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Science & Technology Studies: Impact, Reader Engagement, and Expertise

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Abstract

The first edition of *Science & Technology Studies*, then named *Science Studies*, became available in 1988. Over the past 35 years, the journal has established itself as a prominent international publication, experiencing significant growth in publication volume, manuscript submissions, and readership. This paper commemorates these achievements and reflects on the journal's evolution. A key aspect of this exploration is our journal's role in the Open Access movement, which both enhances transparency and offers new tools for the analysis. The sections delve further into the topic of scholarly impact of STS, starting with a discussion of impact factor metrics followed by insights from our Editorial Team. The paper then utilizes the extensive archives of the journal and the capabilities of new tools to explore reader engagement with our publications. The paper concludes with a discussion of our way forward into the next years and decades.

Introduction

The inaugural issue of *Science & Technology Studies*, then titled *Science Studies*, was published in 1988. Established by the Society for Science Studies, now known as the Finnish Society for Science and Technology Studies, we now celebrate the journal's 35th anniversary, with 36 volumes successfully published.

The journal's initial mission was to disseminate research and discussions from Finland and other Nordic countries to an international audience, as the first editor-in-chief, Veronica Stolte-Heiskanen (1988), stated in the first issue. Over the past 35 years, the journal has established itself as a prominent international publication, with significant growth in publication volume, manuscript submissions, and readership. This paper not only commemorates these achievements but also reflects on the journal's evolution.

On the journal's 30th anniversary, the then-coordinating editor, Salla Sariola (2018), offered a retrospective of the journal's history. Her outline addressed the journal's transformation into an international journal in the early 2010s, the introduction of special theme issues and Open Access publishing, and its significant role as the house journal for EASST since 2012. Sariola's analysis also examined the geographical location and gender of contributing authors.

This paper will not duplicate the earlier effort, which was published only five years ago, though an update in 2028-2029 would be more than apposite to celebrate our 40th anniversary. Instead, it utilises the extensive archives of the journal and the capabilities of new tools to explore Science and Technology Studies (STS) as a field of knowledge production. A key factor in this exploration is our journal's role in the Open Access movement, which both enhances transparency and enables unique analyses.

Moreover, the appraisal deliberately departs from focus on Journal Impact Factors (JIFs), which has become an increasingly popular and mainstream approach to academic publishing and evaluation (Vann, 2017). By leveraging the features of our Open Journal Systems (OJS) publishing platform and utilising insights from our international Editor Team's discussions, I rather address less conventional questions and challenge some of the standard narratives in academic evaluation. My paper concludes with a discussion of our way forward into the next years and decades.

Beyond Journal Impact Factors

The Journal Impact Factor (JIF) is calculated and published annually by Clarivate Analytics. It is a widely deployed metric for assessing journal citation counts. A JIF is determined by dividing two numbers; the number of citations in the current year to journal publications in the preceding two years; and the number of all the 'citable' articles published also in the preceding two years. It thus measures average citations: with an impact factor of 1.0, a journal's articles from one or two years ago have been cited once on average. With a JIF below 1.0, there has been less than one, and with a JIF of 3.0, on average of three citations. Some academic journals also publish their JIFs for the preceding five years, which demonstrates that the default two-year window may be experienced as too narrow in many cases to understand impact and performance adequately.

Katie Vann (2017), a former long-term managing editor of *Science, Technology, & Human Values* and *Engaging Science, Technology, and Society*, has provided a comprehensive discussion of the JIF, which is utilised and expanded in this section. To start with, we should note that *Science & Technology Studies* has a JIF, and similarly to Vann (2017), we acknowledge it as an important aspect in attracting scholarly attention. We, the editors, do not mean to undermine the value that publishing in journals with (high) JIFs may have for people's careers, despite the well-acknowledged limitations of this metric.

This paper discusses some of these impact factor limitations. As STS focuses on the social construction of knowledge, STS scholars are themselves well-equipped to understand the nuances of how metrics are calculated, to recognize methodological implications, which merit critical examination, and to scrutinize possibly detrimental effects.

Vann (2017) identifies several key implications with the JIF metric:

1. The JIF always focuses on citations within a specific time frame, i.e., the past two or five years, and it only includes citations from journals indexed in Clarivate's Web of Science.
2. In use, the JIF conflates citations with impact, since it assumes that the influence of scholarly texts can be understood primarily by their citation counts within a certain period.
3. This conflation can lead to an overestimation or underestimation of published papers' true value, as the JIF visibly depends on citation practices within certain fields of inquiry and whether these citations are included in the JIF calculation.

Although the JIF may be suitable for established, monodisciplinary fields, its application to a multifaceted and interdisciplinary field such as STS is thus not trivial. The JIF was initiated in the 1960s and 1970s, primarily as a tool for university librarians to determine journal purchases. When used in academic evaluation, its implication becomes different: it assumes a field in which an article's impact links directly to current interest, which is, furthermore, an interest well covered by other publications in recognised journals. An ideal of there being a state-of-the-art of scholarship, and well-recognised recent advancements, is both presupposed and performed by this metric. As will become clear below, this journal also endorses rigour and the advancement STS research, but assigning a simple measurement to it, applicable in different disciplines and fields, is not straightforward.

Indeed, there is a number of well-established issues in scholarly and policy discussions concerning JIFs. Among the best-known and most publicly visible statements is presented in the San Francisco Declaration on Research Assessment (DORA), first published in 2013 and currently signed by more than 2,000 organisations. The first recommendation of DORA to publishers is to:

> Greatly reduce emphasis on the journal impact factor as a promotional tool, ideally by ceasing to promote the impact factor or by presenting the metric in the context of a variety of journal-based metrics (e.g., 5-year impact factor, EigenFactor, SCImago, h-index, editorial and publication times, etc.) that provide a richer view of journal performance. (DORA, 2013: n.p.)

Another similar example closer to the field STS is the Leiden Manifesto for Research Metrics, published as a comment in *Nature* (Hicks et al., 2015). By addressing what JIFs include and exclude in their calculations, it posits that a focus on publishing in high-impact journals can stifle the pluralism and societal relevance of research not automatically captured by the impact metrics.

These kinds of issues with publication metrics and understanding of performance are also clearly visible in STS. On a field as diverse and multivocal, in which scholars frequently reference work across the social sciences, humanities, and even the sciences and engineering disciplines, the JIF measurement approach can alter the understanding of what constitutes impactful scholarship (Vann, 2017). The JIF of this journal seems to be a case in point – it has tended to change visibly between years and past years were no reliable indicator for future developments.

Indeed, in a journal that publishes four issues a year normally with four research articles in each – special theme issues allow more papers – our JIF has been contingent to the publication and citation activity at a given time. Years with highly-cited research articles (Hyysalo et al., 2019) and special theme issues such as the "The many Modes of Citizen Science" (Kasperowski and Gullenberg 2019; Strassel, 2019; Schrögel and Kolleck, 2019) boost the JIF in the two years that follow and hence give visibility to our whole impact. Years where fewer highly-cited papers and issues are published conversely underestimate this impact. These indicators thus introduce potential for false precision (Hicks et al., 2015) as the actual value of the publication activity does not lie in any middle point of these two ends and becomes challenging to interpret from this evidence.

There are, however, several other ways to approach the impact of scholarly texts. Vann (2017: 95) compellingly argues that the JIF "misconstrues how reading, and the texts STS scholars read, figure in the formation of STS expertise, and how that expertise is expressed in STS knowledge production". This is where the tools provided by our Open Journal Systems (OJS) platform become invaluable and allow to explore impact in more nuanced ways. The subsequent sections will discuss this topic, starting with insights from our Editorial Team.

Contributions to the field: designations and challenges

Last year, the Editorial Team meeting of *S&TS* gathered to address a fundamental question regarding our desk-top selection practices: what falls within the journal's scope, and how can we effectively recognize contributions to our field?

One key factor in asking this question are the volumes that the journal deals with. Since we started gathering publishing statistics after installing the Open Journal Systems (OJS) in 2016, *S&TS* has received on average a little over 200 article suggestions every year. Each of these suggested articles must be vetted carefully by desk-top review even before they can potentially enter peer review. The submission frequency grew dramatically after 2020: from having only some 50 submissions in the late 2010s, we received nearly 500 submissions in 2021 and 350 in 2022, though the figure has now lowered again to a little over 260 submissions received in 2023. Nevertheless, to use simple averaging, this situation means that more than one article is submitted into our publishing system every two days. A dedicated Screening Editor vets each of these papers and assigns them to individual Editors that then select some of them into peer review.

Our actual rejection rate has been consistently over 60% for the several past years. In concrete terms, this means that two thirds of those papers that go into peer review will not be accepted for publication even after the peer review has been concluded.

The situation of having to deal with frequent submissions and an active pipeline while maintaining high publishing quality leads to broader questions about the nature of STS expertise and its recognition in a flagship journal. A selection of the Editorial Team, including Karen Kastenhofer, Alexandra Supper, and Mikko J. Virtanen, was hence tasked with addressing a key issue: *Can we safeguard the rigour of research papers submitted and published in the journal even more systematically, and if so, how?*

The team divided the question into two subthemes. The first was defining *general* criteria for rigorous STS research and instruments to implement them in desk-top evaluation. The second concerned incentivising author positioning by means of outlining and discussing initial assumptions, choices and ramifications so as to allow for *approach- and text-specific* desk-top evaluation. This includes explicitly stating topics, specifying research designs, defining contexts, outlining processes, and adopting a reflective stance toward the conducted research, including the underlying assumptions and forms of knowledge (see also Silvast & Virtanen, 2023; Lippert & Mewes, 2021; Hyysalo et al., 2019).

The team thus recognized the complexities in defining rigour and the downsides of prescribing it, particularly in a diverse, evolving, and heterodox field like STS. Thinking about these issues, knowledge and experience are qualities that editorial engagement and peer review can bring to bear. Yet, while the insights of seasoned researchers are vital, we should not risk stalling the innovative contributions of newer STS scholars.

With that being said, there remains an imperative to uphold publishing quality and fit of papers with our journal and community. We emphasise the need for STS contributions that resonate with a broader audience and steer clear of scholarly provincialism. Consequently, we warmly welcome contributions that extend beyond case studies and enrich wider STS scholarship—whether in conceptual, methodological, empirical, research ethical, or a combined manner.

To address this need concretely, the idea of a formal, separate category for theoretical essays was also debated. Concerns were raised that a separate category might diminish the theoretical depth perceived in all other articles and hence reify a difference between 'empirical' and 'conceptual' research at the level of categories. Indeed, as we demonstrate below, our readers most typically engage with papers that do not fit neatly into this dichotomy either but pursue new concepts and empirics at the same time. Therefore, rather than introducing new categories as solution, we rather advocate for diverse contributions—theoretical, conceptual, and methodological—across all types of articles.

Lastly, an essential aspect of our professional role as editors involves adhering to ethical standards. As per the guidelines of the Committee on Publication Ethics (COPE), an organisation comprising editors, publishers, universities, and research institutes, it is of paramount importance to have clear definitions and processes for promoting integrity in research and publication activities, including authorship, conflict of interests, peer review processes, and beyond (COPE, 2022). Our journal will be actively updating its relating policies in 2024.

Understanding STS readers

The Open Journal Systems (OJS) platform offers a unique glimpse into reader engagement with our publications through its comprehensive statistics. OJS not only tracks the number of downloads for each article but also records our self-registered readers.

At the time of this writing, *S&TS* has 3,239 registered users on the OJS platform, 1,043 of them self-designated as readers. Site usage data shows how all of our site visitors – including but not limited to the registered users – use the journal and when. For instance, during December 2023, we observed normal daily views of abstracts ranging from 120 to 500, while full-text reads varied between 80 to 250 (a notable dip in readership occurred during the Christmas period, which we see in a positive light). The release of a new issue mid-month typically results in a surge, with abstract views almost doubling to 900 five days after the release of the December issue, and full text downloads also increasing albeit at a more moderate pace. This pattern underscores our readers' anticipation of and engagement with each new journal issue.

Figure 1 displays the broader trajectory of readership starting from when we began collecting OJS statistics in 2016. It demonstrates a steadily raising trendline of growing readership. To take an example, during November 2016, the journal boasted 860 abstract views, which dramatically increased to 9,314 by November 2023. Text readings have also seen a notable increase, suggesting that a large portion of our audience engages with the content, not just summaries. This upward trend persisted even through the pandemic years, highlighting the enduring interest in the journal.

We posit that a major factor in this growth is our adoption of the Diamond Open Access model, similarly to other pioneering journals like *Tecnoscienza – Italian Journal of Science & Technology Studies* (Coletta et al., 2022). This approach, where neither authors nor readers have costs for publishing or accessing content, and where articles are freely available under a Creative Commons licence, aligns with our commitment to open and accessible STS scholarship. We transitioned to Diamond Open Access in 2017 and our subsequent listing in the Directory of Open Access Journals (DOAJ) happened in 2021 (Sariola, 2021). We owe the ability to maintain this model to the generous support from EASST and the Federation of Finnish Learned Societies through the Finnish Society for Science and Technology Studies.

While OJS does not offer detailed demographics of our users, it does reveal their reading preferences. This behavioural data helps address questions raised by Vann (2017) regarding the impact of STS and the concerns about research rigour discussed above.

The most-read papers, as shown in Table 1, offer insights into the readership and interest. Although STS is often associated with detailed case studies, the most frequently read articles tend to be rather theoretical, methodological, or a mix of both (Hyysalo et al., 2019). These papers present varieties of knowledge bases and evidence and their content is empirical as well. Nevertheless, I would argue that a key contribution lies in their conceptual themes that broaden up notions of science and technology from an STS standpoint. These themes are heterogeneous and include citizen science (Strasser et al., 2019), the social construction of ignorance (Pinto, 2017), interdisciplinarity (Balmer et al., 2015), Actor-Network Theory in urbanities (Blok, 2013), public participation (Schrögel and Kolleck, 2019), future expectations (Brown, 2003), and even the

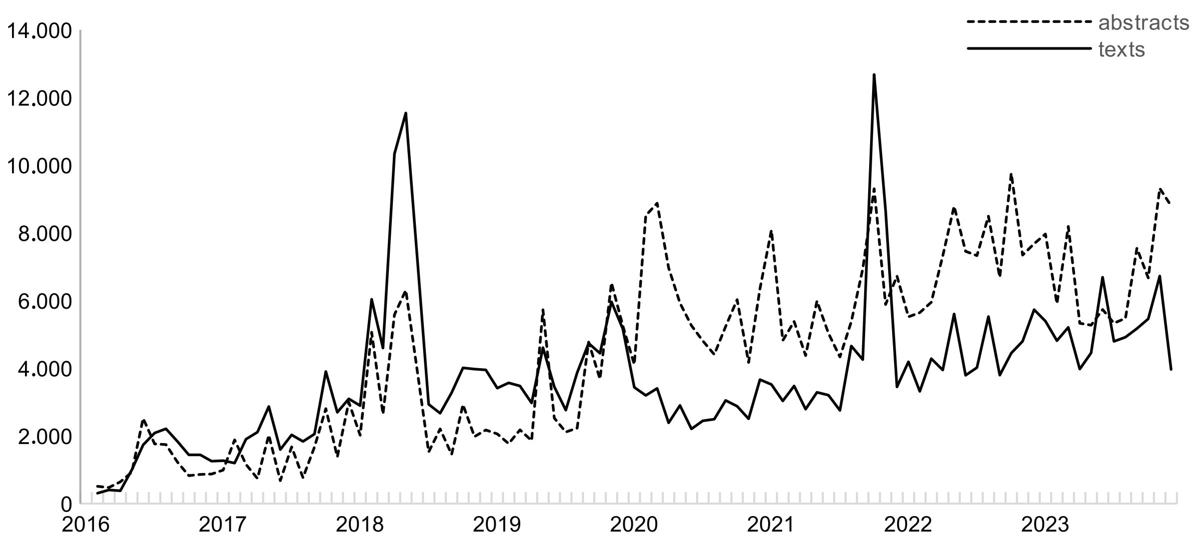

Figure 1. Number of monthly abstract views and article file views in *Science & Technology Studies***,** 1 February 2016 – 31 December 2023. *Source***:** *S&TS* Open Journal Systems Articles statistics, 21 January 2024.

relationship between STS and design thinking (Moore and Karvonen, 2008). This selection of reading indicates a strong and broad interest of our audience in conceptual and methodological innovation.

Additionally, and interestingly, book reviews, particularly those of works by Haraway and Latour, have also gathered significant readership. They have done this despite their low citation rates, underscoring a further disconnect between citation frequency and actual impact (Vann, 2017). This finding puts positive light to the role of book reviews in scholarly discussions. Two scholars from the Finnish *Historical Journal* have expressed this important role:

> Discussing research is a key part of scientific activity. Book reviews form hence a very important element of scientific writing. They make research visible and inform colleagues about what is happening in the field, they tie scientific debates together, help relate emerging ideas in research and, at their best, offer a variety of tips and perspectives for further reflection. The evaluation of new literature in any field is therefore a vital service to the rest of the scientific community. (Roitto and Laine-Frigren, 2020: 356, translation by the author.)

But other kinds of publications in the system also lack a clear correspondence between the number of citations and the frequency of reads. Not all

Table 1. The most frequently read papers from *Science & Technology Studies***,** 1 February 2016 – 31 December 2023. *Source***:** *S&TS* Open Journal Systems Articles statistics, 18 January 2024.
*: the databases used include Google Scholar (GS), Scopus, and Web of Science (WoS) for the broadest possible coverage of citations. *S&TS* was not indexed in Scopus before 2012 and in Web of Science before 2015. *S&TS* book reviews are not indexed by Scopus.

Paper	Type	Abstract views	Text views	Total views	Times cited*
Strasser et al. (2019) 'Citizen Science'? Rethinking Science and Public Participation	Research paper	8,737	4,884	13,621	393 (GS), 207 (Scopus), 52 (WoS)
Hyysalo et al. (2019) Method Matters in the Social Study of Technology: Investigating the Biographies of Artifacts and Practices	Research papers	5,499	2,516	8,015	69 (GS), 31 (Scopus), 22 (WoS)
Kenney (2017) Review of Donna Haraway (2016) Staying with the Trouble: Making Kin in the Chthulucene	Book review	1,564	6,372	7,936	8 (GS), 4 (WoS)
Langlais (2006) Review of Bruno Latour (2005) Reassembling the Social: An Introduction to Actor-Network-Theory	Book review	362	5,963	6,325	3 (GS)
Pinto (2017) To Know or Better Not to: Agnotology and the Social Construction of Ignorance in Commercially Driven Research	Research article	3,450	2,748	6,198	49 (GS), 24 (Scopus). 22 (WoS)
Balmer et al. (2015) Taking Roles in Interdisciplinary Collaborations: Reflections on Working in Post-ELSI Spaces in the UK Synthetic Biology Community	Research article	3,595	2,106	5,701	170 (GS), 92 (Scopus), 79 (WoS)
Blok (2013) Urban Green Assemblages: An ANT View on Sustainable City Building Projects	Research article	2,503	3,155	5,658	97 (GS), 41 (Scopus)
Schrögel and Kolleck (2019) The Many Faces of Participation in Science: Literature Review and Proposal for a Three-Dimensional Framework	Research article	3,169	2,161	5,330	77 (GS), 39 (Scopus), 66 (Wos)
Moore and Karvonen (2008) Sustainable Architecture in Context: STS and Design Thinking	Research article	2,704	2,987	5,061	67 (GS)
Brown (2003) Hope Against Hype - Accountability in Biopasts, Presents and Futures	Research article	2,898	2,093	4,991	689 (GS)

highly cited papers feature frequent reads at our OJS platform, though it bears stating that the statistics here do not capture readers in other places such as ResearchGate or Academia.edu or any parallel publication platforms of universities.

The chronological distribution of the most popular papers is also noteworthy. Despite the earlier articles being out there for reading for a longer time, the majority of the most-read papers in Table 1 were published after 2012, with none predating 2003. More than half of these papers were published even in or after 2015, with three from 2019, suggesting that our readership is keenly interested in contemporary scholarship.

Overall, the articles attracting the most attention from our readers seem to be those that push the boundaries of traditional STS debates and introduce new ideas and methodologies. This interpretation reinforces the importance of our editorial discussions on how to best evaluate theoretical, methodological, and empirical rigour in submissions while not too fervently 'mainstreaming' STS publications. We thus eagerly anticipate future submissions that will continue to advance the field in these directions!

Conclusions

The journey of the *Science & Technology Studies (S&TS)* journal over the past 35 years reflects upon the evolution of the whole field of Science and Technology Studies (STS). From its beginnings as a regional Nordic and Finnish publication that aimed for an international audience in late the 1980s, the journal has grown into an internationally recognized scholarly platform. It has become an increasingly important channel that has a specific part in the ecosystem of STS publishing worldwide and that upholds specific publishing values in doing so. Our successful transitioning to the Diamond Open Access model and the adoption of tools like the Open Journal Systems (OJS) have broadened the readership and enhanced the dissemination of knowledge, as this editorial has also demonstrated.

To fully capture this wide impact of scholarly work, traditional metrics such as JIFs have clear complexities especially in an interdisciplinary field like STS. A more nuanced understanding of 'impact' is necessary to understand our field and its evolution. Fortunately, there are many ways to move beyond citation counts and acknowledge the diverse ways in which STS scholarship informs and shapes scholarly discussions. In this editorial, the readership of STS papers was utilised as a specific and underutilised source of evidence. The data from the OJS revealed the most-read papers and their content and showed the community's enduring interest for theoretical and methodological advancements in our field.

