science (Sturgis and Allum, 2004). Discrediting or censoring 'misinformation' can be interpreted as a way to prevent people developing or maintaining wrong ideas, by reducing their exposure to them, and thus aligns with the deficit model. If the push to increase public understanding of science is thought of as 'selling science' (Nelkin, 1987), countering misinformation can be seen as an attempt to hobble competition in the ideas marketplace.

Some members of the public have useful insights, including about how their own social location influences their beliefs, as in the famous study of Cumbrian sheep farmers in Britain in relation to sources of radioactivity (Wynne, 1992). Studies of Covid misinformation seem to assume that members of the public who do not subscribe to the currently dominant scientific view are deficient in knowledge. However, some people may have personal experience of both the disease and potential remedies, and the shortcomings of government policies, that are not adequately considered by scientists.

Simis et al. (2016) argue that one reason for the persistence of the deficit model, despite its shortcomings, is that it provides a simple fix for policy problems, specifically via reform of the science curriculum to make citizens better educated about science. The idea of addressing misinformation is a similarly simple fix for policymakers, which may help explain the burgeoning level of research for the area, implicitly relying on a version of the deficit model. Suldovsky (2016) gives another reason for the persistence of the deficit model: it gives scientific authorities 'epistemic privilege.' The concept of misinformation assumes that sort of privilege.

Conclusion

In many studies of misinformation, researchers assume they have access to the truth (or its best available approximation) and that their task is to explain why some people reject this truth, while seeking ways to overcome this rejection. The acceptance of currently dominant scientific knowledge claims is signalled by the term 'misinformation' itself, especially when it is not critically examined. This is not inherently problematic, but it does limit investigators to a 'sociology of error,' in which the primary task is to explain belief in falsehoods, while reasons for belief in scientific truth are unstudied. Furthermore, when studying controversial issues, a focus on scientific-medical misinformation obscures the role of ethical and political disagreements. With this approach, analysts become de facto supporters of the current scientific orthodoxy and associated ethical and social stances.

Using a positivist, asymmetrical approach means not being able to access insights available using other approaches for studying scientific controversies: group politics, constructivist, and social structural. Studies of misinformation seldom even acknowledge that there is a scientific controversy in which some highly credentialed and published experts disagree with the orthodox position. They have the limitation that when orthodox views change, a new explanation is needed for why some people disagree with it, a problem most obvious in relation to Covid as the lab-leak origin theory changed from being labelled a conspiracy theory to being treated as a serious possibility.

Accepting current scientific orthodoxy means not considering the role of social structures, which can influence the generation and acceptance of knowledge claims. In the case of Covid,

pharmaceutical companies and their government and medical allies have, according to critics, played an important role in promoting vaccination as the solution to the pandemic and denigrating treatments by non-patentable drugs (e.g., Kory, 2023). Whatever one's assessment of the role of vested interests in responses to the pandemic, they deserve consideration, but this is absent from studies using the framework of misinformation.

More generally, invocation of 'misinformation' provides a pretext for censorship on the grounds that members of the public should not be exposed to incorrect ideas. In the vast body of commentary on censorship and free speech, a key idea is that open intellectual engagement and expression of values is vital to create better policies and practices (Baker, 1989; Barendt, 2005; Hare and Weinstein, 2009). Understanding the role of the misinformation label in ongoing struggles over free speech can help in challenging censorship, especially censorship that protects vested interests.

What's wrong with 'misinformation'? It is a loaded term, built on unstated epistemological assumptions, that implicitly denigrates anyone who questions orthodoxy, and limits the scope of social scientific investigation. Stretching this point, it might be said that the concept of misinformation, by offering a misleadingly narrow and one-sided understanding, is itself a form of misinformation.

One implication is to be wary whenever the term misinformation is used. Another is to deal with issues in terms of the arguments and evidence, without automatically assuming one side is correct, and without applying stigmatising labels.