These insights are not just concerned with discussing our editorial directions, though they do have several bearings on what those directions are like and how they may evolve. The arguments here could serve as a guidepost for scholars seeking to make meaningful contributions to the field and for triggering discussion in the broader STS community. As a journal, we believe that publishing is at the heart of designating what scholarly fields are and what they could become. We hence hope that both our authors and readers will think with us concerning the nature of STS contributions and the role of expertise, coupled with the need for rigour coupled with innovation and reflexivity in STS research.

As we move to 2024, the embracing of Open Access and the engagement with emerging scholarly needs and practices will be at the core of the *S&TS* journal's discussions and practices. In doing this, we hope to be part of setting an ambitious course for the future of STS scholarship.

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References

Balmer AS, Calvert J, Marris C et al. (2015) Taking roles in interdisciplinary collaborations: Reflections on working in post-ELSI spaces in the UK synthetic biology community. *Science & Technology Studies* 28(3): 3-25.

Committee on Publication Ethics (COPE) (2022) Ethics toolkit for a successful editorial office. Available at: https://publicationethics.org/sites/default/files/cope-ethics-toolkit-journal-editors-publishers.pdf (accessed 18.1.2024).

Coletta C, Crabu S and Perrotta M (2022) Doing STS in Times of Crises. *Tecnoscienza–Italian Journal of Science & Technology Studies* 13(1): 5-8.

The Declaration on Research Assessment (DORA) (2013) San Francisco Declaration on Research Assessment. Available at: https://sfdora.org/read/ (accessed 22.1.2024).

Hicks D, Wouters P, Waltman L, De Rijcke S and Rafols I (2015) Bibliometrics: the Leiden Manifesto for research metrics. *Nature* 520(7548): 429-431.

Hyysalo S, Pollock N and Williams R (2019) Method matters in the social study of technology: Investigating the biographies of artifacts and practices. *Science & Technology Studies* 32(3): 2-25.

Kasperowski D and Kullenberg C (2019) The many modes of citizen science. *Science & Technology Studies* 32(2): 2-7.

Kenney M (2017) Review of Donna Haraway (2016) Staying with the Trouble: Making Kin in the Chthulucene. *Science & Technology Studies* 30(2): 73-76.

Langlais R (2006) Review of Bruno Latour (2005) Reassembling the Social: An Introduction to Actor-Network-Theory. *Science & Technology Studies* 19(1): 93-100.

Lippert I and Mewes JS (2021) Data, Methods and Writing: Methodographies of STS Ethnographic Collaboration in Practice. *Science & Technology Studies* 34(3): 2–16.

Moore SA and Karvonen A (2008) Sustainable architecture in context: STS and design thinking. *Science & Technology Studies* 21(1): 29-44.

Pinto MF (2017) To know or better not to: Agnotology and the social construction of ignorance in commercially driven research. *Science & Technology Studies* 30(2): 53-72.

Roitto M and Laine-Frigren T (2020) Arvion mekin ansaitsemme: kirja-arviot ja tieteellisen kirjoittamisen taito [We deserve a review too: book reviews and scientific writing skills]. *Historiallinen aikakauskirja* [Historical Journal] 118(3): 356-360.

Sariola S (2018) 30th anniversary issue of Science & Technology Studies. *Science & Technology Studies* 31(3): 2-4.

Sariola S (2021) What does openness conceal? *Science & technology Studies* 34(2): 2-5.

Schrögel P and Kolleck A (2019) The many faces of participation in science: Literature review and proposal for a three-dimensional framework. *Science & Technology Studies* 32(2): 77-99.

Silvast A and Virtanen MJ (2023) On theory–methods packages in science and technology studies. *Science, Technology, & Human Values* 48(1): 167-189.

Stolte-Heiskanen V (1988) Foreword. *Science Studies* 1(1): 3.

Strasser B, Baudry J, Mahr D, Sanchez G and Tancoigne E (2019) Citizen science? Rethinking science and public participation. *Science & Technology Studies* 32(2): 52-76.

Vann K (2017) Surplus and indicator. *Engaging Science, Technology, and Society* 3: 92-107.

The Valuable Plurality of the Citizen Sciences

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Abstract

Citizen science is a multilayered concept. Although it is generally understood as a form of public engagement with science and technology, it can take various forms, with widely different roles for citizens. Despite this vastness, a contributory strand of citizen science dominates the field, which formally limits citizens' roles to those of data gatherers for professional scientists or experts. This has led critics to argue that citizen science is not as inclusive, socially transformative, or democratizing as its advocates claim, and to appeals by scholars, practitioners, and policymakers for more dialogue and deliberation in all stages of citizen science processes. In this piece, we share our reflections on these questions drawing on our experiences as participant observers in contributory citizen science projects in various parts of the world. Responding to the above critiques, we illustrate how such projects can have emancipatory potential in terms of impacting policy agendas, inciting behavioral change, and engaging hard-to-reach societal groups. We argue that the future of citizen science lies in pluralizing the citizen sciences by experimenting with various modes of democratic representation, participation, and deliberation.

Keywords: Citizen Science, Contribution, Deliberation, Empowerment, Participation, Pluralism.

Introduction

Sighting birds, scanning photographs of galaxies taken by space telescopes, monitoring waterways, exploring molecular patterns in cells. These are but a few of the many activities citizen scientists partake in across the globe. In the vast majority of these projects, citizens' roles are circumscribed to those of data gatherers or contributors; that is, citizens are mobilized to collect data for scientific experts without being given opportunities to set the agenda for research or science policy. This has led critics to argue that citizen science is not as inclusive, socially transformative, or democratizing as its advocates claim (Mirowski, 2017); and that citizen science processes serve the interests of science or industry, as citizens generate data for professionals through routinized labor using the latest crowdsourcing technologies and digital platforms (Mahr and Dickel, 2019). Others contend that citizen science can come at the expense of genuine collaboration, for instance when citizens' experiential knowledge about a problem is overlooked or dismissed (Gabrys, 2017), or that knowledge generated from citizen science projects too often excludes communities of color and vulnerable socio-economic groups (Mahmoudi et al., 2022). As Cooper et al. (2021) point out, in the United States participants in citizen science projects are overwhelmingly white adults, above median income, with a college degree, which effectively means that citizen science is not open to all members of society.

These criticisms are noteworthy. Not only do they signal significant limitations of citizen science, they urge us to explore the conceptions of science and citizenship at work, and to develop modes of public engagement that engage a wider array of stakeholders and communities, while facilitating reciprocal relationships between participants.

Yet, despite such shortcomings, there is also much to be said in favor of citizen science approaches in which citizens gather data for scientists or experts. Drawing on our experiences as researchers and practitioners in public engagement with science and technology, we illustrate how such approaches can be emancipatory in terms of impacting policy agendas, inciting behavioral change, and engaging hard-to-reach societal groups. Against claims that contributory citizen science is less meaningful than co-created citizen science or that it is "only about the data," we argue that contributory formats can be enabling of articulations of citizenship, social justice and democratization, particularly when they are responsive to shared problems of concern, such as ecosystem pollution, public health issues, etc. Adding to current debates about the roles of participants in citizen science (Bruckermann et al., 2022; Eckhardt et al., 2021; Haklay, 2018; Phillips et al., 2019), and combining Science and Technology Studies (STS) perspectives (Kasperowski and Kullenberg, 2019) with theories of democracy (Mutz, 2006), we propose that the future of citizen science lies in experimenting with, and combining, various modes of democratic representation, participation, and deliberation – and thus, in valuing the rich plurality of the citizen sciences.

From data collection to dialogue

Discussions about the meaning and purpose of citizen science rely on a common distinction within the citizen science literature, which differentiates between a citizen science based on contributions made by citizen-volunteers (which for the sake of simplicity, we will refer to as *contributory citizen science*), and citizen science as a form of science enacted by citizens themselves (commonly referred to as *participatory science, community-based citizen science,* or *extreme citizen science,* although other designations abound) (Eitzel et al., 2017; Haklay, 2013). Since the term citizen science came into vogue in the mid-nineties, the first conception has gained traction in the life sciences and in the media, aligning with a tradition of involving amateur scientists and lay people in scientific activities such as data collection (Bonney, 1996: 7-15). The second conception, which is often attributed to the sociologist of science Alan Irwin (1995), foregrounds the necessity of opening up science and science policy to wider publics. In recent years, it has made inroads into the life sciences, potentially expanding citizen science practices, for instance through the inclusion of citizens in the formulation of research questions and the interpretation of scientific data. As Cooper and Lewenstein (2016: 58) observe, life scientists and practitioners increasingly frame their citizen science initiatives as "democratic," thus creating overlaps between previously distinct meanings of citizen science. This has led to the development of a third term, *co-creative* citizen science, where citizens participate in all levels of a project, from designing the research question to analyzing data (Shirk et al., 2012).

Social scientists and STS scholars have been influential in shaping this language of co-creation and broad public engagement, with the aim of advancing science and technology democratization, inclusion, and social justice (Kasperowski and Kullenberg, 2019). Building on traditions of participatory action research, cooperative research, and transdisciplinary knowledge, many social studies of citizen science conclude with calls for more civic engagement, more two-way dialogue between experts and lay persons, and more co-creation generally (Senabre et al., 2021).

Herzog and Lepenies (2022: 499) provide a helpful overview of such appeals to co-creation in the social sciences and humanities literature, arguing that a deliberative approach to citizen science can help to fulfill epistemic, ethical, and political goals, whereby citizens "do not only deliver data points, but also participate in discussions about the goals and implications of research." As noted elsewhere (Van Oudheusden, 2014), such calls typically rest on a deliberative view of innovation (increasingly framed as 'co-creative') that emphasizes the active involvement of citizens in research and in processes of joint discovery and invention.

We return to the notion of deliberation (and related terms) below. For now, suffice it to point to a rhetorical shift in how citizen science is portrayed and presented: from processes of data collection and crowdsourcing (whereby organizations solicit contributions, such as data, from a large group of individuals) to citizen science along the lines of deliberation and dialogue. This shift is manifest in the way research is funded and valorized. For more than a decade now, the European Commission has structured its research funding envelopes around the principles of citizen engagement in science, echoing a strong normative commitment to co-creation and deliberation, e.g., by involving citizens "at all stages of research and innovation, from developing agendas and methods, to collecting and analysing data, through to monitoring and evaluating activities" (EC, 2022a: 2). Researchers seeking grant funding must adhere to open science principles, integrating into their research proposals procedures that involve "all relevant knowledge actors including citizens, civil society and end users in the cocreation of R&I [Research and Innovation] agendas and contents (such as citizen science)" (EC, 2022b: 37-38).

With the EU-wide move to open science, many national research and funding institutes, think tanks, and others are adopting similar policies. For instance, in its report "Moving forward together with open science," the Rathenau Institute, which is supported by the Dutch government, maintains that "public engagement is *meaningful when it contributes to the democratisation of knowledge development*" (emphasis added) (Schölvinck et al., 2021: 4). The authors of the report argue that people should "get a say in the goal of the research, its execution and their own role in it" (Schölvinck et al., 2021: 6-7). Similarly, the Organisation for Economic Cooperation and Development (OECD) contends that citizen science is "a way to *democratise* a scientific process, opening it up to everyday people, and *tapping into their motivation and curiosity to co-create and further research goals*" (emphasis added) (OECD, 2022: 42).

The language of co-creation also emerges in the (science) policies of countries that have adopted other terms than citizen science, such as participatory science or community science (so as not to exclude people who do not officially hold formal membership as citizens of a nation state). In New Zealand, the Participatory Science Platform (PSP, n.d.), which is linked to the Ministry of Business, Innovation and Employment, states on its website that "It [participatory science] *goes beyond the idea of scientists crowd-sourcing their data,* to build a *true partnership* between scientists/technologists and the broader community" (emphasis added).

The presentation of co-created citizen science along the lines of true partnerships between participants, meaningful engagement and real involvement "beyond crowdsourcing" depicts co-creation as the ultimate form of engagement in which citizens play an active role and share decision-making with participants. Deliberately or inadvertently, this imagines dialogic and co-created forms of participation as the optimal form, and consequently portrays contributory citizen science as a less-than-optimal process, at best secondary to co-creation. This framing has real-world consequences, as it informs expert judgement and shapes funding policies (especially but not exclusively in Europe; see e.g., ORION Open Science, 2019). To cite a recent article in *Nature* on community science featuring Rosy Mondardini, the managing director of the Citizen Science Center Zurich:

> …now gaining in popularity, is co-creation, in which members of the community work together with scientists from the start. Mondardini's centre advocates co-creation because the scientific literature indicates that it offers the best results for both scientists and volunteers, she says. (Dance, 2022: 642)

As Haklay (2018: 53) notes, the view that there are better and lesser forms of citizen science resonates with a longstanding theory of participation common to disciplines such as geography, environmental studies, urban studies, and public policy, among others. This theory is metaphorically presented by the participation ladder (Arnstein, 1969), where lower rungs on the ladder correspond with *nonparticipation,* middle rungs with *tokenism,* and higher rungs with *citizen power.*

Whereas the aspiration to improve citizen engagement in various stages of a citizen science process (i.e., with citizens actively involved in all stages of research) is certainly important and laudable, the suggestion that co-creation is *superior* to contributory citizen science is problematic. As we illustrate in the next section, presenting three cases from different world regions (Flanders; Uganda; New Zealand), contributory forms with limited roles for participants can be empowering for large groups of people and may even be able to generate more societal and scientific impact than small-scale deliberative frameworks. This is not to argue against co-creative citizen science (all authors are involved in co-creative projects), but to value a plurality of citizen science approaches, leaving room for different types of engagement with problems, communities, and resources.

From nosing around to tracing parasites and controlling car batteries

In 2018, a team of academics, in close collaboration with the Flemish environmental protection agency and a regional newspaper, distributed easy-to-assemble air pollution sensors to 20,000 people in Flanders (the northern, Dutch-speaking region of Belgium). For one month, volunteers took readings of nitrogen dioxide (NO_2) in their street, after which they returned the sensors to the laboratory. The campaign, dubbed *Curieuze-Neuzen/CuriousNoses* (based on a wordplay in Dutch, 'nosing around'), yielded a trove of unique scientific data on traffic-related emissions in the Flemish region. Campaign organizers used the data to validate and improve existing measurement methods and models by controlling and calibrating them with NO_2 measurements collected at official reference monitoring stations; raise critical awareness among the public and politicians of air pollution; and push for collective action for sustainable mobility and city planning (Van Brussel and Huyse, 2019). Thanks in large part to the news media, the campaign stimulated massive interest in air pollution. Following the publication of the campaign results, air quality became a major topic in the local elections, and its importance was amplified during the so-called climate strikes organized by students (Van Oudheusden and Abe, 2021). The data had judicial implications too. In October 2018, the Court of First Instance of Brussels in the case *Greenpeace v Flemish Region,* acknowledged the data collected via the CuriousNoses project as indicative measures to judge violations of Directive 2008/50 on ambient air quality and cleaner air for Europe (Misonne, 2020).

At this time of writing, follow-up projects to CuriousNoses have been initiated in Flanders and Brussels and across Europe (e.g., Ireland's Clean Air Together project, which is modelled on CuriousNoses). One reason why the CuriousNoses projects are successful is that they spring from communal concerns such as air pollution and tackle these issues by way of society-wide mobilization. Project initiators forge ties with vested knowledge networks, comprising scientists, authorities, and the media– thus acting as concerned scientists, who join forces with various groups such as policy experts, non-governmental organizations, and protest movements. In this way, they seek to advance a 'strategic' type of citizen science that is able to create both scientific and societal impact by using relatively simple technologies and by leveraging the power of big data to produce scientific data on a mass scale, which formal institutions must then take seriously.

As a second case, we turn to Uganda, where in 2019 a multidisciplinary group of university researchers (biologists, epidemiologists, geographers) launched a pilot study by the name of ATRAP (Action Towards Reducing Aquatic Snail Borne Parasitic Diseases). The project sought to explore key aspects in the development of a citizen science framework to monitor snail hosts that transmit schistosomiasis and fasciolosis – two tropical parasitic diseases that pose a major burden on public and veterinary health, respectively. The aim was to use these data to support local targeted snail control measures in remote, resource-limited environments. To this end, researchers trained 25 citizen scientists to report on snail host abundances in predefined water contact sites in and around Lake Albert on a weekly basis. As described by Brees et al. (2021), the selected volunteers recorded and submitted georeferenced data on snail counts, basic water chemistry parameters, and photographs of the identified snails using a freely available mobile phone application. After submission to a central server, a semi-automatic validation flagged faulty reports. Regular feedback was provided by WhatsApp and in person visits, with a refresher training organized on a yearly basis.

Similar to the CuriousNoses case, ATRAP initiators used a highly structured data-collection protocol and a directed citizen scientist recruitment strategy both to maximize scientific output and to tackle the issue at hand. The snail sampling activity has also proven useful to raise awareness of schistosomiasis among communities and to develop preventive public health strategies, for instance through the placement of signposts near high transmission sites. They may spur other activities for, or with, local communities; a point to which we return shortly.

To conclude this section, we consider a third, distinct case by the name of Flip the Fleet (flipthefleet.org), originating in New Zealand. This project is driven by a small, dedicated group of car owners, businesspersons, and data scientists seeking to build a future for electric transport by accelerating the uptake of electric vehicles (EVs). EV owners provide monthly records on their car's distance travelled, efficiency, charging patterns and average speed. At the time of writing, 645 EV drivers have signed up since the testing phase of the project began in July 2016, followed by a public launch in 2017.

Apart from generating scientific data on EV use, cost savings, battery health and environmental impacts, project initiators seek to inform the debate on the use of Low Emission Vehicles in New Zealand. As indicated on the FtF website, they want to create conditions "so that business investment in infrastructure, public policy and our own choices maximize the benefits and pleasure of EV ownership." According to project initiators, this debate about EV uptake is presently underway in New Zealand.

Due to the technical complexity of the IT development and design, Flip the Fleet was initially construed as a contributory citizen science project driven by three citizen-consumers, with other participants contributing data or sharing their stories. However, with time test drivers became more involved, providing advice on ways to enable more participant feedback throughout the data-gathering process. Presently, more local, co-created projects are being tested, suggesting that a contributory citizen science setup may prompt collaborative and deliberative citizen science approaches.

Developing a louder voice

These three examples illustrate the emancipatory potential of contributory citizen science in which experts, scientists, or academics design the experiment and then ask volunteers to help. Emancipation here comes in various forms. In the CuriousNoses case, resident groups and municipalities drew on the campaign's findings to push for tighter traffic pollution policies in cities and many citizens changed their behaviors; for instance, by adopting more sustainable modes of commuting to work, such as by bike (Huyse et al., 2019). As conveyed to us by a government advisor, even conservative Flemish policymakers, habitually opposed to environmental policies and at best indifferent to citizen participation, acknowledged the need to take into account the CuriousNoses campaign.

The ATRAP project served as a proof of concept to upscale snail sampling and address the pressing need for more accurate data on the incidence and spread of schistosomiasis among local populations. In western Uganda, several of the citizen scientist volunteers who participated in ATRAP are deferentially referred to as "Doctor of Water" or "Snail Doctor" by fellow community members. Thanks to this newly acquired status, one of the citizen scientists is now actively involved in community politics. As a pilot study, ATRAP can facilitate the uptake of citizen science in other parts of Africa (Ashepet et al., 2021), including in Chad, where a second citizen science project modelled on ATRAP is now underway.

In New Zealand, Flip the Fleet empowered consumers to make better car purchasing decisions, as car dealers reported "a highly informed clientele that bring FtF charts to the negotiating table" (Love et al., 2018). The initiative also helped citizens to challenge the political and economic drivers for energy and transport investment in ways that are more conducive to LEV uptake, by sharing with citizen-consumers hard data and accessible instruments to demand attention for a challenge that is simultaneously societal, economic, and environmental.

The emancipatory implications described here are far from exhaustive; nor are they unique (see e.g., Cooper, 2017: 192; Cooper and Lewenstein, 2016; Haklay, 2018). But it is well worth spelling them out in light of calls for true, co-creative partnerships, meaningful engagement, and real involvement beyond crowdsourcing. Whereas civic deliberation about scientific research agendas and processes is a necessary component of democratic decision making, a too singular focus on co-creation risks ignoring that not all citizens have the time, resources, or commitment to participate in full, and that participatory engagement inevitably raises questions of strategizing and power. To paraphrase Wesselink and Hoppe (2011), processes of public participation are not only about 'puzzling' (i.e., dialogue) but also about developing effective strategies to make one's voice heard ('powering'). In pluralistic societies, where parties are asymmetrically positioned to begin with, some actors, settings, and knowledges take primacy over others, due for instance to conflicting norms of evidence testing and public persuasion. This explains why, in the CuriousNoses project, initiators deliberately used scientifically validated methods and protocols, enabling shared measurement and observation by experts and nonexperts alike, as a mechanism to gain credibility with scientists and policymakers. By involving research institutes and governmental agencies in the air pollution campaign and by using the data to validate and improve existing measurement models, the data could not be dismissed as irrelevant, and even became directly useful to experts. Although this approach leaves little to no room for alternative data collection techniques and data valuation *in situ* (Tengö et al., 2021), it can be a powerful tool for the design of new evidence-based policies supported by citizen participation, while spurring public debate about questions of 'livability,' environmental sustainability and social justice (Huyse et al. 2019). It is doubtful that the project would have been taken seriously by formal institutions (e.g., policy agencies) or advanced as quickly and effectively without mass-scale participation in which ordinary citizens played a contributing role as data collectors rather than as agenda setters or co-creators.

This observation brings us to the question of representation (i.e., when actors speak, advocate, and act on behalf of others in the political arena) and the place it occupies alongside deliberation and participation in contemporary democracies. Although the two latter terms are often used interchangeably in citizen science and STS literatures, it is fruitful to distinguish between them. Following Mutz (2016: 3), deliberation relies on joint reflexive-critical debate in which interlocutors listen to others and probe their own assumptions for the sake of mutual learning and collaboration. Like co-creation, it is oriented towards building understanding between various groups and interests. By contrast, participation refers to the mobilization of resources by likeminded individuals and groups as partisans in order to impact policy. Participation in this sense is about engaging people in decision-making processes and empowering them to have a voice in the decisions that affect their lives.

We contend that all three types of engagement should play a role in a pluriverse of contending and unequal stakes, data, technologies, and institutions. Pushing the argument further, we suggest that mass participation with citizens acting as "mere data points" (rather than fully engaged deliberators) can be highly effective in spurring policy change, behavioral change, and in reaching a wide range of actors, including members of ethnic, racial, and socioeconomic minorities. This is because a low-threshold technology (relatively cheap, easy-to-assemble, autonomous, intuitive) significantly lowers the barrier for such groups to get involved. To again take the example of CuriousNoses, a simple NO_2 test tube attached to a home window yielded a mass of valuable scientific data without consuming too much of participants' time and energy, while also creating a sense of anticipation and a joint purpose.

Providing people with easy-to-use tools that enable mass-scale measurement and rapid data accumulation and processing is not antithetical to meaningful engagement; it is an important step in tackling grand societal challenges such as environmental pollution or climate change (Mahajan et al., 2020). In other words, again drawing on Mutz's distinctions between forms of democratic engagement, citizen science requires representation alongside participation and deliberation. If citizen science is to develop a louder, stronger voice in a world where every problem and person is vying for public attention 24/7, citizen scientists must be prepared to delegate their voices and data to spokespersons and technologies that speak and act on their behalf and in their interest.

We again emphasize that we are not arguing against co-creation as an important, potentially promising approach to citizen science, but against the idea that co-creation is essential for true and meaningful participation to occur and is what we should, in principle, always strive for. Our interest as citizen science scholars, sympathizers, and participants should lie in exploring how various forms can co-exist and mutually inform one another in the interest of generating forms of productive engagement with diverse groups and cultivating varied ways of knowing and acting. A good way to start is to pluralize the notion of citizen science; i.e., to speak of *citizen sciences* (Strasser et al., 2018). When we begin to appreciate the citizen sciences as many, we are better positioned to do justice to diversity and difference. To do this, we should analyze all citizen sciences – including top-down, contributory forms – as constantly moving practices with the potential for transformation and even radical change. We feel this outlook deserves to be given more attention in areas of scholarship and policy that advocate for deliberative forms of engagement as the best way forward. As we have sought to illustrate, low-level, contributory citizen science can be more than a convenient crowdsourcing practice; it can, in certain contexts and under the right conditions also be democratic and empowering.

A plea for pragmatism

As communities and problems require different forms of engagement and different problem-solving strategies, it is clear that a one-size-fits-all approach will not work. Thus, rather than promote one, norm-defining citizen science model, we would do well to think together seemingly opposing ideals, such as *mass citizen participation versus citizen empowerment*, and *representation versus participation or deliberation*. Our plea then, is for a pragmatic engagement with problems, data, technologies, participation, infrastructures, and the citizen sciences, acknowledging that there are various enactments of citizen science "out there." From this perspective, the most important questions to ask at the start of any citizen science process are: What is the problem or challenge? For whom and why? What kind of change do parties envisage: Scientific, societal, systemic? The language of co-creation typically singles out the level of stakeholder participation as the primary dimension against which to appraise (or from the perspective of a funder, *evaluate*) a citizen science project or process, without sufficient consideration for the types of change originators are seeking to achieve and the impacts citizen science processes are likely to have beyond the remit of civic engagement. Contributory citizen science may, for instance, initiate sustainability transitions in areas such as public health, environmental conservation, or renewable energy. Systemic (macro) change of this kind deserves to be given more consideration when thinking about the role of citizen science in science and society, as do the micro and 'meso' practices of participation or deliberation. Research (e.g., Forrester, 1999: x) shows that in participatory processes, participants not only make meaning for themselves but also enact complex relationships of power, for example, by setting their own agendas. Not only does this suggest that categories of participation cannot be easily separated in practice, but that we should imagine and where possible, artfully weave together different approaches rather than limit ourselves to one mode.

This, we argue, is the best way to avoid, curtail, or manage risks inherent in contributory citizen science processes, such as the risk that aggregating data provided by volunteers is instrumentalized by powerful actors under the guise of opening and democratizing science (Blacker et al., 2021); or the danger that contributory citizen science becomes a one-way consultation (a 'tick box' activity) that strengthens the 'neoliberalization' of science with citizens doing routinized labor for economic reasons (Vohland et al., 2019). Our interest as scholars, practitioners and sympathizers should lie in opening up the various possibilities, albeit in a realistic manner, by carefully considering what is possible in a given context, due for instance to limited time constraints and acknowledging that contributory citizen science remains the dominant citizen science approach across the globe, by far. As the examples in this paper illustrate, citizen science projects initiated by experts can have decisive impacts in ways that benefit both science and society. These projects may spark or sustain various forms of civic engagement and should be understood within broader processes of change, of which citizen science is but a subset. Deliberation can be a viable option in such processes, as can participation and representation. Alongside co-creative citizen science initiatives, we need broad participatory approaches that bring specific concerns into the public arena and that enable the processing of big data on a scale that would otherwise be impossible. This is a more top-down design than a deliberative forum, but it has significantly more reach, which is one of the greatest assets of citizen science that seeks to be a force for positive, society-wide change.

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References

Arnstein SR (1969) A ladder of citizen participation. *Journal of the American Institute of Planners* 35(4): 216-224.

Ashepet MG, Jacobs L, Van Oudheusden M and Huyse T (2021) Wicked Solution for Wicked Problems: Citizen Science for Vector-Borne Disease Control in Africa. *Trends in Parasitology* 37(2): 93-96. Epub 2020 Nov 3. PMID: 33158719. DOI: 10.1016/j.pt.2020.10.004.

Blacker S, Kimura AH and Kinchy A (2021) When citizen science is public relations. *Social Studies of Science* 51(5): 780-796. DOI: 10.1177/03063127211027662.

Bonney R (1996) Citizen science: A Lab Tradition. *Living Bird* 15: 7-15.

Brees J, Huyse T, Tumusiime J, et al. (2021) The Potential of Citizen-Driven Monitoring of Freshwater Snails in Schistosomiasis Research. *Citizen Science: Theory and Practice* 6(1): 18. DOI: 10.5334/cstp.388.

Bruckermann T, Greving H, Stillfried M, Schumann A, Brandt M and Harms U (2022) I'm fine with collecting data: Engagement profiles differ depending on scientific activities in an online community of a citizen science project. *Plos one 17*(10): e0275785. DOI: 10.1371/journal.pone.0275785.

Cooper CB (2017) *How Ordinary People are Changing the Face of Discovery*. London: Duckworth/Overlook.

Cooper C and Lewenstein B (2016) Two Meanings of Citizen Science. In: Cavalier D (ed) *From The Rightful Place of Science: Citizen Science. A series by the Consortium for Science, Policy, and Outcomes*. Phoenix: Arizona State University Press, pp. 51-62.

Cooper CB, Hawn CL, Larson LR et al. (2021) Inclusion in citizen science: The conundrum of rebranding. *Science* 372(6549):1386-1388. DOI: 10.1126/science.abi6487.

Dance A (2022) Community science draws on the power of the crowd. *Nature*, 12 September. Available at: http://dx.doi.org/10.1038/d41586-022-02921-3 (accessed 28 January 2023).

Eckhardt J, Kaletka C, Krüger D, Maldonado-Mariscal K and Schulz AC (2021) Ecosystems of co-creation. *Frontiers in sociology* 6: 642289. DOI: 10.3389/fsoc.2021.642289.

Eitzel MV, Cappadonna JL, Santos-Lang C et al. (2017) Citizen Science Terminology Matters: Exploring Key Terms. *Citizen Science: Theory and Practice* 2(1): 1. DOI: 10.5334/cstp.96.

European Commission (EC) (2022a) *CORDIS Results Pack on citizen science: Inspiring examples of societal engagement for Horizon Europe*. Luxembourg: Publications Office of the European Union, 2017: European Commission. Available at: http://publications.europa.eu/resource/cellar/26c8a71d-bb98-11ec-b6f4-01aa75ed71a1.0001.04/DOC_1 (accessed 28 January 2023).

European Commission (EC) (2022b) *Horizon Europe (Horizon): Programme Guide.* Available at: https://ec.europa.eu/info/funding-tenders/opportunities/docs/2021-2027/horizon/guidance/programme-guide_horizon_en.pdf (accessed 28 January 2023).

Forrester J (1999) *The Deliberative Practitioner. Encouraging Participatory Planning Processes.* Cambridge: MIT Press.

Gabrys J (2017) Citizen sensing, air pollution and fracking: From 'caring about your air' to speculative practices of evidencing harm. *The Sociological Review* 65(2_suppl): 172-192. DOI: 10.1177/0081176917710421.

Haklay M (2013) Citizen Science and Volunteered Geographic Information: Overview and Typology of Participation. In: Sui D, Elwood S and Goodchild M (eds) *Crowdsourcing Geographic Knowledge*. Dordrecht: Springer, pp. 105-122.

Haklay M (2018) Participation in Citizen Science. In: Hecker S, Haklay M, Bowser A, Makuch Z, Vogel J and Bonn A (eds) *Citizen Science: Innovation in Open Science, Society and Policy*. London: UCL Press, pp. 50-62.

Herzog L and Lepenies R (2022) Citizen Science in Deliberative Systems: Participation, Epistemic Injustice, and Civic Empowerment. *Minerva* 60(4): 489-508. DOI: 10.1007/s11024-022-09467-8.

Huyse H, Bachus K, Merlevede T, Delanoeije J and Knipprath H (2019) *Societal impact of the citizen science project "CurieuzeNeuzen Vlaanderen".* Report, HIVA—Research Institute for Work and Society, Belgium.

Irwin A (1995) *Citizen science: a study of people, expertise and sustainable development.* New York: Routledge.

Kasperowski D and Kullenberg C (2019) The many modes of citizen science. *Science & Technology Studies* 32(2): 2-7. DOI: 10.23987/sts.74404.

Love D, Moller H, Ivanov D and Myall D (2018) Using citizen science to promote electric vehicle uptake in New Zealand. *Flipthefleet.org.* Available at: https://flipthefleet.org/wp-content/uploads/2018/10/EVS31-ID5437-FlipTheFleet-June29.pdf (accessed 28 January 2023).

Mahajan S, Kumar P, Pinto JA, Riccetti A, Schaaf K, Camprodon G, Smári V, Passani A and Forino G (2020) A citizen science approach for enhancing public understanding of air pollution. *Sustainable Cities and Society* 52: 101800. DOI: 10.1016/j.scs.2019.101800.

Mahmoudi D, Hawn CL, Henry EH, Perkins DJ, Cooper CB and Wilson SM (2022) Mapping for whom? Communities of color and the citizen science gap. *ACME* 21(4): 372–388.

Mahr D and Dickel S (2019) Citizen science beyond invited participation: nineteenth century amateur naturalists, epistemic autonomy, and big data approaches avant la lettre. *History and philosophy of the life sciences* 41(4): 1-19. DOI: 10.1007/s40656-019-0280-z.

Mirowski P (2017) Against citizen science. *AEON,* 20 November. Available at: https://aeon.co/essays/is-grassroots-citizen-science-a-front-for-big-business (accessed 28 January 2023).

Misonne D (2021) The emergence of a right to clean air: Transforming European Union law through litigation and citizen science. *Review of European, Comparative & International Environmental Law* 30(1): 34-45. DOI: 10.1111/reel.12336.

Mutz D (2006) *Hearing the Other Side: Deliberative Versus Participatory Democracy.* Cambridge, MA: Cambridge University Press.

Organisation for Economic Co-operation and Development (OECD) (2022) *OECD Guidelines for Citizen Participation Processes*. Paris: OECD Publishing. DOI: 10.1787/f765caf6-en.

ORION Open Science (2019) *Co-creation*. Available at: https://www.orion-openscience.eu/activities/co-creation (accessed 28 January 2023).

Participatory Science Platform (PSP) (n.d.) Ministry of Business, Innovation & Employment. Available at: https://www.mbie.govt.nz/science-and-technology/science-and-innovation/funding-information-and-opportunities/investment-funds/curious-minds/participatory-science-platform/ (accessed 28 January 2023).

Phillips TB, Ballard HL, Lewenstein BV and Bonney R (2019) Engagement in science through citizen science: Moving beyond data collection. *Science Education* 103(3): 665-690. DOI: 10.1002/sce.21501.

Schölvinck AFM, Scholten W and Diederen PJM (2021) *Samen verder met open science – Op weg naar betekenisvolle publieke betrokkenheid bij onderzoek* [Moving forward together with open science: Towards meaningful public engagement with research]. Report, Rathenau Institute, The Netherlands. Available at: https://www.rathenau.nl/sites/default/files/2021-02/Samen_verder_met_open_science_Rapport_Rathenau_Instituut.pdf (accessed 28 January 2023).

Senabre Hidalgo E, Perelló J, Becker F, Bonhoure I, Legris M and Cigarini A (2021) Participation and co-creation in citizen science. *Chapter 11.* In: Vohland K, Land-zandstra A, Ceccaroni L et al. (eds) *The Science of Citizen Science.* Cham: Springer Nature, pp. 199-218. DOI: 10.1007/978-3-030-58278-4.

Shirk JL, Ballard HL, Wilderman CC et al. (2012) Public participation in scientific research: a framework for deliberate design. *Ecology and Society* 17(2): 29. DOI: 10.5751/ES-04705-170229.

Strasser BJ, Baudry J, Mahr D, Sanchez G and Tancoigne E (2019) 'Citizen Science'? Rethinking Science and Public Participation. *Science & Technology Studies* 32(2): 52–76. DOI: 10.23987/sts.60425.

Tengö M, Austin BJ, Danielsen F and Fernández-Llamazares Á (2021) Creating synergies between citizen science and Indigenous and local knowledge. *BioScience* 71(5): 503-518. DOI : 10.1093/biosci/biab023.

Van Brussel S and Huyse H (2019) Citizen science on speed? Realising the triple objective of scientific rigour, policy influence and deep citizen engagement in a large-scale citizen science project on ambient air quality in Antwerp. *Journal of Environmental Planning and Management* 62(3): 534-551. DOI: 10.1080/09640568.2018.1428183.

Van Oudheusden M (2014) Where are the politics in responsible innovation? European governance, technology assessments, and beyond. *Journal of Responsible Innovation* 1(1): 67-86. DOI: 10.1080/23299460.2014.882097.

Van Oudheusden M and Abe Y (2021) Beyond the grassroots: Two trajectories of "citizen sciencization" in environmental governance. *Citizen Science: Theory and Practice* 6(1): 1-15. DOI: 10.5334/cstp.377.

Vohland K, Weißpflug M and Pettibone L (2019) Citizen science and the neoliberal transformation of science–An ambivalent relationship. *Citizen Science: Theory and Practice* 4(1). DOI: 10.5334/cstp.186.

Wesselink A and Hoppe R (2011) If post-normal science is the solution, what is the problem?: The politics of activist environmental science. *Science, Technology, & Human Values* 36(3): 389-412. DOI: 10.1177/0162243910385786.

"Should We Stay or Should We Go Now?" Dis/Engaging with Emerging Technosciences

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Abstract

In this paper we focus on a special feature of science and technology studies: the trajectories of our engagement with 'emerging technosciences'. Many of us entertain close links to a particular group of scientists; our scholarly careers and identities build around thematic specialisations, trans-field collaborations and convivialities. But more often than not, such engagement does not last a whole career. With every new technoscientific hype, scholars are pressed to 'move on', to disengage from one field and re-engage with another. It thus seems warranted to explicitly reflect on the temporal patterns of dis/engagement and to look at possible ramifications for individuals, collectives, and the innovation system at large. To inform such reflection, we opted for a mixed-methods approach, tracing patterns and moments of dis/engagement across various disciplines based on scientometric analysis, individual archaeologies of engagement, a qualitative survey, and a focused discussion among fellow scholars from the social sciences and humanities as well as the sciences. Our analysis brings distinct dis/engagement patterns to the fore, relating to disciplinary affiliations as well as career stages. In our conclusion, we discuss the relevance of these findings for science and technology studies scholars and technoscientists as well as for contemporary innovation regimes more generally.

Keywords: Systems Biology, Dis/Engagement, Interdisciplinary Collaboration, Disciplinary Identity, Scientific Community, Innovation Regime.

Introduction

Practicing Science and Technology Studies (STS) comes with the necessity to bridge, in one way or another, the boundaries between social sciences and humanities (henceforth: SSH) and various science and engineering fields (henceforth: TS for technoscience).[i] Interdisciplinary cooperation between SSH and TS has consequently been an important topic of reflection. Various collaborative constellations have been accounted for, from early laboratory studies that "manage[d] to get inside the laboratory walls and show that there too was a political world of negotiated or coerced pacts to get along in the accepted ways, to see what should be seen" (Doing, 2007: 279), to the introduction of 'ELSI research'. This research into the Ethical, Legal and Social Implications (ELSI) of technoscience came with an advisory remit. It has been followed by co-constructive 'post-ELSI' and 'Responsible Research and Innovation' (RRI) programmes, intervening more upstream in science and engineering research and education. STS scholars have extensively discussed these modes of SSH/TS interaction, considering roles and power regimes within collaborative work and methods of 'collaboration as method' in its own right. But while the overarching collaborative trends between SSH/TS have been well outlined and questions of how we collaborate (Prainsack et al., 2010) or how we should collaborate (e.g., Balmer et al., 2015) in single interdisciplinary projects have been well addressed, the overarching dynamic of engagement and disengagement represents a largely unexplored aspect of STS. How and why do individual scholars and scholarly collectives engage with a particular hyped field and, in turn, how and why do they dis/engage again?

In this contribution, we explicitly reflect on the temporal patterns of dis/engagement beyond the single project and look at their ramifications for individuals, collectives, and the innovation system at large. Other than micro-studies that mostly highlight differences between and opposition of TS and SSH, pertaining to power asymmetries, role divisions, and communication barriers, this wider horizon can serve to identify the recurring requirements of engagement and disengagement. It focusses on the potentially similar challenges for scholars from both realms and acknowledges that TS and SSH scholars ultimately collaborate within the same innovation regime, even if belonging to different epistemic cultures (Snow, 1961) or engaging with different societal functions and visions.

A discussion of TS/SSH collaboration within this broader context allows us to benefit from existing analyses of general change in academia or change in innovation regimes. Literature includes the outline of a transition from Mode 1 to Mode 2 science (Gibbons et al., 1994), from normal to post-normal science (Funtowicz and Ravetz, 1993), from academic to post-academic science (Ziman, 2000), and to strategic science (Rip, 2002) or technoscience (Forman, 2007). It resonates with diagnoses of change in university organisations and cultures in higher education research towards the 'managerial' or 'entrepreneurial' university (e.g., Slaughter and Leslie, 1997) and with findings from science policy studies. Various analyses highlight changes in funding schemes – the "transition from exclusive block funding of universities and research organisations to a split funding mode of block funding and competitive grant funding" (Laudel, 2023: 74; see also Gläser and Laudel, 2016) – and funding rationales, reassessing the relative worth of pure research, financial returns, and societal benefits (see also Wallace and Rafols, 2015). It discusses the formative power of discourse in science policy – including 'buzzwords' (Bensaude Vincent, 2014), 'big words' (Bos et al., 2014), and 'umbrella terms' (Rip and Voß, 2013) – as well as resulting hype cycles (Seifert and Fautz, 2021). General systemic tendencies point towards increased (interdisciplinary) collaboration, future-orientedness, fluidity, reactivity, and speed.

To research the temporal patterns of dis/engagement with a view to both the micro- and macro-perspectives outlined above, we chose a mixed-methods approach, targeting the empirical case of systems biology as an exemplar of an 'emerging technoscience'. Established around 2000 as a prominent field of innovation with substantial support from dedicated funding programmes (Kastenhofer et al., 2012), systems biology immediately started to attract attention from science and technology studies scholarship. This attention seems to have waned again in the past years – a hypothesis we wanted to test in quantitative terms. Moreover, with a full cycle of engagement and disengagement, the case is suited for investigating both these movements in qualitative terms, reconstructing the trajectories, experiences, and perspectives of scholars as they either embraced or distanced themselves from this field.

After a more detailed presentation of prevalent perspectives on collaboration and engagement in STS and a delineation of systems biology as an empirical case in the next two sections of this paper, we will retrace the temporal patterns of engagement and disengagement in quantitative terms, by considering topical publications over time and per discipline. Consecutively, we will present qualitative research results that cover trajectories of dis/engagement for individual scholars: starting with our own histories with systems biology, we move on to delineate narrations collected from a broader variety of scholars. We analyse factors for engaging, staying, and disengaging with systems biology and sketch distinct narratives of dis/engagement while also discussing differences and similarities across various disciplines. In our conclusion, we more generally address the relevance of these patterns of dis/engagement for our understanding of ELSI activities and for contemporary innovation regimes.