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Maja Bak Herrie (2025) Thinking Through Data: How Outliers, Aggregates, and Patterns Shape Perception. Stanford: Stanford University Press. 166 pages. ISBN: 9781503641891

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Ronald Fisher, the instigator of modern statistical science, once wrote that "the statistician cannot excuse himself from the duty of getting his head clear on the principles of scientific inference, but equally no other thinking man can avoid an obligation like that" (Fisher, 1971[1935]: 1–2). Reflecting on the metaphysics of how knowledge is produced, Fisher, perhaps inadvertently, as such pointed to the existence of a heterogeneity between statistical modes of thought and ways of acting in the world. For calculating practice involves ordering uncertainty into form, while knowing, in the back of your head, that this world of ours exceeds ordering. This very tension has become a frequently revisited theme in STS, and in *Thinking Through Data* (2025) Maja Bak Herrie distills it on the very first page into the question: "What does it mean to see the world through a curve?"

As a monograph, *Thinking Through Data* does not assert its relevance through topical urgency, as of roughly the 300 references of the book, fewer than twenty have been published after 2019. Instead, it claims relevance by foregrounding an intellectual method for unfolding the historical building blocks of computational practices and data-driven knowledge, while maintaining sustained attentiveness to aesthetic perspectives. In doing so, at its best, the book takes on an almost timeless quality, combining technology, art, and philosophy over the ages. As each chapter, centered on statistical notions of outliers, aggregates, and patterns, follows a genealogical rhythm, they trace historical trajectories, prevailing attitudes, and shared dispositions of data-centered knowledge production.

Each chapter of the book centers on artistic works as points of reference, ranging from textiles and CCTV images to conceptual data mappings. These works are then used as reference points that help the reader "think with and along art" (p.16). This is done by tracing a series of connections between the artworks' function and intention, allowing the works to be placed in relation to different perspectives on outliers, aggregates, and patterns respectively. As a disposition, beyond creating a dynamic reading experience, this adds to the reader's understanding of the components of computational practices and forms of knowledge from many different angles. Approaching what might be read as Fisher's idea of 'principles,' that is, the production of knowledge in and through data, computation and statistical work, the book also advances a central premise. Building on the Foucauldian notion of the *dispositif,* data (or whatever is at the heart of each computational context) in our data-driven era can be conceptualized as a specific *digital object*, conceived as shifting within the frames that render it operative (pp. 4–5).

The use of artworks as references gives each chapter its own cadence. And though the use of artistic and visual projects to illuminate data practices is not new (see e.g., Loukissas, 2019), Bak

Herrie employs this strategy with notable narrative care. Artistic works, philosophy, and computation converge to create new spaces for thinking about statistical knowledge and practices – spaces that gesture toward how we have thought and how we might think otherwise. On that note the chapter on *patterns* stands out for me personally. Centered on Stéphanie Solinas' project *Dominique Lambert*, it develops a nuanced discussion on practice and thinking related to recurring sequences in data, mobilizing both the Deleuzian concept of virtuality, critical data studies, and selected works from the digital humanities. Ultimately, the convergence of artistic piece, the genealogy of computational practices, and philosophical elaboration on knowledge creates a very precise space for elaboration on knowledge creation.

However, viewing the book as a contribution to the scholarly literature on data, less precision is afforded to the book's central concept: the digital object. Although recurrent throughout the text, its analytical relevance is not always fully convincing. This may partly reflect editorial choices, as the rationale for using the contested term *object* appearing relatively late in the book (on p. 117). But also, although the book presents the concept as a necessary intervention, claiming that it "opens up" or "offers an entry point" (p. 118), and while each chapter concludes with a reflection on the digital objects disposition and use, a lingering lack of arguments regarding its specific analytical relevance remains. For one, the ambition to "investigate the heterogeneous digital field" (p. 4) does not clearly distinguish the digital object from already existing dispositif-oriented approaches, such as the data assemblages proposed by Kitchin and Lauriault (2018) or Boyd (2022), or Dourish's (2017) notion of the multiple, mobile natures of information. Moreover, while considerable elaboration is devoted to 'the digital' in outlining the concept, the 'data' we are meant to think through remains comparatively underexplored with regards to approaches in pre-existing literature. By contrast, more data-centered theories drawing on heterogeneous dispositifs, such as Fussell's outline of assemblages and discursive definitions of data (2022), Koopman's (2019) or Isin and Ruppert's (2020) reflections on digital subject formations, or the literature on data domains and computational universalism (Ribes, 2019; Lee and Ribes, 2025), offer similarly motivated but more precise conceptualizations. Reflecting on this, it seems like the book's cultivated sense of timelessness occasionally comes at the expense of its potential timely relevance regarding the epistemological and ontological stakes of data in the mid-2020s.