Science and technology studies' perspectives on collaboration and dis/engagement

There are at least four ways science and technology studies scholarship can be related to engagement. Firstly, anthropologists of science have stressed the affective dimension of scholarly work and the 'engaged habitus' of academic scholarship. Being in academia comes with an expectation of also being emotionally invested. Already in 1942, Merton referred to the "passion for knowledge, idle curiosity, altruistic concern with the benefit of humanity and a host of other special motives" attributed to the scientist and sought their origin in "a distinctive pattern of institutional control" (Merton, 1942: 124). Passion and personal engagement are again on the agenda with the recent turn of STS to the affective dimension (e.g., Schönbauer, 2021; Davies, 2021). Secondly, STS has been presented as an 'engaged programme'. Sismondo (2007) builds on this notion to address "the part of STS that focuses on reform or activism, critically addressing policy, governance, and funding issues, as well as individual pieces of publicly relevant science and technology; it tries to reform science and technology in the name of equality, welfare, and environment" (Sismondo, 2007: 13). Thirdly, STS has become a 'programme of engagement' with the participatory turn in technoscience governance around 2000, aiming to engage publics in technoscientific as well as political decision-making. And, fourthly, practising STS requires a certain engagement with the technosciences, their literatures, practices, cultures, communities, institutions, and individual scientists. In the following, we will focus on this fourth variant of addressing engagement in the context of STS as it is directly relevant for our case, while keeping in mind the other three forms of addressing engagement.

Engagement with technoscience is built into the very programme of STS. For a long time, modes of engagement were mostly the topic of methodological reflections – of how to do sound laboratory ethnography and navigate between 'the field' and one's own disciplinary home. Although the early laboratory studies' epistemological aspirations had resulted in fierce debates between positivist and constructivist camps, they did not yet trigger systematic reflections about STS' relations with the technosciences. This situation changed when STS entered more public and overtly political arenas in the late 1990s and scientists and SSH scholars became more visibly juxtaposed. In the wake of the 'Sokal affair' of 1996, Hacking (1999) scrutinised the multiplicity of roles of constructivist STS scholars. In parallel, public critique of governmental response to the BSE crisis in Great Britain and public controversy regarding agro-biotechnology regulations in Europe triggered a shift in the technoscience governance paradigm. Along a new ELSI programmatic, major technoscientific funding initiatives like the Human Genome Project started to integrate research into social dimensions on a regular basis. Transparency, participatory decision-making, and scrutiny of potential side effects of technoscientific innovation became core components of responsible innovation policy. Scholars analysed the new role sets of STS when publicly entrusted with advisory as well as integrative functions, such as designers, organisers, moderators, evaluators, or commentators in public consultation exercises (Hoppe, 2005; Gisler and Schicktanz, 2009; Bauer and Kastenhofer, 2019). Overall, collaboration, "nearly always imbued with a positive connotation in the late twentieth and early twenty first centuries" (Shrum, 2010: 247), became more scrutinised by STS scholars, including interdisciplinary collaboration (Frickel et.al., 2016).

This critical view is echoed in empirical analyses of STS engagement with technoscience. Studies focus on power asymmetries between collaborating TS and SSH scholars (e.g., Rabinow and Bennett, 2012) and intricacies of scholars' political engagement (e.g., Hackett and Rhoten, 2011). As a result of engagement challenges, STS scholars now suggest the establishment of dedicated collaborative spaces for RRI (Carter and Mankad, 2021; Flipse et al., 2014) and a 'post-ELSI' collaboration agenda (Calvert and Martin, 2009; Balmer et al., 2015). Yet others focus less on the strategic and political aspects of SSH/TS collaboration. Instead, they use anthropological perspectives to delineate practices of affective companionship and care (Mol, 2008; Puig de la Bellacasa, 2011; Adam and Groves, 2011; Viseu, 2015), entanglement (Fitzgerald and Callard, 2015), and attachment (Smolka et al., 2021; de Laet et al., 2021) and thus contribute to what Law and Ruppert (2016) grasped as more 'baroque' conceptions of knowing. Two foci of this work take a prominent place in our own analysis and shall thus be highlighted here: a focus on the affective dimension and a focus on the temporal dimension of engagement.

The temporal dimension of STS work has is addressed by Felt (2016) with a view to the 'temporal choreographies of [public] participation'. Building on Mol's (2008) distinction of a 'logic of choice' versus a 'logic of care', she notes that:

> [p]olicy-makers appear to be quite attached to the idea that there is an ideal moment in the developmental trajectory when sociotechnical issues can be assessed once and for all; after that 'moment of engagement', research should be left on its own again. (Felt, 2016: 192)

Felt's analysis opposes this idea of a production-line of new technoscience certified for societal acceptance via punctual engagement exercises, while advocating for "a wider process of caring" (Felt, 2016: 192?). A recent volume edited by Vostal (2021a) further analyses rhythmic patterns in contemporary academic 'timescapes' diagnosing a "further and tighter approximation, if not a merge, of cultures/practices of variations of capitalism in academia" (Vostal, 2021b: 2), including a 'will to speed'. In this volume, Felt's chapter addresses the power dimension of "the regulation of rhythms, duration, speed, sequencing, and the synchronisation of events and activities" (Felt, 2021: 79–80), but also speaks to the deep affective/collaborative entrenchment of temporal(ised) practices via 'chronosolidarity' and moments of collectivised resistance and repair work.

This leads us to the second focus we want to briefly elaborate here: A rising interest in affects and emotions in STS analyses of scientific collaboration, furthering our understanding of the socio-psychological aspects of dis/engagement. Smolka et al. (2021: 1076) have illustrated how "attending to affective disturbances can open up possibilities for productive engagements across disciplinary divides" (see also Hillersdal et al., 2020). Scholars have highlighted the 'affective costs' of SSH/TS collaborations (Viseu, 2015) and – once again – the power dimension of 'feeling rules' (Smolka et al., 2021 in reference to Hochschild 1979). Yet others have delineated positive effects of affect, as "hot spots and hot moments" can fuel a collaborative group's scientific performance and drive a "scientific and intellectual social movement" (Parker and Hackett, 2012: 21). But overall, these scholars attended to the affective dimension of specific collaborations rather than to the affective dimension of dis/engagement beyond the single project.

To explore the temporal and affective aspects of SSH/TS collaborations, we consider a further strand of STS discourse: analyses of the contemporary innovation regime, its institutional ecosystem, and its governance practices. We particularly want to highlight the rising importance of competitive third-tier research funding and the rising share of so-called strategic or mission-oriented funding programmes. This twofold shift has influenced not only research topics and approaches but also the mechanisms and patterns of innovation in academia. In fact, it has brought about the very phenomenon of 'emerging technosciences' (e.g., Raimbault and Joly, 2021) and the related discursive logics, lobbying networks, and promissory practices (Hedgecoe and Martin, 2003; Brown and Michael, 2003; Schyfter and Calvert, 2015; Kreimer, 2022). In the following section, we shortly illustrate how these aspects of the contemporary innovation regime relate to our empirical case of systems biology.

Engaging with systems biology as an emerging technoscience

The emergence of systems biology dates back more than twenty years.[ii] Systems biology has been defined in scientific textbooks as "the combined study of biological systems through (i) investigating the components of cellular networks and their interactions, ii applying experimental high-throughput and whole genome techniques, and (iii) integrating computational methods with experimental efforts" (Klipp et al., 2009: XVII). Other texts put more emphasis on its epistemic theme rather than on the interdisciplinary epistemic practice by stating that "[s]ystems [b]iology indeed consists of a number of related, well-defined topics, […] all focusing on the mechanisms behind the emergence of functionality" (Alberghina and Westerhoff, 2008: 7) or on its paradigmatic approach, defining systems biology as an attempt "to understand at the system level biological systems that are composed of components revealed by molecular biology" (Kitano, 2001: 1).

The considerable effort invested in defining and demarcating systems biology as a distinct approach or field hints at the strategic importance of such practices. Systems biology's (stated) newness required establishing its identity and thus facilitating effective communication and collaboration within academia. Furthermore, systems biology had to be presented as a unique strand of research by demarcating it from other scientific paradigms, networks, and activities so as to secure dedicated research funds. Or, in the words of two leading systems biology proponents: "A definition can help to identify a new era of science where there is much potential for progress. It can also help direct research effort to where it should be rather than continuing to be spent on the same topics but under a new name." (Alberghina and Westerhoff, 2008: 7). Thus, the pursuit of defining systems biology was linked to distinct features and constellations of the contemporary innovation regime. Definitions served as a medium for boundary work (Gieryn, 1983; Star and Griesemer, 1989) both in a negative sense (allowing for distinguishing systems biology proper from competing approaches) as well as in a positive sense (allowing for identification and engagement of a variety of actors across science, policy, and industry).

Definitions of systems biology also relate to timelines of development. 'New' systems biology was differentiated from earlier systems-level approaches in biology (Herring and Radick, 2019). It was depicted as a quasi-logical further development of molecular biology or genomics driven by big data ('post-genomics'), as a convergence of previously isolated disciplinary approaches, or as a means to achieve specific aims, such as developing whole-cell in-silico models. Systems biology was showcased as both the result of radical change as well as incremental development, as "new and not new at the same time" (Alberghina and Westerhoff, 2008: 4), "still in its infancy" (Kitano 2001), or "still evolving" (Klipp et al., 2009: XVIII). Finally, presentations of systems biology came with distinct affective aspects, highlighting its revolutionary potential, its epistemic uniqueness (e.g., a holistic approach), and its young, open-minded and collaborative spirit, uniting 'wet' and 'dry' specialities. All these temporal and affective attributions were likely to influence engagement with systems biology for both technoscientists as well as STS scholars.

Moreover, systems biology scholars explicitly invited SSH scholars to join efforts to define and better understand systems biology, starting multidisciplinary discussions (Boogerd et.al., 2007; Green, 2017). Dedicated systems biology funding programmes made room for ELSI research. The strong role of dedicated funding blurred customary demarcations like the ones between scientific research, scientific meta-discourse, and lobbying for science further. It also dulled the distinctions between scientists, science studies scholars, and science policymakers. All became enjoined in one cross-disciplinary and cross-sectoral scientific/intellectual movement (Frickel and Gross, 2005) that hinged on the labelling of systems biology.iii At the same time, new boundaries between 'systems biology proper' and 'not-yet systems biology' were established and enacted. National differences in dedicated funding resulted in in different ways of organising systems biology research (Vermeulen, 2018) and in different levels of engagement by local scientific communities (Kastenhofer et al., 2012).

Methodology

To research scales, patterns, and ramifications of dis/engagement with(in) systems biology, we opted for a mixed-methods approach that combined quantitative, self-reflexive, and qualitative experimental methods in three consecutive steps. Our first aim, to get an overview of the temporal patterns of dis/engagement per discipline, translated into a search for indexed publications that addressed systems biology. Such exercises have already been performed for technoscience publications and we could build upon that work. We added new results for publications from the social sciences and humanities. Details and results of this first empirical step are outlined in the section 'quantifying dis/engagement'.

The second step consisted of a self-reflexive exercise: in dialogue, we reconsidered both of our own histories with systems biology to establish potentially interesting perspectives we could build upon when researching other scholars' stories of dis/engagement. Results of this exercise in 'personal archaeology' are outlined in the section on 'the personal view on dis/engagement'. Based on this self-reflexive exercise, we devised a qualitative questionnaire that we then used with interviewees.

A third empirical step started by collecting potential interviewees from fields engaged with(in) systems biology. As we had already undertaken dozens of interviews with systems biologists in previous projects, we focused on adding sociologists, historians, and philosophers of science by building on the publication search as well as on scholarly networks established during our engagement with systems biology. Responses were collected and analysed with an empirically grounded approach (Corbin and Strauss, 2008) and consecutively discussed with selected scholars at a workshop held at the 2019 conference of the International Society for the History, Philosophy and Sociology of Science. The results of this step are presented in the section on 'understanding dis/engagement in qualitative terms'.

This mixed-methods approach comes with some specificities and limitations: firstly, with the quantitative analysis we opted for a keyword-based selection of publications, risking false positives and false negatives as to papers representing systems biology qua theoretical and practical paradigm rather than qua keywords, but all the better capturing discursive dis/engagement with the very label of 'systems biology'. Secondly, our sample includes some important scholars (if importance is assessed by published articles), but it does not represent the full diversity of systems biology scholars. For example, it includes scholars from diverse disciplines and career stages, but not scholars beyond Europe and North America. Thirdly, when it comes to causal theses about a link between distinct characteristics of the interviewee (discipline, location, career stage) and the experiences and positions narrated, the small number of interviewees has limitations. Therefore, we based our analysis on causalities outlined within the stories as well as on a comparison between stories and only cautiously propose causal hypotheses. Fourthly, a narrative approach has the special characteristic of not focusing on facts but on "memories of earlier events […] influenced by the situation in which they are told" and by everything that happened in between the told incident and the narration of this incident. Moreover, "the narrative takes on some independence during its recounting" (Flick, 2014: 273, 268), independence from the interviewer's own mindset, categories, or language. Finally, our 'personal archaeology' adds potential as well as limitations as it certainly comes with its own blind spots. Besides drawing our readers' attention to these issues in this sub-section, we will consider all of them in our analysis and discussion as best possible.

Tracing temporal patterns of dis/engagements per discipline in quantitative terms

Dis/engagement of technoscientists and social sciences and humanities scholars with systems biology can be outlined in quantitative terms. It can be measured by checking the term 'systems biology' in keywords of scientific publications and in the names of research groups and institutions. For the natural sciences, such quantitative analyses have already been presented in the past (Powell et al., 2007). Kastenhofer et al. (2012: 1) report that "[t]he number of publications featuring 'sys-

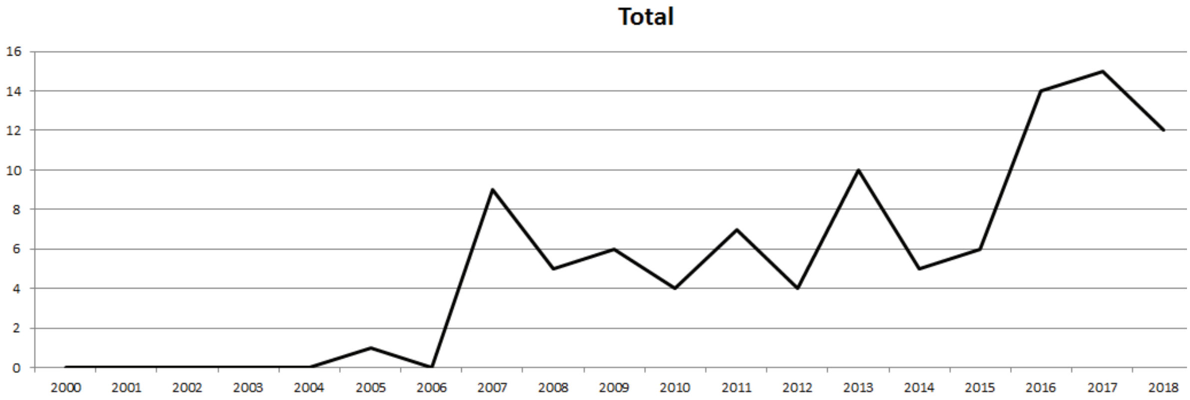

Figure 1. Philosophical, historical and sociological papers on 'systems biology' (Social Sciences Citation Index SSCI + Arts & Humanities Citation Index A&HCI 2000-2018 web of science, 'Systems biology' as topic, search 2 July 2019, Total number = 102 papers)

tems biology' as a keyword has increased steadily from four in the year 2000 to 1362 in the year 2011 (…). The relative frequency of such papers shows the same steady increase with a stabilising trend since 2011." A repetition of this search (Web of Science, 4 August 2022), reveals a flattening of the curve after 2012 from 1496 to 1129 publications in 2019. In 2021, the number only slightly recovered in absolute terms to 1248 publications.iv Although scholarly publications still refer to systems biology, the obvious historical peak was in 2012.

For this project, we performed another search in the Web of Science database, focussing on publications from the social sciences and humanities. This resulted in 102 papers from the Social Sciences Citation Index (SSCI) and the Arts & Humanities Citation Index (A&HCI) between 2000-2018, with the topic 'systems biology' and categories relating to the history, philosophy, and sociology of science (including 'social issues', 'ethics' and 'education research', see Figure 1).

The first paper had been published in 2005 and the number of papers per year was still increasing moderately. As to the disciplinary split of these papers, the largest and most clearly still rising component was categorised as 'history and philosophy of science'. Another discernible component consisted of papers on 'social issues' and 'ethics', with some peaks in 2007, 2012/13, and 2016/17 (see Figure 2).

While finalising this paper in August 2022, another search was performed to clarify the later development of this trend: the total number of papers had further decreased to 13 papers in 2019, 12 papers in 2020 and 8 papers in 2021, thus confirming a peak around 2017 and a consecutive downward slope, in line with other factors like the

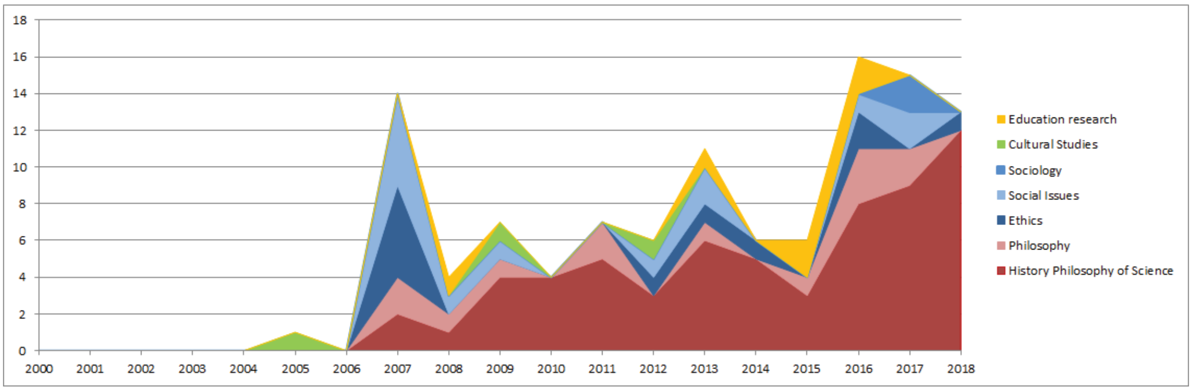

Figure 2. Disciplinary split (same search, with plural attributions slightly changing the total sums per year; 'social issues' includes 'social sciences biomedicine', 'ethics' includes 'medical ethics', 'sociology' excludes 'social issues', 'philosophy' excludes 'history philosophy')

move of funding programmes from systems to synthetic biology or artificial intelligence.

A search for social sciences and humanities publications with the keyword 'biotechnology' results in a graph with multiple peaks (e.g., in 2009, 2013, and 2018) with 'history and philosophy of science' taking the lead and 'ethics' outnumbering 'social issues' over time; a search for 'nanotechnology' results in a clear peak in 2016 with 'history and philosophy of science' as well as 'ethics' studies; a search for 'synthetic biology' reveals a later uptake and a less stable trend, starting with two publications in 2007 and meandering between 2 and 10 publications from 2012 to 2019, peaking in 2020 with 16 papers. The disciplinary split resembles that of SSH studies on systems biology, with a slight boost of 'social issues' research. The keyword 'artificial intelligence' again features a more stable presence in SSH publications, increasing from maximum 2 attributions until 2017 to 51 attributions in 2021, spearheaded by contributions on 'social issues', 'ethics', and 'education' rather than on 'history' or 'philosophy'.

Overall, these numbers confirm the hypothesis of field-specific hypes. Hypes seem to result in individual waves – with a systems biology peak in 2012 in TS and in 2017 in SSH, a synthetic biology peak in 2018 in TS and in 2020 in SSH, an artificial intelligence peak still building up in 2021 in both realms – and an overall, wave-induced irregular rhythm of engagement with technoscience.[v] Sticking with the metaphoric language: all waves taken together make for quite a heavy sea.

The personal view on dis/engagement

To further understand these engagement dynamics, we started with an analysis of our own involvements with systems biology. These involvements had triggered our interest in the topic of dis/engagement with an emerging technoscience and they also shaped how we approached it, what we were most interested in, and what we were possibly not aware of. Thus, it seemed only logical to undertake a kind of 'personal archaeology' of dis/engagement before surveying other scholars' experiences.

We had met in Vienna in 2011 when we were both already engaged with systems biology; Niki with a focus on collaboration and in the middle of a move from Vienna to Manchester, Karen with a focus on epistemic cultures based in Vienna and Hamburg. From then on, we had stayed in loose contact, exchanging our experiences, setbacks, and inspirations. In 2014, we organised a joint track on "Systems Biology: A Paradigm at Work" at the 24th International Congress of History of Science, Technology and Medicine in Manchester, gathering other scholars from the history, philosophy, and sociology of science who were interested in systems biology. In 2016 and 2017, we again joined forces in a session and workshop on a more generic theme – 'community and identity in contemporary technosciences' – at the 4S/EASST in Barcelona and later at an STS Austria event in Vienna. Being engaged for more than a decade in researching systems biology, we had started to ponder whether, when, and how we would move on to another topic like some of the colleagues we had initially met in 2014. Over the years, our engagement with the field had waxed and waned, influenced by the availability of funding as well as by our employment histories. We started discussing the various pros and cons of contin-

Figure 3. Niki's unopened boxes

uing some sort of engagement and how such a decision would tie into our epistemic projects and professional careers.

When discussing the issue of staying with or leaving systems biology as a research topic, Niki mentioned that she still had boxes with empirical material from her last research project on systems biology. They had been left unopened since she had changed places years ago, but she had not yet been ready to discard them. This image of the unopened boxes resonated profoundly with Karen as a symbol of her own state of engagement with systems biology and inspired us to collect further pictures, metaphors, and stories to test whether other colleagues were in a similar situation, possibly with similar open questions, or in different situations and possibly holding inspiring answers. The upcoming biennial meeting of the International Society for the History, Philosophy, and Social Studies of Biology (ISHPSSB) provided the perfect opportunity to discuss these issues in a broader community of scholars. We organised a workshop on staying with or leaving systems biology as a research topic or research field and invited pertinent scientists, historians, philosophers, and sociologists. Its title we derived from the song "Should I stay or should I go?" by The Clash, thereby also invoking a specific generational aspect to the issue.

Understanding dis/engagement in qualitative terms

Inspired by our quantitative findings and our bilateral reflections, we composed a questionnaire which primarily invited four kinds of personal narrative accounts: "your story/stories of getting involved in the field", "your story/stories of how you sustained your involvement in the field", "your story/stories of how you moved out of systems biology studies", and "what did you take with you or what do you see as left open or even unopened and lingering?". Participants were encouraged to address those questions that seemed most significant to them, for their own scholarly positioning, reflectionor their own scholarly positioning and reflection. In line with our narrative approach, we called the questionnaire a 'story book'.

After a successful test run, we distributed the questionnaire via personalised emails. We aimed for scholars from technosciences, the social sciences and humanities that had at some point been clearly engaged with systems biology. With an idea that experiences and views might vary with disciplinary affiliation, geography, and career stage, we aimed for a diverse sample of participants. In total, we selected twenty-three scholars: the eight most frequently named authors of the Web of Science search, thirteen further scholars who we knew were engaged with systems biology, and two renown scientists engaged in systems biology. Nine scholars reacted to our query, providing personal stories, perspectives, and opinions. Thus, we had eleven 'story books' to work with (including our own stories), volunteered from two systems biologists, four social scientists, and five philosophers (of which one also affiliated with history of science).

The story books covered between 500 and 2500 words each and were compiled for content analysis along the themes 'initial engagement', 'sustaining engagement', 'disengagement', and 'left-overs'. We analysed them in accordance with Grounded Theory (Corbin and Strauss, 2008), devising empirically grounded codes on 'what drives individual scholars', 'characteristics of the science / innovation system we are part of', 'social and cultural characteristics of our scholarly contexts', 'disciplinary differences in relating to systems biology', 'the very character of systems biology' and finally, 'a nascent discourse on dis/engagement'. The stories also included generic aspects pertaining to career patterns or the role of targeted funding. All results were presented to attendees of the ISHPSSB workshop that assembled some survey participants and other interested scholars and provided opportunity for a plenary discussion resulting in further insights. In the following four sub-sections, we first consider 'factors for engaging, staying, disengaging' and then organise our results on the three themes of 'the innovation system we are part of', 'finding one's place', and 'patterns of change'. To assure anonymity, no pseudonyms are provided; details about disciplinary backgrounds, locations or career stages are given for individual quotes only when necessary.

Factors for engaging, staying, and disengaging with systems biology

The stories about engaging with systems biology, staying with/in systems biology, and disengaging with systems biology spoke very much to our own experiences as well to the temporal patterns coming to the fore in our quantitative analysis. Most interviewees provided such narratives of change, while a few rejected them outright (an aspect we will come back to later).

Our analysis showed how engagement with systems biology was related to contextual factors, such as discursive hypes, targeted funding programmes, and the local prevalence of systems biology; interactional factors such as the influence of supervisors and collaborators and the perceived openness of systems biology; and individual factors such as pre-existing frames of mind, generic interests, and supplementary expertise that fit well with systems biology. In turn, stories of staying with/in systems biology brought factors to the fore that allowed for an engagement with systems biology beyond a single project, including contextual factors such as discursive settlement, ongoing funding, and the local persistence of systems biology; interactional factors such as institutional support, secure positions, collaborators, and finding a place and being welcomed by systems biologists; and individual factors such as yet unfulfilled epistemic dreams and visions, a wealth of empirical material or a lack of more attractive alternatives. This step, from a single engagement to a series of projects on the same theme, marked the difference between a loose, haphazard commitment, choosing systems biology as just another empirical case, and an ongoing thematic specialisation that might well end up in being identified as a scholar of systems biology. Identification of and with systems biology were sources of ambiguity; for example, should one speak of 'systems biologists' or of 'scientists practicing systems biology'? Was systems biology a field or an approach? Could one demarcate a 'systems biology proper' from systems biology as a buzzword?

Stories about disengaging with systems biology featured mostly contextual factors such as a lack of institutional support, the end of targeted funding, a discourse that shifted away from systems biology, closing down of systems biology centres, or a lack of systems biology at a new location one had moved to due to career requirements. Thus, leaving systems biology was in many cases depicted as an involuntary act and, in some cases, a somewhat painful moment, even when scholars had successfully moved on to another promising theme. Respondents mentioned personal regret at having to leave systems biology. Many aspects were depicted as left open, with questions not yet answered satisfactorily and problems not yet convincingly addressed. There was some ambivalence about the general notion of 'leaving systems biology' or 'systems biology leaving us'; this uncertainty can once again be related to systems biology's unclear denotation as an approach, a paradigm, a field, or a community.

The research and innovation system we are part of

Transitioning from one systems biology project to a series of projects marked the transition from engaging with to staying with/in systems biology and played a crucial role in the narrated identities. However, one of the most prominent forces in the interviewee's narratives on entering, staying with, and leaving the field was public funding and its presence or absence, un/certainty, or time frames. Scholars were well aware of the consecutive waves we tracked quantitatively and our qualitative research delivered more details on the character of these waves and on how scholars navigated them. Funding was depicted as being closely connected to a science policy discourse shaped by promissory lobbying and media cycles.

Likelihood and availability of funding stimulated engagement. For example, one interviewee was told by science policymakers that systems biology was "the currently exciting topic", which motivated them to engage in its study. In turn, a postdoc wrote that "systems biology was not on [their] radar at the time. But when [they] learned of the postdoctoral position with [Y], [they] began to read up on the field and become familiar with it". Scientists engaged in systems biology research stressed that systems biology was more dependent on targeted funding than other fields or approaches because it was interdisciplinary (and, thus, costlier) and did not fit into the usual funding schemes. This resonates with a statement published by the scientist Olaf Wolkenhauer:

> The truth is that in collaborative life science projects most experimentalists do not dare to make themselves too dependent on other labs – the risk of failure (in terms of receiving further funding and generating publications) is considered too high. A massive change in research culture is required to make real progress. Policymakers need to steer this process; otherwise necessary changes will not happen. Interdisciplinary research requires an extra effort on behalf of all sides, including strategic consideration for targeted research programmes and support for the initiation of cross-disciplinary collaborations. (Interview quote from Casini, 2011: 9)

Uncertainty around funding and its limited timelines influenced dis/engagement, with one interviewee noting that "in the very beginning (…) it also was uncertain whether one would stand a chance of getting funded". The decisive importance of funding gained most momentum in settings with a lack of institutional commitment to the topic and the researcher not holding a secure position. These combined uncertainties led to disengagement with systems biology, also influencing how supervisors advised their PhD students. One scientist reflected:

> I got my PhD in [a related field]. When I wanted to switch to systems biology, the director of the institute and other senior colleagues worried that I would ruin my career with such a focus on biological questions. Now I do not have to worry anymore, because I am lucky enough to have [a secure position]. Now I have the freedom [to choose].

Another early career scholar specified that "the project [they] joined … was funded for five years by the [funding organisation]", thus shaping the timeline of their career, their dis/engagement with systems biology, and their professional identity options.

The importance of intense multidisciplinary and multi-laboratory engagement in systems biology and its discrepancy with expectations held by funding agencies was pointed out by one of our interviewees:

> "If you change the way your experimental partner designs his/her experiment, this is a great success [within systems biology] but not so easy to communicate with a funding body as a big story."

Changing the experimental set-up accounted for an essential innovation in the eyes of the systems biologist (as "a systems approach is a way of thinking, a rational approach to handle complexity") and hinged on intense and costly mutual engagement, while it represented no worthwhile news as such to the science policymaker waiting for marketable technological breakthroughs. Along such lines, scholars assumed that continued funding to engage with systems biology would simply not happen in the highly competitive innovation system. Thus, the innovation regime's definition of desired innovation co-determined the right level of engagement that should be sustained.

Moreover, with continuously changing innovation hypes and topics of targeted funding, the next buzzword at play fostered disengagement. Synthetic biology became an alternative funding target in many countries and when scientists began to move that way, some STS scholars moved with them. Artificial intelligence (AI) was also mentioned several times as a potential successor in attracting targeted funding. With no additional money in the funding pipeline, a new hype equated the likely end of an older one: as AI "[came] along with stunning results from image analysis, published on a weekly basis in top journals", people already "[saw] an end to systems biology as a consequence". However, there was also reluctance to change horses. In some cases, scholars uneasily felt that switching fields had neither been a personal choice nor an epistemic necessity. One interviewee concluded that

> "if you can swing some of that [AI] and machine-learning funding in [systems biology's direction] and you want a[n X] scholar [like me] to tag along, you have my number!"

Continuing engagement depended on the availability of dedicated funds both for systems biology research and for investigating its sociological, historical, or philosophical aspects. Switching from one field to another was not a choice based only on epistemic motivations, but also hinged on this very field and its community persevering over time. This high dependence on dedicated funding also led to a discussion on scientific freedom during the workshop. Certain aspects of the contemporary innovation system were seen as challenging scientific freedom.i

Finding one's place

Especially for the phase of sustaining engagement with systems biology, SSH scholars mentioned that feeling welcome in systems biology or being welcomed by systems biologists was one important factor in finding one's place and deciding to stay. This comprised being invited to joint activities (meetings, preparation of project proposals and co-authored papers), staying in contact over a longer period, making friends, and co-shaping a field's very conceptions and practices. Differences in the individual stories corelated with different disciplinary affiliations. Philosophers of science mentioned most often that they had been invited into the field of systems biology as illustrated by this comment:

> I have been pleasantly surprised by the interest from the scientists in talking to philosophers of science. Some of them even attend philosophy of science meetings and publish on philosophical topics. Thus, systems biology for me is an area where engagement with the scientific practice has been welcomed and where there is a great openness to thinking out of the box. This means that there is also a potential for philosophers of science to not only analyse the practice but also actively take part in it and shape it.

Likewise, the systems biologist Olaf Wolkenhauer stated in an interview that he

> "would urge philosophers of science not to wait until [they/the systems biologists] have died, to only then analyse the work done and where we got it wrong" (Casini, 2011: 10).

He specified that his

> "interest in the philosophy of science and epistemology stems from the fact that scientific explanation in biology is hampered by complexity and uncertainty. (…) Philosophers can help [them/systems biologists] with this." (Casini, 2011: 9)

In sum, philosophy of science – mostly in the form of epistemology – had become a welcome means to support systems biology in its quest to develop and demarcate its own, distinct epistemic approach and paradigmatic position. Historians engaged with systems biology considered the emergence of systems thinking in biology and addressed issues of identity, continuity, and change (Drack et al., 2007; Morange, 2009; Herring and Radick, 2019). Because systems biology reflects contemporary trends, histories of systems biology converged with more sociological approaches in discussing the emergence of systems biology and its novelty.

Sociologists of science also addressed the issue of being welcomed, but in the context of leaving systems biology for other fields like synthetic biology or artificial intelligence. These fields had extended invitations with a view to fix problems with societal acceptance and/or acceptability:

> The [synthetic biology] scientists approached [y] for some social scientists to do ELSI work on a grant they were putting in, and [z] asked me if I would be interested in being part of it. Being approached by scientists to be on their grants wasn't something that had happened to me before. […] synthetic biology seemed to provide more opportunities for collaboration and intervention, because it was perceived to be contentious in a way systems biology wasn't and therefore required social scientific input.

The social scientist also noted that they

> "got more wrapped up in the field and its development than [they] had been in systems biology, where [they] had adopted a traditional detached social scientific researcher role."

Thus, the character of the engagement changed fundamentally with the intensity and rationale of being welcomed by the scientists. With synthetic biology, sociologists ended up focussing mostly on potential societal issues, whereas systems biology was mostly discussed as an exemplary case of a so-called 'emerging technoscience' (Bensaude Vincent, 2014) or of biology becoming a more collaborative science (Vermeulen, 2009; 2016).

Being welcomed was also an issue for systems biologists themselves. They recounted not having been welcome in the beginning (in the scientific community, at their research institutions, or with their funding applications). The situation had changed only after intense lobbying work, discursive acknowledgment, institutionalisation, and practical habitualisation of interdisciplinary collaboration between physicists, biologists, medical researchers, engineers, computer scientists, bioinformaticians, and mathematicians. What had not met with much approval at first was then (almost) normal.

Adding to the issue of being welcome or not, the issue of 'who knocks on who's door' came to the fore. Olaf Wolkenhauer recounted that "[i]n the first years, [he] as a modeller had to approach the biologists – in the beginning without success." (Bergs and Terstiege, 2016: 66, translation by authors), but over time this changed:

> In the very beginning, collaborations of medical scientists and biologists with us modelers were still high risk. (…) But with time the individual disciplines converged within systems biology. Now, we do not have to argue anymore that it makes sense to build mathematical models. In many projects the scientists know from the beginning that the collaboration will prove fruitful for both sides.

In contrast, for STS scholars the transition from one collaborative project to the next seemed quite bumpy, suggesting that sustained collaboration came less naturally between STS scholars and scientists than among systems biologists. With a lack of institutionalised forms of collaboration, social ties figured strongly in decisions to keep researching the field, next to availability of recurring funding and unsolved epistemic issues: Staying in contact with systems biologists after the completion of a joint project was mentioned as a central factor in thinking about re-engaging with systems biology.

Patterns of change

Just as scholars from different disciplines had been welcomed differently in systems biology, we also found differences pertaining to the general storylines of engagement and disengagement. In this sub-section, we delineate the storylines of engagement along four (partly nuanced) motifs: firstly 'continuous journey', secondly 'going with the flow' / 'being caught by an undercurrent', thirdly 'switching fields', and fourthly 'systems biology ending' / 'systems biology dissolving'.

When a scholar's engagement with systems biology was depicted as part of a continuous journey, then switching fields was not in the picture and change less of an issue. As a philosopher of science stated:

> I don't really see myself as having worked on systems biology at some point and then deciding to stop doing so. I have been working on a whole range of [biological] questions for many years, and at some point, I wrote, or co-wrote, one or two things on systems biology. It was a major topic of discussion […] in the mid-2000 and seemed a natural topic to think and write about then. But I never made a conscious decision that this was what I was working on, beyond deciding to write a particular paper, and I certainly never decided I was finished with the topic.

This account related to a secure, senior position with less likelihood that a shifting funding environment would have an impact on the interviewee's decision about what to work on. It reverberates with a refusal to 'jump on a bandwagon' or to go with the hyped 'buzzword of the day' and does not necessitate the existence of a distinct systems biology place, community, or field. Younger scholars in less secure positions described their engagement and disengagement along pictures of 'going with the flow' or 'being caught by an undercurrent'. In our sample, these also stemmed from philosophers of science, but accounts came with a more instrumental flavour, (not) working on systems biology was depicted as a necessary career choice:

> After these two years, the fact that I had built up expertise in [x] from studying [systems biology] led

> to opportunities I wouldn't have had otherwise. At the same time, I used [x] as a channel to engage with the [y] community here and this has been successful. […] I have moved more deeply into [z] issues, forming a group of philosophers interested in [z]. Again, [x] and [systems biology] have served as my basic entry point.

Junior philosophy scholars also recounted continuity, but seemed more concerned about strategic career building, or basically keeping their career alive.

In contrast, interviewees with a sociological affiliation built on a storyline of 'switching fields' altogether or even 'being switched to another field'. One scholar recounted that "[i]t was synthetic biology that took me out of systems biology." After working on both for a couple of years, they had found that they "couldn't sustain them both" and had stayed solely with synthetic biology as it seemed to provide more opportunities for collaboration and impact. The motif of 'switching' seemed to be specific to ELSI researchers performing applied social research, following a general notion that more or less the same approach could be applied to different technosciences. A change of topics was motivated by ceasing funding, loss of public interest in a topic, and/or the topic being judged as comprehensively analysed. For ELSI researchers, 'switching' meant to build up new collaborative networks and new topical as well as contextual expertise. Another kind of switching was referred to by scholars who switched to a more generic level of analysis, like interdisciplinarity or the general logics of emerging technosciences. They switched from analysing 'a field as such' to an orientation towards analysing a field as 'an example of'.

Finally, we came across the motif of 'systems biology ending' or 'dissolving' in both scientific and SSH accounts. This sentiment aligns with announcements of 'deaths' of specific fields or approaches in the literature (see also Morange, 2008). 'Death of' stories seem to depict a genre in their own right. They can be interpreted as a logical companion to accounts of emergence or radical innovation: because of limited resources (scientific personnel, media attention, funding, etc.) the emergence of new fields must correlate with the demise of existing ones; radical innovations are meant to render existing approaches obsolete. Larry Moran, emeritus professor in the Department of Biochemistry at the University of Toronto, commented on the topic of "Genomics Is Dead! Long Live Systems Biology!" in his blog in 2007:

> I still remember when recombinant DNA technology was going to change the world. Then it was developmental biology and evo-devo. Along the way [we] were told with a straight face that sequencing the human genome would cure cancer and everything else. After a while it all got very boring. We put up with the hype on the grounds that it was good ~~spin~~ framing for the general public. If it brought in lots of money, then what's the harm? Well it turns out there was some harm done. We scientists are losing our credibility. (Moran, 2007)

Moran distinguished between rhetoric and practice; he argued that radical scientific innovation and the new labels that went with them only existed in science lobbying. His own account resonates more with the 'continuous journey' motif than with a 'death of' motif as "Most scientists are already tired of these fads masquerading as revolution".

From our questionnaire material, we reconstructed two main storylines on scientific transformation that determine the mode of engagement: a 'death of' narrative, denoting the substitution of systems biology by another emerging field along the next revolution, and a 'normalisation' narrative, rendering the need for a special label obsolete after systems biology's approach had become ubiquitous. The 'death of' narrative was applied to discursive as well as practical change; it fit well with a funding context in which labels undergo a specific hype cycle. The 'normalisation' narrative depicted gradual change in scientific practices and communities and a discourse that reacted to this change. Both narratives could also be merged as illustrated in the following statement by a scientist:

> I am observing that people already speak of the end of systems biology, which makes me sad. (…) I kept saying that I don't mind if the term systems biology disappears — when mathematical modelling and systems approaches are so well

> established in the life sciences that we all are just doing biology, medicine, using these approaches. We are however far from having firmly established these approaches, nor are they widely accepted. A key problem is a lack of appreciation of the complexity of living systems and the urge for quick results.

Again, discursive patterns, funding logics, the urge for quick results in a competitive innovation system, and specific characteristics of systems biology – its time-consuming, heterodox, and interdisciplinary character – combined in a distinct way and interacted with dis/engagement. Last but not least, this last quote also hints at the emotional aspects of dis/engagement, although it does not become clear if the sadness relates to the announcement of the end of systems biology as a label, a vision, or an approach. In any case, we interpret it as a sign of engagement and identification with the field and as an illustration of how engagement with an emerging technoscience can run deep in contrast with a mere strategic and temporary move. The negative emotions triggered by the potential demise of a field might also help explain why disengagement and demise are so seldomly addressed in the context of contemporary technosciences, which are mostly depicted as exciting, promising, and prospering.

Discussion: the irregular rhythms of technoscientific dis/engagements

Although TS/SSH engagement has indeed met with some interest in STS on the level of single projects, longer lasting engagement or its opposite, disengagement, seem to have stayed "hidden in plain sight" (Gläser et al., 2016). This observation can be linked to different causes: Gläser et al. (2016: 26) note that "the study of [emerging] fields is in danger of neglecting generic governance structures and processes for the simple reason that these appear to be always already there". In addition, our analysis shows that the study of such fields simply ceases when they are no longer in the spotlight, without consideration of a farther-reaching rationale for disengagement. Disengagement is seldomly advertised and theorised in explicit terms; rather, it is tacitly effectuated if deemed warranted or even beneficial by relevant actors. Disengaging from science and science policy hypes has only recently been an issue and only in strategic terms, such as a plea to not blindly 'jump on band-wagons' and thus buy into potentially empty promises. Thus, it is fair to say that long-lasting engagement, as well as disengagement, continue to represent blind spots in contemporary analyses of science, technology, and society.

With our quantitative appraisal, we have provided a more robust picture of temporal and disciplinary patterns of dis/engagement with emerging fields. Our results corroborate a single-wave pattern for the medium horizon of two decades of SSH interest in systems biology. But whereas the social sciences present a rather unstable publication pattern and thus enforce the wave-like pattern with research on social and ethical issues, history and philosophy of science publications present a much more stable quantitative development. Moreover, we found a succession of waves for SSH engagement with various emerging fields such as systems biology, synthetic biology, or artificial intelligence, thus extending the diagnosis of single waves to that of a wave-like rhythm or a 'heavy sea'. Every rise corresponds to SSH scholars newly engaging with an emerging field, every decline with their disengagement.

It is interesting to note that only dramatic rises of TS publications are followed by peaks in SSH publications, with a time lag of five years in the case of systems biology. The fact that the wave-like pattern for SSH publications on systems biology especially corresponds to publications on social issues, supports the impression that SSH are meant to assess "sociotechnical issues … once and for all" at "an ideal moment in [a technochsciences] developmental trajectory" (Felt, 2016: 192). It also supports the thesis of a "co-construction of the empirical object 'emerging field'" not only directly by science policy, but also indirectly by "policy-led science studies" (Gläser et al., 2016: 26). It can be assumed that this mechanism is even more pronounced with policy advisory (and thus, policy-led) fields like technology assessment.

A better understanding of how rhythms of dis/engagement are (co-)produced by contemporary innovation regimes also allowed us to reflect on further implications of these entanglements. Most notably, we have seen the rise (and fall) of systems biology, synthetic biology, nanotechnology, and, most recently, artificial intelligence. How deep these rhythms run, whether they only pertain to funding rhetoric, or also correspond to transformations of theoretical conceptions, paradigmatic approaches, and technological potentials, is still to be discussed. Depending on one's concept of innovation, they can be perceived as features of a highly successful innovation machinery or as mere window dressing. Assessing the productiveness of wave-like patterns thus also necessitates a critical appraisal of the kind of (science-based) innovations we are striving for in our societies – and the timelines needed to accomplish them.