Nevertheless, I would argue that in *Thinking Through Data*, Bak Herrie's principal contribution lies in the fusing of art piece, philosophical underpinning and reflection on data as a form of method. It offers readers, individually or collectively, an aesthetic-philosophical handbook for elaborating on spaces where computations unfold. As a collective reading, it would be particularly well suited to doctoral courses or reading seminars engaging critically with data. For the individual reader, it offers both a nuanced genealogy of data-thinking and an invitation to think through data in both familiar and new ways. Well-researched and generous, and with a keen eye for the narrative art, it does not resolve the tension Fisher alluded to. It rather leaves it open, as it should, asking what it means to see the world, and what must always remain beyond the curve.

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Ulrike Felt (2025) Contesting the Chronopolitics of Research. Singapore: Palgrave Macmillan. 421 pages. ISBN: 9789819646081

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How long will you need to read this review? Book reviews are much quicker to ingest than books themselves and they are thus well suited to the increasingly scarce time of researchers. Yet, despite its centrality in the organisation of academic life, researchers' time has been surprisingly neglected in STS. Ulrike Felt's new, open access book offers an essential (and timely) contribution to STS debates on the role of temporalities in academic research. Moving beyond accounts focused on the acceleration of academic work, and those displaying nostalgic imaginaries of slower golden times, Felt demonstrates that researchers inhabit 'epistemic living spaces', a concept emphasising how people perceive the structures in which they work, characterised by multiple and often contradictory temporalities. Time, she argues, should be understood not as linear but as a multilayered configuration of 're-timing' (p. 3). To read this review, you will therefore have to synchronise the heterogeneous temporalities you navigate: the institutional time of funding and evaluation for the projects you applied to, the epistemic temporalities inherent to your objects of study, and your subjective experience of anticipation and waiting, which are strongly shaped by your career stage.

Felt's book opens with a vivid anecdote of her early STS work at CERN, conducted at a time when academic timescapes were radically different. She recalls "going slowly through a pile of papers" without interruptions from emails or other devices, and getting "lost in time" (p. xi). This autobiographical starting point illustrates the central argument of the book. Researchers' relationships to time have drastically changed due to structural transformations in academia. The turn towards neoliberal university models has institutionalised the rhythms of project-based funding, while the increasing reliance on digital technologies creates the impression that anyone should be available at any time. Felt calls this a new 'temporal regime' that "tacitly governs both our lives and what we can know in contemporary academia" (p. 6). She convincingly shows that time is "a site of exercise of power" (p. 7), which shapes the type of knowledge and academic lives made possible. Importantly, Felt demonstrates that this temporal regime shapes differentiated experiences. Early career researchers must plan ahead their careers, and make difficult decisions about remaining in or leaving academia, which often leads them to commit to safer epistemic projects, especially at the postdoctoral stage (Fochler et al., 2016). By contrast, obtaining tenure does not provide the temporal freedom once imagined by senior researchers, who find their time diffracted across

numerous activities. In that regard, the book itself reflects Felt's long-standing engagement with questions of time, developed over her entire career, while navigating the varied demands placed on a professor in STS.