When scrutinizing effects these waves have on individual scholars exposed to them, it makes sense to also consider other formative aspects of the contemporary innovation regime.[ii] Laudel (2023: 74) notes that "most researchers [are now forced] to actively construct a match between resources – their funding portfolio – and their research portfolio". Our research on patterns of dis/engagement with emerging technosciences helps to better understand how scholars handle this challenge which requires constant re-orientation – on the technical level, but also on the epistemic, affective, and social level. Doing science therefore includes the constant re/building of social ties, the constant re/establishment of one's place within scientific communities as well as paradigmatic landscapes and constant processes of de/identification (see also Kastenhofer and Molyneux-Hodgson, 2021; Kastenhofer and Bauer, 2022). All these processes are subsumed in the notion of dis/engagement and play a role in how scientists and STS scholars accounted for dis/engagement with systems biology.

Furthermore, our analysis highlights how across disciplinary accounts, dis/engagement with systems biology is closely linked to projects, funding opportunities, science policy, and innovation regimes. In addition, our focus on social and affective dimensions showcases the importance of networks, colleagues, friendships, being welcomed and finding one's place. Finally, engagement seems to be also linked to specificities of the field: in the case of systems biology, the paradigmatic interest in complexity rendered collaborations with epistemologists more attractive; in the case of synthetic biology, the publicly perceived ethical, legal, and social implications made collaborations with social scientists and ethicists more called-for and even a sine-qua-non in specific funding programmes. Many of these factors resonate with more general aspects of our current innovation regime, such as projectification and funding rationales, which make long-lasting engagement and identification with one field and/or label dependent on the continuous acquisition of project funds or require flexibility to switch strategically between fields. This can be detrimental for individual scholars as well as whole research ensembles: not only might 'the bubble burst' before it even 'delivers' (cp. Kastenhofer, 2013b: 16), but also researchers must rebuild their identity and network, re-establishing expertise and reputation with every switch to a new label.

Interestingly, our own discussions on dis/engagement with systems biology from an SSH position were equally relevant to scientists engaging with systems biology. From previous studies, we know that some scientists consciously opted to call themselves systems biologists while others saw themselves as central in furthering systems biology but abstained from labelling themselves as such (Vermeulen, 2009; Kastenhofer, 2013a). This diverse pattern can be linked to the diversity of local funding environments. In some (trans)national contexts, systems biology was specifically funded as an emerging research field; in others, it was financially supported as an emerging research community; in yet other contexts, it was perceived as an approach not needing dedicated funding – rendering deep engagement and identification difficult, costly, and risky (Kastenhofer et al., 2012; Vermeulen, 2018). Thus, patterns of identification can converge along shared geographies (and funding regimes) rather than disciplines. Moreover, the similar exposure of both TS and SSH scholars to hype cycles and dis/engagement waves makes room for enacting 'chronosolidarity' as suggested by Felt (2021).

However, modes of dis/engagement were also co-determined by disciplinary affiliation and career stage in our sample. When support and funding for systems biology started to wane, senior scientists working in systems biology could move back to their original discipline, or move along to the next wave of funding, sometimes literally changing their identity from systems biology to synthetic biology. In contrast, scientists early in their career, still being trained and socialised in(to) the emerging field, were less prepared to transition to a new label or a more stable, traditional field. Within the social sciences and humanities, we saw senior scholars opting for looser engagements with the new label, determining engagement on their own terms. Early career scholars dependent on third-party funding had to disengage with a new post-doc project on another topic or a teaching job that did not allow much time for research. Overall, this pattern resonates with the power dimension inherent in the exposure of scholars to shifting hypes and funding priorities as addressed by Felt (2021): the less secure a scholar's institutional and social position (as determined by work contract, scholarly reputation, and networks), the less power they hold and the more effort they have to put into engagement and identity work, resulting in more difficulty to later disengage and disidentify.iii Recurring exposure to this dilemma may well lead to more cynical takes on engagement and identification over time, to practices of staging engagement and rites of choreographing one's scholarly identity.

How these power dimension of dis/engagement fare in relation to place-based, centre-periphery dynamics, we could unfortunately not cover adequately in our current empirical analysis. Such a discussion has been well prepared by other scholars like Pablo Kreimer (2022) or Liscovsky Barrera (2022) and should certainly be extended. For systems biology, a centre-periphery constellation can be assumed not only for the global context, but also among European countries with different scales of dedicated funding. In this paper, we focused not on geographical centres and peripheries but on the dynamics related to career stages and disciplinary hierarchies. Interestingly, we not only saw different trajectories of dis/engagement between scholars at different career stages and scholars from TS and SSH fields, but also among the social sciences and humanities scholars. These differences were closely related to different role expectations. Philosophers were engaged by systems biologists to help with epistemological issues, and this was also how they depicted their role themselves. Sociologists were contracted to help address societal issues and concerns, but when it turned out to be quite hard to determine what these issues would be in relation to systems biology, the sociologists concentrated on better understanding systems biology as an emerging field. We identified differences in dis/engagement that show the importance of reflection on the relationship between different SSH approaches and the type of engagement they engender. As dis/engagement comes in different forms, it can be a rich source of mutual learning in STS, SSH, and beyond.

Finally, the dynamics of engagement and disengagement have implications for our own identity as STS scholars and our own community. While we study topics and themes that are valid and relevant across scientific fields (such as controversies, regulation, public engagement, etc.), many of us are entertaining a close connection to a specific discipline or a particular group of scientists, even when developing broader theories on knowledge creation and governance. Careers are built through engagement with specific scientific disciplines or groups. In some cases, the scientific area of study even corresponds to a scholars' initial academic education. In-depth knowledge of a particular (sub-)discipline through intensive immersion is an asset for STS research and also a crucial aspect of scholarly identity (Schönbauer, 2019). The closer the link, the stronger the identification between an STS scholar and 'their' scientific field. Consequently, the faster the labels or 'gravitational centres' in technoscience change, the more these dynamics are likely to substantially affect individual scholars and their careers, networks, and community. As such, rhythms of dis/engagement influenced by innovation regimes are affecting the type of work we (can) do, as well as the careers and communities we (can) create. It is therefore not only important to ask how we dis/engage, but also on what terms and to which lengths and depths. We thus hope that this contribution fosters more discussion on the dynamics of dis/engagement in STS and beyond.

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References

Adam B and Groves C (2011) Futures tended: Care and future-oriented responsibility. *Bulletin of Science, Technology & Society* 31: 17-27.

Alberghina L and Westerhoff HV (eds) (2005) *Systems Biology. Definitions and Perspectives*. Springer.

Balmer AS, Calvert J, Marris C et al. (2015) Taking Roles in Interdisciplinary Collaborations: Reflections on Working in Post-ELSI Spaces in the UK Synthetic Biology Community. *Science & Technology Studies* 28: 3-25.

Bauer A and Kastenhofer K (2019) Policy advice in technology assessment: shifting roles, principles and boundaries. *Technological Forecasting & Social Change* 139: 32-41.

Bensaude Vincent B (2014) The politics of buzzwords at the interface of technoscience, market and society: The case of 'public engagement in science'. *Public Understanding of Science* 23: 235-253.

Bergs M and Terstiege G (2016) "projekte können auch auf eine gute art scheitern": Interview mit Olaf Wolkenhauer. *systembiologie.de* 2016: 66-68.

Boogerd FC, Bruggeman FJ, Hofmeyr JH and Westerhoff HV (eds) (2007) *Systems Biology: Philosophical Foundations*. Amsterdam: Elsevier.

Bos C, Walhout B, Peine A and van Lente H (2014) Steering with big words: articulating ideographs in research programs. *Journal of Responsible Innovation* 1: 151-170.

Brown N and Michael M (2003) A Sociology of Expectations: Retrospecting Prospects and Prospecting Retrospects. *Technology Analysis & Strategic Management* 15: 3-18.

Calvert J and Martin P (2009) The role of social scientists in synthetic biology. Science & Society Series on Convergence Research. *EMBO reports* 10: 201-204.

Casini L (2011) Interview with Prof. Olaf Wolkenhauer. *The Reasoner* 5: 3-10.

Carter L and Mankad A (2021) The Promises and Realities of Integration in Synthetic Biology: A View From Social Science. *Frontiers in Bioengineering and Biotechnology* 8: 622221.

Collins HM and Evans R (2002) The Third Wave of Science Studies: Studies of Expertise and Experience. *Social Studies of Science* 32: 235-296.

Corbin J and Strauss AL (2008) *Basics of Qualitative Research: Grounded Theory Procedures and Techniques*, Thousand Oaks, CA: Sage.

Davies SR (2021) Performing Science in Public: Science Communication and Scientific Identity. In: Kastenhofer K and Molyneux-Hodgson S (eds) *Community and Identity in Contemporary Technosciences*. Cham: Springer International Publishing, pp. 207-223.

de Laet M, Driessen A and Vogel E (2021) Thinking with attachments: Appreciating a generative analytic. *Social Studies of Science* 51: 799-819.

Doing P (2007) Give Me a Laboratory and I Will Raise a Discipline: The Past, Present, and Future Politics of Laboratory Studies in STS. In: Hackett EJ, Amsterdamska O, Lynch ME, et al. (eds) *The Handbook of Science and Technology Studies*. 3rd ed. Cambridge: MIT Press, 279-295.

Drack M, Apfalter W and Pouvreau D (2007) On the Making of a System Theory of Life: Paul A Weiss and Ludwig von Bertalanffy's Conceptual Connection. *The Quarterly Review of Biology* 82(4): pp. 349-373.

Felt U (2016) The temporal choreographies of participation: thinking innovation and society from a time-sensitive perspective. In: Chilvers J and Kearnes M (eds) *Remaking Participation: Science, Environment and Emergent Publics*. London: Routledge, pp. 178-198.

Felt U (2021) The Temporal Fabric of Academic Lives: Of Weaving, Repairing, and Resisting. In: Vostal F (ed) *Inquiring into Academic Timescapes.* Bingley: Emerald Publishing, pp. 267-280.

Felt U, Fouché R, Miller CA and Smith-Doerr, L (2017) Introduction to the Fourth Edition of The Handbook of Science and Technology Studies. In: Felt U, Fouché R, Miller CA, et al. (eds) *The Handbook of Science and Technology Studies*. 4th ed. Cambridge, MA; London: MIT Press, pp. 1-26.

Fitzgerald D and Callard F (2015) Social Science and Neuroscience beyond Interdisciplinarity: Experimental Entanglements. *Theory, Culture & Society* 32: 32.

Flick U (2014) *An Introduction to Qualitative Research*. London: SAGE.

Flipse S, van der Sanden M and Osseweijer P (2014) Setting up spaces for collaboration in industry between researchers from the natural and social sciences. *Science and Engineering Ethics* 20: 7-22.

Forman P (2007) The Primacy of Science in Modernity, of Technology in Postmodernity, and of Ideology in the History of Technology. *History and Technology* 23: 1-152.

Frickel S and Gross N (2005) A General Theory of Scientific/Intellectual Movements. *American Sociological Review* 70: 204-232.

Frickel S, Albert M and Prainsack B (2016) *Investigating interdisciplinary collaboration: theory and practice across disciplines*. New Brunswick, New Jersey: Rutgers University Press.

Funtowicz SO and Ravetz JR (1993) Science for the post-normal age. *Futures* 25: 739-755.

Gibbons M, Limoges C, Nowotny H, Schwartzman S, Scott P and Trow, M (1994) *The New Production of Knowledge. The Dynamics of Science and Research in Contemporary Societies*. London, Thousand Oaks, New Delhi: SAGE Publications.

Gieryn TF (1983) Boundary-work and the demarcation of science from non-science: strains and interests in professional ideologies of scientists. *American Sociological Review* 48: 781-795.

Gisler P and Schicktanz S (2009) The role of social sciences in science policy making. In: Schulz-Schaeffer I, Werle R and Weyer J (eds) *Science, Technology & Innovation Studies*, special issue 9(1).

Gläser J and Laudel G (2016) Governing Science. How Science Policy Shapes Research Content. *European Journal of Sociology* 57: 117–168.

Gläser J, Laudel G and Lettkemann E (2016) Hidden in Plain Sight: The Impact of Generic Governance on the Emergence of Research Fields. In: Merz M and Sormani P (eds) *The Local Configuration of New Research Fields. On Regional and National Diversity*. Cham: Springer, pp. 25-43.

Green S (ed) (2017) Philosophy of Systems Biology: Perspectives from Scientists and Philosophers. In series: Wolfe CT, Huneman P and Reydon TAC (eds) *History, Philosophy and Theory of the Life Sciences*. Cham: Springer.

Hackett EJ and Rhoten DR (2011) Engaged, Embedded, Enjoined: Science and Technology Studies in the National Science Foundation. *Science and Engineering Ethics* 17: 823-838.

Hacking I (1999) *The social construction of what?* Cambridge, MA; London: Harvard University Press.

Hedgecoe A and Martin P (2003) The Drugs Don't Work: Expectations and the Shaping of Pharmacogenetics. *Social Studies of Science* 33: 327-364.

Herring E and Radick G (2019) Emergence in Biology: From organicism to systems biology. In: Gibb S, Hendry RF and Lancaster T (eds) *The Routledge Handbook of Emergence*. 1 ed. Abingdon: Routledge, pp. 352-362.

Hillersdal L, Jespersen AP, Oxlund B and Bruun B (2020) Affect and Effect in Interdisciplinary Research Collaboration. *Science & Technology Studies* 33: 66-82.

Hochschild AR (1979) Emotion Work, Feeling Rules, and Social Structure. *American Journal of Sociology* 85: 551-575.

Hoppe R (2005) Rethinking the science-policy nexus: from knowledge utilization and science technology studies to types of boundary arrangements. *Poiesis & Praxis* 3: 199-215.

Kastenhofer K (2013a) Two sides of the same coin? The (techno)epistemic cultures of systems and synthetic biology. *Studies in History and Philosophy of Biological and Biomedical Sciences* 44: 130-140.

Kastenhofer K (2013b) Synthetic biology as understanding, control, construction and creation? Techno-epistemic and socio-political implications of different stances in talking and doing technoscience. *Futures* 48: 13-22.

Kastenhofer K and Bauer A (2022) "Are You a TA Practitioner, Then?" – Identity Constructions in Post-Normal Science. *Minerva* 61: 93-115.

Kastenhofer K and Molyneux-Hodgson S (eds) (2021) *Community and Identity in Contemporary Technosciences*. Cham, Switzerland: Springer.

Kastenhofer K and Torgersen H (2016) Transhumanismus und Neuroenhancement: technowissenschaftliche Visionen als Herausforderung für die Technikfolgenabschätzung. *FIfF-Kommunikation* 2/16: 52-56.

Kastenhofer K, Torgersen H, Klein F and Klement L-L (2012) *Systems Biology in Austria 2011. The Establishment of a New Field in a National Context* (project report). Vienna: Institute of Technology Assessment (ITA).

Kitano H (2001) *Foundations of Systems Biology*. Cambridge MA, London, UK: MIT Press.

Klipp E, Liebermeister W, Wierling C and Kowald A (2009) *Systems Biology*. Weinheim: Wiley VCH Verlag.

Kreimer P (2022) Techno-Scientific Promises, Disciplinary Fields, and Social Issues in Peripheral Contexts. *Science as Culture On-line first.*

Laudel G (2023) Researchers' responses to their funding situation. In: Lepori B, Jongbloed B and Hicks D (eds) *Handbook of Public Funding of Research*. Cheltenham: Edward Elgar, pp. 261-278.

Law J and Ruppert E (2016) *Modes of Knowing. Resources from the Baroque.* Manchester: Mattering Press.

Liscovsky Barrera R (2022) Internationalisation in context: dominant and peripheral discourses. *EASST Review Volume* 41(1). Available at: https://www.easst.net/article/internationalisation-in-context-dominant-and-peripheral-discourses/ (accessed March 7th, 2023).

Merton RK (1942) A note on science and democracy. *Journal of Legal and Political Sociology* 1: 115-126.

Mol A (2008) *The Logic of Care: Health and the Problem of Patient Choice*. London and New York: Routledge.

Moran LA (2007) Genomics Is Dead! Long Live Systems Biology!, Sandwalk. *Strolling with a sceptical biochemist-blog*., September 7th, 2007. Available at: https://sandwalk.blogspot.com/2007/09/genomics-is-dead-long-live-systems.html (accessed August 7th, 2019).

Morange M (2008) The Death of Molecular Biology? *History and Philosophy of the Life Sciences* 30: 31-42.

Morange M (2009) A new revolution? The place of systems biology and synthetic biology in the history of biology. *Embo Reports* 10: S50-S53.

Parker JN and Hackett EJ (2012) Hot spots and hot moments in scientific collaborations and social movements. *American Sociological Review* 77: 21-44.

Powell A, O'Malley M, Müller-Wille S, Calvert J and Dupré J (2007) Disciplinary baptism: a comparison of the naming stories of genetics, molecular biology, genomics and systems biology. *History and Philosophy of the Life Sciences* 29: 5-32.

Prainsack B, Svendsen MN, Koch L and Ehrich, K (2010) How do we collaborate? Social science researchers' experience of multidisciplinarity in biomedical settings. *BioSocieties* 5: 278-286.

Puig de la Bellacasa M (2011) Matters of care in technoscience: Assembling neglected things. *Social Studies of Science* 41(1): 85–106.

Rabinow P and Bennett G (2012) *Designing human practices: an experiment with synthetic biology.* Chicago, Ill.: University of Chicago Press.

Raimbault B and Joly P-B (2021) Emergence of technoscientific fields and the new political sociology of science. In: Kastenhofer K and Molyneux-Hodgson S (eds) *Community and Identity in Contemporary Technosciences*. Cham: Springer, pp. 85-106.

Rip A (2002) Regional Innovation Systems and the Advent of Strategic Science. *The Journal of Technology Transfer* 27: 123-131.

Rip A and Voß J-P (2013) Umbrella Terms as Mediators in the Governance of emerging Science and Technology. *Science, technology and innovation studies* 9: 39-59.

Schönbauer S (2019) We Are Standing Together in Front. How Scientists and Research Groups Form Identities in the Life Sciences. *Science & Technology Studies* 32(1): 60-80.

Schönbauer SM (2021) A Passion for Science: Addressing the Role of Emotions in Identities of Biologists. In: Kastenhofer K and Molyneux-Hodgson S (eds) *Community and Identity in Contemporary Technosciences.* Cham: Springer International Publishing, pp. 283-301.

Schyfter P and Calvert J (2015) Intentions, Expectations and Institutions: Engineering the Future of Synthetic Biology in the USA and the UK. *Science as Culture* 24: 359-383.

Seifert F and Fautz C (2021) Hype After Hype: From Bio to Nano to AI. *NanoEthics* 15: 143-148.

Shrum W (2010) Collaborationism. In: Parker JN, Vermeulen N and Penders B (eds) *Collaboration in the New Life Sciences.* Farnham: Ashgate, pp. 247-258.

Sismondo S (2007) Science and Technology Studies and an Engaged Program. In: Hackett EJ, Amsterdamska O, Lynch ME and Wajcman J (eds) *The Handbook of Science and Technology Studies*. 3rd ed. Cambridge: MIT Press, pp. 13-31.

Slaughter S and Leslie LL (1997) *Academic Capitalism: Politics, Policies, and the Entrepreneurial University.* Baltimore: Johns Hopkins University Press.

Smolka M, Fisher E and Hausstein A (2021) From Affect to Action: Choices in Attending to Disconcertment in Interdisciplinary Collaborations. *Science, Technology, & Human Values* 46: 1076-1103.

Snow CP (1961) *The Two Cultures and the Scientific Revolution. The Rede Lecture 1959*. New York: Cambridge University Press.

Star SL and Griesemer JR (1989) Institutional Ecology, 'Translations' and Boundary Objects: Amateurs and Professionals in Berkeley's Museum of Vertebrate Zoology, 1907-39. *Social Studies of Science* 19: 387-420.

Vermeulen N (2009) *Supersizing Science: On Building Large-Scale Research Projects in Biology.* Maastricht: Universitaire Pers Maastricht.

Vermeulen N (2016) Big Biology; supersizing science during the emergence of the 21st century. *NTM Journal of the History of Science, Technology and Medicine* 24: 195-223.

Vermeulen N (2018) The choreography of a new research field: Aggregation, circulation and oscillation. *Environment and Planning A: Economy and Space* 50: 1764–1784.

Viseu A (2015) Caring for nanotechnology? Being an integrated social scientist. *Social Studies of Science* 45: 642-664.

Vostal F (2021a) *Inquiring into Academic Timescapes*. Bingley: Emerald Publishing.

Vostal F (2021b) On Times, Scapes and Chronosolidarity in Academia. In: Vostal F (ed) *Inquiring into Academic Timescapes*. Bingley: Emerald Publishing, pp. 1-17.

Wallace ML and Rafols I (2015) Research Portfolio Analysis in Science Policy: Moving from Financial Returns to Societal Benefits. *Minerva* 53: 89-115.

Ziman J (2000) *Real Science: What it is and what it means,* Cambridge: Cambridge University Press.

Notes

i In this text, we are interested in science and technology studies including social, cultural, historical and philosophical studies of science. We follow an aggregated perspective (social + cultural + historical + philosophical studies of science) in our quantitative analysis and a more integrative perspective (STS as a field, programme, movement, or community in its own right, e.g., Sismondo, 2007; Felt et al., 2017) in our qualitative analysis and discussion (see methodology section of this paper).

ii Systems biologists refer to earlier scholars, like Ludwig von Bertalanffy or Robert Rosen, who formulated central epistemic approaches and theoretical concepts of biological systems thinking and modelling already in the mid-20th century. However, the establishment of modern systems biology is commonly attributed to the beginning of the 21st century.

iii Kastenhofer (2013a) reports on scientists' critique of the use of 'systems biology' as a buzzword; Kastenhofer and Torgersen (2016) critically discuss social scientists' uptake of new technoscientific labels and expectations as 'jumping on the band wagon'.

iv As the total number of publications and Web of Science entries keeps increasing each year, a slight increase in absolute terms can equal stagnation or even decrease in relative terms.

v Moreover, Collins and Evans (2002: 240) in their analysis of paradigmatic waves within STS hint at the diverse ways waves can succeed each another: "The relationship between Wave One and Wave Two is not the same as the relationship between Wave Two and Wave Three. Wave Two replaced Wave One [while] In this strange sea, Wave Two continues to roll on, even as Wave Three builds up."

vi This position presupposes that there was a kind of ideal situation, free from non-epistemic influences like lobbying, mission orientation, career requirements, or scientific routines – a presupposition that warrants further discussion in its own right.

vii Whereas on the aggregated and mid-term level, we can possibly speak of a co-construction of hypes and waves, on the level of the individual scholar and their daily routines, speaking of exposure to such phenomena seems more adequate. Individual perceptions of levels of exposure may still differ, as our qualitative material shows.

viii However, we assume that radical epistemic disruption also poses a challenge to established scholars, which might result in some caution in acknowledging and embracing such change.

Questions and Explanations in Sociology: A Science Studies Field Study

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> "what would be required for this [investigation of practices of social scientists and statisticians] to be worthwhile is the description of those practices within the framework of a set of key methodological concerns – focusing, for instance, on how research questions are selected and formulated; how sources of data and methods are chosen, and on the basis of what considerations; what counts as evidence, how it is produced, what is treated as sufficient evidence (...)."
>
> Martyn Hammersley (2020:6)

Abstract

This is a study of an action research project conducted in one of the biggest university departments for sociology in a Central Eastern European capital during the first half of the 2000s. The paper shows that researchers' images of society have a strong impact on social scientific methodology, scientific explanations and narratives. I offer an example of how realist approaches to science and technology studies can be used in a field study and discuss the benefits and limitations of such an endeavor, which I define as an interpretive and explanatory social scientific work. The analysis shows ways in which latent knowledge structures influenced the wording of a questionnaire used in the research, the types of data that were gathered, and how the data were interpreted. These knowledge structures include notions concerning local policy discussions, different social policy traditions, and images of a Roma minority struggling with the effects of structural poverty and prejudices.

Keywords: Sociology, Methodology, Social Policy, prejudice, Central Eastern Europe.

Introduction

The reflexive turn in social sciences drew attention to the topic of theoretically and empirically based knowledge construction processes. Several authors (Mauthner and Doucet, 2003) highlighted the importance of reflexivity at the data analysis stage, examining the ontological and epistemological assumptions built into particular methods of data analysis. In this paper on social scientific methodology as applied in a project conducted in Central Eastern Europe (CEE), I approach social scientific research based on two understandings. First, regarding it as an explanation tool, I study how specific research practices, in a given region and at a given time, shape scientific findings and the ways in which they are presented. Second, understanding scientific practices as things that need to be explained, I examine how local and regional knowledge about society shapes the ways research objects are enacted and research is conducted.

The analysis is about an action research project which was conducted in cooperation of a local and a US team of social scientists in one of the biggest university departments for sociology in a Central Eastern European capital in the first half of the 2000s. My aim is to show the ways in which latent knowledge structures influenced the wording of a questionnaire used in the course of the research, the types of data that were gathered, and, finally, the interpretation of data. These knowledge structures include notions concerning local policy discussions, different social policy traditions, and images constructed by liberal sociology of a Roma minority struggling with the effects of structural poverty and prejudices. Often, evaluative studies like this one are carried out with the intention to improve one's field of study, i.e. to make sociology or other disciplines "better" (whatever "better" should mean for the authors of the work). Albeit making some critical comments, I myself do not wish to point to "more correct", "better" or "more adequate" social scientific methods, suggesting they should be employed instead of the ones used in the study under examination. Neither do I try to explain "wrong" methods, "wrong" interpretations, or invalid results of scientific practices with reference to social factors (in contrast to the "right" ones that need no explanation[1]), since I do not identify "wrong" or "right" methods, interpretations, or results at all. Instead, I analyze how the researchers' relation to social policy discourses of the time and the local and regional discourses and images about Roma shaped the ways in which they formulated their questions, created and then interpreted their data, and how these discourses even influenced the very understanding of researchers about the things in the world that exist and can be measured.

Though sociologists have been reflexive about their methods throughout the history of the discipline, science and technology studies research on the actual practices related to social scientific methods has been scarce, especially considering the vast quantity of research on the methods used in "hard" sciences (one of the earliest being ethnomethodological studies such as Garfinkel, 1967). Basically, there are hardly any science and technology studies about the processes and practices employed by, and conflicts among, social scientists themselves (notwithstanding some very recent exceptions concerning ethnographic research, see the articles of a special issue about situated practices of STS ethnographic collaboration and its data practices in the 34(3) issue of this journal, Lippert and Mewes, 2021, or the special issue by Ploder and Hamann, 2020). Babones (2016) urged social scientists to extend quantitative social scientific practice involving reflexive moments concerning research methods. He rightly points out that researchers tend to convey an image of their research practices suggesting that their methods are positivistic, while in fact they are not. Often it is the practitioners of social sciences themselves who then turn to a more reflexive, empirical study of their own field (Einola et al, 2021; Hammersley, 2020: 4). There is a respectable body of (positivistic) secondary literature on statistical analyses that focuses on 'errors' which influence the research process. This literature presents better ways of doing particular statistical analyses, often pointing out that the 'subjective' judgment of the researcher plays an important role in the research process, without discussing the nature, or the origins and traditions of research practices that end up being simply called 'subjective'.

There is a significant amount of scholarly literature discussing how the same question in a questionnaire is interpreted differently by various respondents (e.g., Hardy and Ford, 2014; Galasiński and Kozłowska, 2010). Such works can hardly be characterized as belonging to the discipline of *STS*, since they rarely deal with explaining *how* and *why* these different interpretations come into being, or the ways in which they influence the processes and the outcomes of scientific endeavors. Rather, they simply state that social scientific research is a result of different processes of "construction", while failing to analyze the historical and social reasons that enable these 'constructions'. Mair et al (2016) is an exception in pointing out how social scientific research projects, in different locations and at different times, are shaped by the cultural contexts of the meanings from which they originate. For instance, the completion of the same number of school grades meant a comparatively high level of education in certain periods of history, while in others it represented low educational attainment (Mair et al, 2016). There is also some recent empirical scholarly work in fields other than natural sciences about what the same number means in different contexts, and how the citing of numbers may function as a tool to achieve scientists' goals (Holtrop, 2018). In her comprehensive analysis of how social scientific research is made a subject of rigorous study, Erin Leahey (2008) distinguishes two types of studies on research practices. In some studies, research practices appear as explanatory variables, while in others as an outcome of research interests (Leahey, 2008: 36). Among the former, there are studies, for example, on how the quality of interactions between the interviewer and the interviewee is influenced by specific research practices. Among the latter belong studies on the societal impact on research practices, like which institutions use statistical testing more frequently than others, and why.

In my work, I rely partly on Lynch's (2013) approach that he characterises as an ontographical one. STS done from an ontographic perspective does not make the distinction between epistemological and ontological research questions. I believe that while investigating practices in specific cultural and historical circumstances, references to scientific, political and social contexts can be made without compartmentalizing "into domains corresponding to the traditional concerns of politics, ethics, epistemology, and ontology" (Lynch, 2013: 453-456). Focusing on both the conditions of production and the conditions of possibility, I discuss some key latent knowledge structures that define the researchers' assumptions about what entities exist in the real world and which others do not. They also inform both the process of data collection, i.e., creating questions for a survey, and the process of the interpretation of data, during the analytical phase of the research. These research practices, incorporating all such external and contingent knowledge elements or structures, shape the understanding and terminology of how certain things in society are defined, made possible and created, and then used in other societal fields and interactions.[2] At the same time, I understand and analyze social scientific practices as the outcomes of social scientific traditions and the commitments to certain cognitive formulations, also pointing out that these traditions and commitments are sustained and reinforced by the very social scientific practices they engender. I pinpoint the *a priori* variables that shape the methodology of empirical social scientific research and the *a posteriori* variables that influence the interpretation of data (Bollen, 2002).

But is this a sound way of doing explanations in STS? Can I channel my knowledge about the disciplinary background of the scientists, about their experiences or their knowledge of different societies when explaining how they practice science (a realist point of view, making use of already existing notions about things in specific countries, regions, and disciplines)? Or should I rely only on the observation of the practices, discussions and workflows employed by the scientists under study? Can we explain how science is made (in this case: ask how notions regarding political and social contexts of Central Eastern European countries ought to be used as explanatory factors when discussing how sociology is practiced there, Latour, 1988) by referring to already existing "things" in the realm of history, society, politics, etc., or to the "context" of the life-worlds (Mauthner, 2015)? Can one assume the existence of "the real", even if hybrid, contingent, processual, or never completely represented (Lippert and Mewes, 2021: 2)? And is it legitimate to explain social phenomena (in our case, in the field of science) using existing concepts, notions, or terminology constructed by other scientists investigating other social phenomena? In other words: should one aim to explain some phenomena encountered when studying scientific practices with some aspects of society or politics, even though believing that the things we study and the society where they exist are co-produced? Or should STS be executed without determining the causes of the studied phenomena in the "real world"?

My answer to the last question is 'no'. The act of "explaining away" – that Pickering (2017: 135) attributes to Durkheimian social science – is in my understanding precisely what would make science and technology studies interesting, what would produce explanations why science is being done in particular ways. Oftentimes, it seems to me, STS-studies – rather than having an explanatory aim – remain exciting, yet somewhat descriptive exercises about how human and non-human actors go about their daily businesses in the field of science. In this article, I choose to pursue a twofold approach when explaining phenomena. As also discussed by the scientists involved in that research, the specificities and differences between the local and the US workgroups I observed were striking. Since they had already been verbal about them, I often did not have to engage my knowledge of the different contexts the scientists worked in when describing how science works, how scientists act, what methods they use, or how they write questionnaires and create variables and datasets. With the purpose of shaping the research process in their intended ways, the research participants had commented on the circumstances during the discussions and negotiations accompanying the research process. However, there were knowledge structures, disciplinary or historical differences that did not come up explicitly in the discussions I witnessed: therefore it was I who included these in the analysis in a "realist" fashion, i.e. drawing on my knowledge of the researchers' life-worlds.

And here a short notice on the topic of reliability: Talking about how scientists organize their "dances" (Pickering 2017: 136), Andrew Pickering calls a form of solution to the problem of how to produce more-or-less robust knowledge in STS "islands of stability" (Pickering 2017: 137). We as (STS) scientists might use such islands when working on our own studies; there, we have some sort of reliable regularity, while knowing very well that stability is not a once-and-for-all achievement guaranteed by knowledge (Pickering, 2017: 139-140). Or as Bloor (1999: 90) says, we can assume that observation will always enable us to uncover a reality more complicated than what we can assimilate into our current conceptual schemes and theoretical systems. Certainly my approach – just like all the others – is ready to be scrutinized by those interested in doing so, in the light of new findings and understandings.

Topic and methodology of the project under study

To understand my methodology, we first need to look briefly into the methods that were used in the project I have made the subject of my analysis. To ensure the anonymity of my research objects, I choose not to specify the exact type of the action research method, the precise location, or the exact year, since there have been only few such projects conducted in the region. It was an academic setting, at one of the biggest departments for sociology in a CEE capital in the first half of the 2000s. The local researchers (I use 'local' in this text to point to the researchers based in the country where the project was conducted), all of them sociologists, have long been engaged in research on attitudes of the majority society towards the Roma. The local research heads were among the most influential sociologists and survey methods experts in the country, holding important academic positions. They often consulted a colleague for social policy issues, and involved MA students to handle and analyse the data. They had been investigating prejudice against Roma for several decades, using survey as the primary methodology.

This particular research project was conducted in close cooperation with two political scientists coming from the US, who had invented the method serving as the basis of the research: an action research method, usually focusing on locally important policy topics. A project based on this method begins with a representative survey (the sample reflecting the ethnic composition of the country's population, its age groups, socioeconomic backgrounds, etc.) about the views of the population regarding the topic under investigation and about the so-called level of information on the topic. This is followed by a two-day meeting with some of the people who had been in the sample of the survey, also involving experts in different aspects of the research topic. During this meeting, the participants discuss the key questions of the research in small groups and plenary, where they are "objectively" and "scientifically" informed about the most important aspects of the topic. To achieve this, experts are invited to take part in panel discussions, and information material is handed out to the participants. Subsequently, the same survey is conducted again among the participants of the two-day meeting. According to the inventors of the method, the differing outcomes of the two tests indicate whether the information provided and the discussions held during the meeting successfully contributed to "more informed choices" by the respondents regarding important policy topics.

In the research project I chose to analyze in this paper, the local researchers focused both on policy issues regarding the Roma minority and on the question of whether prejudices of the majority society can be reduced by a kind of information training. Between the two surveys, during the two-day-meeting, the social factors behind the lower-than-average educational and socioeconomic status of the Roma ethnic minority were explained to the selected members of the majority society in lectures, information sheets about the Roma and in-person meetings with Roma individuals. In this paper, I give selective attention to the various elements of the research process. My main concern being how the local and the US researchers' very different aims and backgrounds influenced the composition of the initial survey and their interpretation of the data, I pay less attention to how the two-day meeting was designed and conducted.

The topics of discrimination (Kroon et al., 2016), prejudice against (Mudde, 2005; Fekete, 2014) and the exclusion of (Kovács, 2015; Kóczé, 2020) Roma, the biggest ethnic minority in Europe, have been the subjects of intensive research throughout Europe, especially in CEE, where the ratio of this minority in the population is relatively high compared to other parts of Europe and the rest of the world. Prejudice has been one of the main subjects of attitude studies in this region, and there has also been substantial research on poverty and its causes and effects in terms of hostility against Roma (Loveland and Popescu, 2015). 2005-2015 was officially declared the decade of Roma inclusion in twelve European countries, which pledged to improve the socioeconomic status of Roma and to take measures to further their social inclusion. Research over the decades has shown how and in which ways Roma face prejudice and suffer discrimination in schools and on the job market.

For many scientists, a methodological challenge when doing social scientific research on a minority is how to "explain" the unfavorable situation of this minority. It can be particularly challenging to discern the (combination of) causes behind the observed disadvantages, distinguishing between some of the main possible factors:

1. belonging to a minority and having to face discrimination and prejudices held by the majority society on that account. In CEE, such 'visible minority groups' primarily include the Roma, alongside some sexual minorities and certain deprived groups, such as the homeless.
2. being someone (regardless of ethnicity) who is socially underprivileged, poorly educated, and poverty-stricken.
3. having to suffer from poor infrastructure and/or policy decisions (concerning healthcare, schooling, public transportation, the job market, etc.).
4. having personality traits that hinder someone from being successful and/or efficiently raising her social status. Such traits include lack of motivation (for a myriad of reasons), not being able to handle money well, etc. (Simmel, 1908: 455-456).
5. fate, bad luck.

The attitudes of members of the majority society towards a minority, individual personality traits, the living conditions of poverty and discrimination, and infrastructural/policy circumstances all represent intersecting factors. They together influence the opportunities of people belonging to a certain minority and, thus, their chances of success. Furthermore, not only are the factors listed above used to explain the unfavorable situation of a minority, but they also serve to analyze people's opinions about these factors (Lepianka et al, 2009). They feature more or less prominently in lay explanations regarding the causes of poverty. Explanations vary primarily according to the ways in which they combine references to the above mentioned factors. Works citing the first three factors (membership in a minority, underprivileged status, poor conditions) are usually classified under the so-called "continental" tradition, in which societal or structural explanations of poverty – external to the individual – prevail.

By contrast, the fourth factor stresses the alleged individual causes of poverty, where the responsibility for poverty lies within a person, while the fifth factor (fate) is prominent in explanations in which neither society nor individuals are blamed for poverty (Feagin, 1972; Lepianka et al, 2009: 421-423)

Methodology

The methodology applied here is mixed. Using anthropological non-participatory observation, I followed the action research project as a young researcher, with the purpose of conducting a field study on the making of sociological knowledge. I had no previous experience in minority/prejudice studies and did not know more about these things than any regular sociologists, making me relatively new to this topic. At the same time, I was specialized in the epistemology of survey sociology, so the methodology of the data collection was not novel to me. I had personal ties to the department and especially knew one professor rather well – she was a colleague of the heads of the local research group in a medium-sized department, where most researchers knew each other well and were on good terms; so the research heads agreed to my field study in their research project.

I followed through all the stages and steps in the project, which meant extensive and intensive observations, and taking part in dozens of meetings with local colleagues and others from the US throughout the duration of the project. The US colleagues – two senior researchers who introduced this action research method to the country – were in close email and telephone communication with the local research group, mainly for the purpose of writing the questionnaire together. They also came in person to the 2-day event. Besides the opportunity to witness personal conversations, I also had access to the texts of emails and conference calls between the local and the US research teams. I conducted my analysis of the different stages and versions of the text of the survey, including any comments, corrections, based on these sources. In this paper, I discuss only two steps in the whole research project: aspects of how the survey came into being, and how some of the data were then narrated in scientific texts.

In discussing a multinational project, where the know-how and the copyrighted design comes from US colleagues who play a vital part during the whole project, also visiting to attend project meetings in person, one could easily fall into the trap of solely interpreting the situation according to a hierarchical center-periphery model: Western scientists arriving to the East, in order to colonize local research production. In this paper, I will show that this is not necessarily the case. Studies on postmodern society often urge to focus on analyses of local forms of knowledge production. This empirical study shows how different forms of knowledge interacted and came into conflict in the process of composing the survey, in discussions and disputes concerning the survey questions, pointing out how elements of certain types of social scientific knowledge emerged out of these interactions and conflicts.

Discussion

One project, different objectives?

The purpose of the US-American colleagues who participated in the project was to establish whether people's opinions change after gaining more information about certain topics (through experts' participation in the workshops and their contributions to the educational materials distributed). Their fundamental hypothesis was that the more information a person has, the more she is able to determine which policy measure suits her preferences and will contribute to her interests: people like to make rational decisions, and there is impartial information out there, which helps them do that. Hence, for the US researchers, it was essential to integrate questions in the survey concerning the respondents' knowledge of the given issues. Such questions mobilizing the respondents' knowledge on certain subjects are needed in this particular research setup for two reasons. First, those who are better informed when the two-day meeting comes to a close may change their opinions, and these questions are intended to measure this change. Second, these questions allow the people who designed the project to present it as a potentially significant contribution to political decision making. The project "adds to the legitimacy of the process by allowing the researchers to claim that the post-deliberation opinions are also more informed opinions" (to cite an email of a US researcher sent to the researchers of the country where the project was conducted).

The local researchers had other ideas and, arguably, goals. In a conversation of ours, the head of the local research team contended that "prejudice is irrational, and when we know more, it will diminish." For them, the priority was not so much to study policy preferences and their relationship with the level of individuals' information, but *how to reduce prejudice*. The difference between the two groups might be defined with reference to Fleck's (1979:39) terminology 'thought collectives', described as distinct communities of persons mutually exchanging ideas or maintaining intellectual interaction. The point of distinguishing thought collectives here is to show how they have emerged and which scientific practices they yield to.

Does the object exist?

In a project that focuses on social policy, differing interpretations of the purpose of the research are fundamentally entangled with notions of politics in CEE after 1990. For this reason, the very issue of which questions are suitable to measure knowledge about certain facts was contested by the participants. There were some questions that were easily passed by the US colleagues, but which were regarded as problematic by the local researchers. The local researchers tried to convince the US colleagues that there was not necessarily one correct answer to certain questions measuring the level of information/knowledge. In a conference call, the US research head asked the local one what the correct answers to the following questions were: "Who contributed the most in the last 15 years to lessen the number of poor people, the left-wing parties or the right-wing parties? And who contributed the most to ameliorate the situation of the Roma? And to lessen discrimination against the Roma? And to diminish conflicts between different ethnic groups?" One of the local research heads replied that he could not confidently give a correct answer to these questions, since "political parties are moving, are learning, and have no fixed positions". A local senior researcher in the project touched on some of the important ways in which the local party system and policies were different from their US counterparts, and explained that questions that seem unambiguous in the US cannot be posed in their country. Questions regarding policies that have been part of the public discourse in the USA or in Western Europe are not always easy for respondents of a survey in CEE to interpret, she claimed. This is why, according to her, researchers have to be cautious, since the same questions can be interpreted quite differently in the different local contexts. The American colleagues seemed to have assumed that there was a language or an existing discourse for people to talk about policy measures designed for poor people. However, the local researcher stressed that this was not the case since "this is a new democracy where discourse about policy options is new".