To methodologically analyse something as dispersed and difficult to grasp as time, the book adopts a dual analytical strategy, examining it simultaneously at institutional and individual levels. On the one hand, Felt examines devices that organise academic time, which she calls 'time generators', such as research projects, CVs, evaluation cycles and metrics. These elements "shape how time is produced and organized" in academia and define "who can impose specific forms of time on whom" (p. 72). For instance, CVs structure career scripts by compelling researchers to present their trajectories as linear, even though personal and professional lives are often far messier. On the other hand, and more extensively, Felt devotes considerable attention to researchers' narratives, which are essential to study the lived, subjective and affective dimension of time (see also, Brunet and Müller, 2024). Narratives, Felt argues, are a 'form of knowing' and express the 'lived time' of research. Through these accounts, Felt reveals how researchers experience pressure, waiting, acceleration, uncertainty, or pleasure, and how they continually weave together conflicting temporal demands. Combining an institutional and experiential analysis enables the book to offer a rare synthesis in STS, where micro-ethnographic and macro-structural analyses are often separated.

To provide analytical tools and study the re-timing of academia, Felt's book develops a rich and articulated conceptual apparatus (timescapes, temporal regimes, time generators, temporealities, etc.). This conceptual richness enables Felt to avoid oversimplifying how time shapes and is shaped by academic work. She emphasises that academic timescapes are full of tensions and contradictions, between acceleration and delay, freedom and precarity, pleasure and pressure. One consequence of this multi-layered time is that researchers must navigate 'academic arrhythmia': a feeling that the tempo of academic life is, at the same time, "too fast, too slow, or irregular" (p. 48). For theoretical STS debates, the conceptual apparatus brings questions of multiplicity (Mol, 2002) to the center, by showing that temporal paradoxes and ambivalences shape academic life and that researchers simultaneously inhabit diverse and often incompatible timescapes. Yet, Felt does not stop at diagnosis. She wants to intervene in the chronopolitics of academic research, for instance by fostering more livable academic spaces for young researchers. To this end, she proposes a form of temporal carework that acknowledges the plurality of time in academic work and offers reflexive tools for imagining more livable academic temporalities. Concretely, research institutions could support this temporal care by making the fragmented temporal structures they have put in place, such as funding cycles, career trajectories, or evaluation processes, more coherent with respect to epistemic rhythms, and by acknowledging how different forms of time affect researchers' lives.

For STS scholars, a key point of Felt's book is that the re-timing of academic research has profound epistemic implications. Felt shows that various temporalities shape knowledge spaces (such as labs and fieldwork), research practices (preparing, waiting, maintaining), research objects as well as relations to societal issues. For instance, she notes that some infrastructures require decades of continuous investment, while other technologies, such as CRISPR-Cas9, promise to dramatically speed up work. Another epistemic implication stems from career choices and project funding cycles, which require researchers to "balance one's time investment against the potential gains in knowledge" (p. 342) and thereby weigh on which questions are either pursued or left aside. While Felt occasionally points to differences between natural and social sciences, disciplinary distinctions remain secondary in her account, suggesting that time cuts across disciplinary boundaries in a similar way. A more fine-grained analysis of how temporalities are experienced and shaped within different epistemic cultures would offer a compelling continuation of this work – perhaps even the basis for a second book!

Among the many possible avenues for further analysis, we would suggest two additional ones. The first, on an individual level, would draw on the notion of 'time tricksters' discussed at the end of the book. How do some researchers game

time generators, subvert academic timescapes for their own benefit or to defend their teams or epistemic practices? The second concerns the institutional level, since evaluation frameworks and practices are at the heart of the book. How can current reform movements, particularly those led by COARA (Coalition for Advancing Research Assessment), be treated as attempts to transform academic timescapes? Taking into account all types of academic outputs, such as datasets or reviews, or introducing narrative CVs seem to be potent ways to reconfigure trajectories and their accompanying accounts.

Overall, the reflections presented in Felt's book invite us to attend to the substantial temporal investment required by diverse academic activities, including writing or reading book reviews. Book reviews, in particular, play an essential role in sustaining scholarly communities, yet they often remain largely unaccounted for in dominant research evaluation frameworks. By taking a bit of your time, we hope that this review has shown why attending to academic temporalities matters for academic lives and knowledge practices.

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