Various political alternatives (for example: integrative/universalist approaches or affirmative action policies targeting specifically a minority) have been discussed in the US for several decades and have gradually become part of public narratives. However, such concepts and policies remained virtually absent in Central and Eastern Europe under state socialism, since social policy concepts were not an important or prominent part of public discourses and debates in the region. Under state socialism, general discourses on social policies were very limited, and there were very few legitimate alternatives of them on the political market: official narratives on poverty and ethnic conflicts could not really be openly discussed, even in the scientific community, until the fall of the Iron Curtain. The equivalent terms in the various languages of the region for what in English would be 'social policy' and/or 'social care' were often marginalized or excluded (see, for example, on Hungary and Poland: Aczél et al, 2015: 41-42). In accordance with the official ideology, poverty and social problems did not exist since the turn to communism following the Second World War, as the system purportedly provided work and thus a decent living for everyone. (In fact, they did exist, however, they were hardly mentioned: Ferge and Juhász, 2004: 234). With a perfect economic policy – according to the state socialist doctrine – social policy or social care would become unnecessary. After the fall of the Iron Curtain, it took a long time until many Western social policy terms became part of the mainstream social policy narratives (Aczél et al, 2015: 51). Ferge (2001: 110) states that, for example in Hungary, the social policies of the first two governments after the regime change in 1989 did not have clear-cut political or ideological profiles.

Another difference between the discourses of the US and the local researchers lies in the fact that the emerging welfare policies of the CEE countries after 1990 cannot easily be compared to the existing Western schemes. They are hybrid formulations, as besides the new elements they incorporate various features of the previous welfare policies in Europe (Kuitto, 2016: 3). Manning (2004: 216) distinguishes three phases of changes in social policy after the fall of the Iron Curtain. Only in the second one, in the mid-1990s, did new policy debates begin to emerge. Before that, governments were characterized more by their distance from the successor communist parties than by the ideologies and policy alternatives they represented. As a consequence, real public narratives on social policy were barely a decade old at the time of the study.

To sum up: the local researchers contended that stances regarding social policy measures were not really formed at the time of the project. 'Social policy' as such existed during state socialism, however, the *idea* of social policy measures was not necessarily something meaningful for the general public, as envisioned by the US researchers. The local researchers linked the existence of positions regarding social policy formed in the broader public to the existence of public discourse about such topics, which did not really exist under state socialism. For the US colleagues, on the other hand, it was evident that social political stances existed as subjects of scientific inquiry, ready to be measured by a questionnaire. After much debate and negotiations, a compromise between the two groups was achieved. Thus questions about parties and their relation to social policy measures were included, however, only in a simplified form.

What is measured?

In what sense is the wording of a questionnaire shaped by the attitudes and knowledge elements of the authors? How does the text of a questionnaire gain meanings, making different scientific discourses possible? What are the questions used in a questionnaire able to measure? In this section, I analyze the content, composition and semantic features of the survey on social policy issues developed by the international research team, citing the research report written by the local researchers.

In the questionnaire, there are questions regarding the roles of different factors involved in the poverty of Roma and non-Roma populations. One of the questions was this: "In your opinion, what is needed (...) to ameliorate the situation of the Roma? (...) Is it necessary for the Roma to have fewer children?" This question was asked from both Roma and non-Roma respondents. When speaking about Roma respondents who agreed in their replies to the latter question, the local researchers wrote in the research report that "They (...) put the *reasonable* limitation of the number of children in a top place [emphasis by me]". The authors added the word "reasonable", not used in the questionnaire. With putting the question like this, they suggested that it was reasonable to believe that limiting the number of children helps to avoid poverty. By contrast, when commenting on the replies given by non-Roma respondents to the same question, the authors described those who replied "yes" to the question as to whether it would be necessary to limit the number of children if one sought to ameliorate the financial circumstances of Roma as a hostile attitude, a prejudice:

> If we consider that behind the (…) the high number of children there is an attitude that emphasizes the responsibility of the Roma, we have to say that the majority society deprives the Roma of the solidarity that is due to the "innocent" poor who are vulnerable to external circumstances. (quote from the research report)

We might ask: why? Why is it necessarily a sign of prejudice when a member of the majority, non-Roma population thinks that having fewer children would improve someone's financial circumstances? And why is a Roma respondent who suggests the same thing considered *reasonable*?

The question whether having children contributes to one's financial impoverishment might be regarded as directed at the respondent's opinion of how much children cost, how effective family subsidies in a certain country are, etc. Yet, in this research, when a non-Roma respondent answered "yes" to this question, this reply was seen by the local researchers as an indication of prejudice against Roma, not of the costs of raising children in that particular country. Here, the local researchers were drawing on their prior knowledge concerning a widespread prejudice, according to which Roma have "too many" children, i.e. they are unable to support (Orosz et al, 2018: 320). This knowledge is the decisive factor which explains why the same answer to the same question is interpreted in radically different ways, depending on the ethnicity of the respondent. In the researchers' assumption, the common prejudice concerning the large number of children born to Roma women is the context in which this question is interpreted by the ethnic majority respondents.

Another question formulated by the local researchers was the following: "If the budget of the country allowed it, whose situation would you ameliorate first? Please order the groups according to whose situation you would ameliorate first!" The groups were the following: "retired people, big families, unemployed people, Roma, refugees, people with disabilities, people belonging to the country's ethnic majority who moved to the country from abroad" (*anonymized by me*). When the local researchers discussed this question at a meeting, they defined it as a question measuring prejudice. Their discussion evolved around whether it was possible to interpret responses prioritizing the unemployed or families with many children as an indication that the respondent in question wanted to provide support for Roma. The researchers concluded that they could not assess whether these responses could actually be interpreted as indications that the respondents meant to support the Roma, since they did not have any information concerning how the respondents perceived people belonging to the Roma minority in the first place. The local researchers discussed the possible conclusions they could draw concerning the respondents' prejudices of Roma on the basis of the respondents' answers to this group of questions. During the writing of this part of the questionnaire, one of the researchers wondered:

> What the hell do I ask with this question? If she/he doesn't say that she/he would support the unemployed or those with many children, I do not know what she/he thinks about the Roma.

The US colleagues made the critical observation that the categories overlap: In other words, Roma can be unemployed or retired, may have disabilities, etc. So this group of questions – according to the US researchers – cannot measure prejudice towards Roma. At the end, the critical observations of the US colleagues were disregarded.

For the US researchers, the above cited question measured the subjective variable of *preferences*. This kind of inquiry is made in policy research projects, in which then items are compared according to the degree of preference expressed by the respondents (Saris and Gallhofer, 2004: 245). The local scientists tried to determine the extent of an *attitude/prejudice,* and they did so using the same question that was meant by the US researchers to measure the *policy preferences* of the respondents. We have seen that the local researchers aimed to assess prejudices against Roma, while the US researchers' purpose was to measure the respondents' policy preferences and how these policy preferences changed with the respondents having more "objective" information.

Nature or nurture? Latent knowledge structures and social political concepts

The American colleagues initially wanted to delete the above mentioned questions regarding possible reasons behind poverty altogether.[3] At the same time, the local project leader insisted that these questions were backed up by standard theories, and have also been used in other surveys in the US. He was referring to questions to determine whether respondents attribute poverty to social / external, or personal / internal factors (see above on the five different ideal-types explaining the situation of Roma). The US researchers argued that the answer categories (Roma, unemployed, living with disabilities, etc) were overlapping, i.e. not mutually exclusive (which is obviously the case, see Lepianka, 2009), a discouraged practice in social scientific questionnaire-writing. The local scientists were not aware of any such problems: for them, it was obvious that the answers were structured around the categories of either internal or external attribution of causes, and the fact that the categories are overlapping did not matter to them. The two categories of attribution were so important for the local scientists that the topic was included in the one-page briefing material about the project written by one of the local research heads, which was published on the project website:

> There has been a shift in the causal attribution of poverty; views that blame the poor for their fate are still popular, but views that stress external, social circumstances and injustices have become somewhat more dominant, which points us to the fact that social solidarity has increased.

Another block in the questionnaire about the factors influencing the social status of ethnic groups allows some insight into the local scientists' attitudes towards the same topic: the reasons for the poor status of the Roma minority. In the section on non-Roma people, questions concerning the possible causes of *poverty* are asked, yet when it comes to Roma people, the respondents are asked to name the possible causes of their *disadvantaged situation*.[4] This terminological difference (the use of the term 'poverty', on the one hand, and 'disadvantaged situation', on the other) suggests that, in the view of the local scientists, the social status of the ethnic minority (the Roma) is caused not only by lack of financial resources, but by social exclusion and prejudice against them: so not just financial problems, but social/structural ones as well (see Chapter 2). This notion determines how the questionnaire is phrased: while the ethnic majority of the country is "poor", the Roma are "disadvantaged". Another question that sheds light on the knowledge structure of the local sociologists was eventually excluded from the final questionnaire. It was taken from another questionnaire used in a similar project in Australia, which also dealt in part with conflicts between ethnic groups. The question asked the respondent to compare the situation of Roma and non-Roma in different areas of life.[5] In contrast with the Australian questionnaire, which offered evenly distributed potential answers to this question, the local, rather lopsided answer structure of the questionnaire under study looked like this: "much worse", "worse", "the same" and "better". In other words, there was only one positive response and one neutral one, while there were two negative options: an uneven distribution toward the negative side of the possible answers. Another question concerned how the respondents would improve the housing situation of Roma. The local researchers included several possible answers, like one that favored building new block houses for Roma on previously uninhabited city/town outskirts, or another one that suggested moving Roma to regions of the country, which were becoming depopulated. The US team members then simplified the answer categories in the following way: building new flats or moving Roma into existing flats. This shows that the US researchers were completely unfamiliar with two knowledge elements that the local colleagues considered crucial. The first of these was that a social policy measure encouraging Roma to move to city or town outskirts would result in a form of geographical segregation, which in many ways would reproduce the already poor housing conditions of the Roma. The second is the fact that the US colleagues failed to realize that the originally proposed answer categories included a latent reference to the well-researched prejudice about Roma being noisy people. According to the local researchers, the belief (or prejudice) that Roma are undesirable neighbors forms an important part of the discursive context of such questions.

The answer categories to questions in the survey were often formulated with the background notion of so-called latent variables. Latent variables are defined in various ways or by a combination of different approaches: they are regarded as hypothetical constructs put together by scientists as attempts to measure existing phenomena, as much as things that are impossible to measure or to observe (Bollen, 2002). Latent variables often help researchers arrive at explanations concerning the relationships between two or more variables. Many variables in the psychological and social sciences cannot be observed directly. For this reason, they are considered latent, and the only option is to observe them indirectly, through the values of an observed variable. The exploration and study of latent variables are a central part of social scientific investigations, and discussions of the importance of latent variables are often regarded as the essence of such endeavors. The ultimate goal is to find causal structures that could explain how society works. Social sciences, as opposed to psychology or biology, use experiments as a methodological tool rather marginally. Experiments would try to ensure that only one (or very few) independent variables are manipulated between measurements. As experiments are not feasible most of the time, social scientists have to rely on other means (including references to latent variables) to narrate causal structures in their scientific texts.

Latent variable models have been used widely in quantitative social scientific research (Loehlin and Beaujean, 2017: ix), but they have rarely been analyzed scientifically (Bollen, 2002: 606). Latent variables in sociological and social psychological research can entail, for example, motivations, notions, prejudices, attitudes, etc. which influence interviewees in their answering patterns. They can serve as a means to summarize a number of variables, resulting in fewer factors (Bollen, 2002: 608). *A priori* latent variables are hypothesized prior to the examination of the data, while *a posteriori* latent variables are derived by researchers on the basis of the data analysis (Bollen, 2002: 615).[6] In our case, an *a priori* latent variable influenced the ways in which the researchers envisioned the answer structure that was offered to the respondents: structural vs. individual explanations of poverty (see the first part of this article).[7] In the above mentioned cases, where there was some dispute among the local and the US research teams regarding overlapping answer categories, it became obvious that knowledge on the latent variable of the possible prejudices about poverty and the causes of disadvantaged situations was guiding the local sociologists when writing the questionnaire and then interpreting the answers given by the respondents.[8] One of the researchers put it like this during the writing of the questionnaire, after going through all the possible answers in case of the abovementioned questions about how to ameliorate the situation of the Roma, and after categorizing them into structural/individual explanations: "We are in the hands of the respondents whether this typology will come out or won't."

The structural explanation of poverty echoes a very important notion of how the Roma minority is perceived by many social scientists in the CEE region: in modeling post-communist deprivation, many sociologists studying Roma minorities use the image of a social group segregated from the rest of society and stricken by discrimination. Their vision combines different aspects of minority existence. People belong to such a group when they are both socially excluded (also suffering discrimination: Barany, 2002, sometimes to an extreme degree, like in a caste system: Ladányi and Szelényi, 2006: 15) and economically excluded from other classes on account of their race/ethnicity. In this sociological understanding, the Roma minority has, due to structural causes, not been able to participate in economic growth, as it was unable to acquire the necessary education and skills (Stewart, 2002). This theory of Roma is only one of the many possible social scientific notions attached to this ethnic group (itself composed of socially and culturally diverse groups). There are approximately twelve million Roma living in Europe under widely varying circumstances. In CEE, the Roma minority typically consists of people who are settled, in contrast to more nomadic Roma groups in Northern and Western Europe (Ladányi and Szelényi, 2006: 22). Sociologists do not typically analyze the ethnic traits of groups, since this kind of research is usually conducted by ethnographers or anthropologists. Indeed, understandings and descriptions of Roma in mainstream CEE sociological literature tend to characterize them as a group facing racism, segregation, prejudice, and discrimination (Oblath, 2006; Vajda 2020). We have seen that it is precisely this notion of Roma that influenced the way in which the questionnaire was constructed and the data collected by the questionnaire interpreted by the local scientists.

Conclusion

A study of sociological practices that wants to be explanatory cannot escape certain realist commitments (Hammersley 2022:145). The difficulty, as Bloor (1999:92) puts it, is to decide which things should be topicalised for *investigation* and which others should be reserved as *resources*. It is a privilege to have social sciences as a field of study, because references to political or social factors often become explicit during the research process that the STS-scholar studies and thus serve as resources.

At the same time, besides such obvious references, there are contextual knowledges that have to be drawn into the study by the STS researcher in order to interpret what she sees. After all, knowledge about objects that we assume to have particular characteristics independently of our awareness of them (even though we know very well that this type of knowledge is an ever-contested one) needs to be included as long as we want to make STS an explanatory sort of scientific discipline.

I believe, and I tried to prove, that references to scientific, political and social contexts can be made in an STS study, without compartmentalizing into the traditional fields of "politics, ethics, epistemology, and ontology" (Lynch, 2013: 456). Dealing with both the conditions of production and the conditions of possibility (Lynch, 2013: 453-454), it seemed necessary to outline the large picture, containing some of the elements that seemed to me the most important ones. Some of the knowledge elements that I have discussed define the researchers' assumptions about what entities exist in the "real world" and which others do not. They also inform both the process of data collection, i.e. creating questions for a survey, and the process of the interpretation of data, during the analytical phase of the research.

We have seen how notions regarding the prejudices prevalent in a CEE society as well as various ideas and discourses around social policy issues in the early 2000s impacted social scientific methods and data analyses in a particular social scientific research project, shaped by particular disciplinary, social and historical circumstances. Questions in the social sciences cannot always be easily arranged in measurable categories based on the type of objects they intend to measure, since for different scientists the same question may measure different things. We have seen that researchers' knowledge about latent dimensions of the possible prejudices concerning the disadvantaged situation of Roma and the causes of their poverty influenced the local social scientists when drafting the questionnaire and interpreting the respondents' answers to the questions.[9] The tensions behind these disputes emerged from different traditions, knowledge elements and scientific attitudes – some of these understandings and attitudes explicitly came up in the extensive discussions during the research process, contributing to changes in the applied methods and enabling specific research results.

Processes and practices of assigning meaning are by no means self-explanatory but, rather, contested and conflicting operations that enact different understandings of the research objects under study. More importantly, these understandings themselves are based on different (scientific, political and regional) traditions and discourses, potentially creating inherent tensions or even conundrums in a research project. Albeit certainly representing an important issue in the international science market, analyses of diverging contexts and traditions in the constitution of meaning in the course of research have rarely been conducted so far in the field of quantitative social sciences.

The project under study here, done in the mid-2000s in CEE, offers an example of the ways in which *a priori* and *a posteriori* latent variables can influence the composition and wording of a questionnaire, the types of data that are gathered, and how the data are interpreted. In this case, these variables included knowledge concerning local public discussions, notions of social policy, and images of a minority struggling with the effects of structural poverty and prejudices. As I showed, these variables can be sustained and reinforced by some of the scientific practices I analyzed, contributing to their perception as being parts of the objective reality.

Different understandings of the purpose of the project led the participants to different interpretations of what certain questions measured, and these differences in interpretation created conflicts during the process of drafting the questionnaire. For the local researchers, the assumed prejudices of the ethnic majority population concerning Roma constituted the most important context, framing both the questions and the interpretation of the *answers*. Thus, the influence of knowledge elements regarding prejudice towards Roma explained why the same answer to the same question was interpreted in fundamentally different ways by the local researchers when the respondent identified him/herself as Roma or as a member of the majority society. As for the US scientists, attitudes towards social policy measures were among the main scientific interests of the research project. However, according to the local sociologists, such attitudes often *did not even exist* among the local respondents interviewed in the project. Thus, the same answer to certain questions had different meanings for the two research groups, depending on what the teams thought the question measured.

The Roma minority, the unemployed, people with many children: these are categories of the population which emerge from specific historical circumstances in a given country. In the present case, for the local research team the historical context shaped the discourse on social policy that was essentially censored under state socialism and then allowed to burgeon after the fall of the Iron Curtain, resulting in (at the time of my field research) a decade-long heated debate concerning policy measures affecting visible, often stigmatized, minority communities and other vulnerable groups. The local researchers' reference to this discourse influenced the ways in which questions were formulated, data created and then interpreted. However, ignorant of what the CEE historical context entailed, the US researchers did not share the same understandings of the named population categories. In general, different historical sensibilities represented by the two teams shaped the understanding of researchers concerning the things in the world that exist and can be measured. Or, using other, more constructivist terms: their divergent discourses created the very things that they thought could be measured.

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References

Aczél Z, Szelewa D and Szikra D (2015) The changing language of social policy in Hungary and Poland. In: Béland D and Petersen K (eds) *Analysing social policy concepts and language: comparative and transnational perspectives*. Bristol, Chicago: Policy Press, pp. 35–57. DOI:10.1332/policypress/9781447306443.003.0003

Aspers P (2014) Performing ontology. *Social Studies of Science* 45(3): 449–453. doi:10.1177/0306312714548610

Babones S (2016) Interpretive Quantitative Methods for the Social Sciences. *Sociology* 50(3): 453–469. DOI: 10.1177/0038038515583637.

Barany Z (2002) *The East European Gypsies: Regime Change, Marginality, and Ethnopolitics*. New York: Cambridge University Press.

Bloor D (1999) Anti-Latour. *Studies in History and Philosophy of Science* 30(1): 81–112.

Bollen K (2002) Latent Variables in Psychology and the Social Sciences. *Annual Review of Psychology* 53(1): 605–634. DOI:10.1146/annurev.psych.53.100901.135239

Einola K and Alvesson M (2021) Behind the Numbers: Questioning Questionnaires. *Journal of Management Inquiry* 30(1): 102-114. DOI:10.1177/1056492620938139

Feagin JR (1972) Poverty: We still believe that God helps those who help themselves. *Psychology Today* 6(6): 101–129.

Fekete L (2014) Europe against the Roma. *Race & Class* 55(3): 60–70. DOI: 10.1177/0306396813509196.

Ferge Z (2001) Disquieting Quiet in Hungarian Social Policy. *International Social Security Review* 54: 107–126. DOI: 10.1111/1468-246X.00094

Ferge Z and Juhász G (2004) Accession and social policy. The case of Hungary. *Journal of European Social Policy* 14(3): 233–251. DOI:10.1177/09582870404044621

Garfinkel H (1967) *Studies in Ethnomethodology*. Englewood Cliffs, NJ: Prentice Hall.

Galasiński D and Kozłowska O (2010) Questionnaires and Lived Experience: Strategies of Coping With the Quantitative Frame. *Current Sociology* 16(4): 91–101. DOI: 10.1177/001139289037001010

Fleck L (1979) *Genesis and Development of a Scientific Fact*. Chicago: University of Chicago Press.

Hammersley M (2022) Is 'Representation' a Folk Term? Some Thoughts on a Theme in Science Studies. *Philosophy of the Social Sciences* 52(3): 132–149. DOI: 10.1177/00483931211072470

Hammersley M (2020) From methodology to methodography? *Methodological Innovations* September-December: 1–8. DOI: 10.1177/2059799120976995

Hardy B and Ford LR (2014) It's Not Me, It's You: Miscomprehension in Surveys. *Organizational Research Methods* 17(2): 138–162. DOI: 10.1177/1094428113520185

Holtrop T (2018) 6.15%: Taking Numbers at Interface Value, *Science & Technology Studies* 31(4): 75–88. DOI: 10.23987/sts.56743.

Kóczé A (2020) Gendered and Racialized Social Insecurity of Roma in East Central Europe. In: Baar van H and Kóczé A (eds) *The Roma and Their Struggle for Identity in Contemporary Europe*. Berghahn, pp. 124–150. DOI: 10.2307/j.ctv1k3nr1x.11

Kovács K (2015) Advancing marginalisation of Roma and forms of segregation in East Central Europe. *Local Economy* 30(7): 783–799. DOI: 10.1177/0269094215601812.

Kroon AC, Kluknavská A, Vliegenthart R and Boomgaarden HG (2016) Victims or perpetrators? Explaining media framing of Roma across Europe. *European Journal of Communication* 31(4): 375–392. DOI:10.1177/0267323116647235

Kuitto K (2016) *Post-Communist Welfare States in European Context. Patterns of Welfare Policies in Central and Eastern Europe*. Cheltenham: Elgar.

Ladányi J and Szelényi I (2006) *Patterns of exclusion: Constructing Gypsy ethnicity and the making of an underclass in transitional societies of Europe*. Boulder, CO: East European Monographs.

Latour B (1988) *The Pasteurization of France*. Cambridge, MA: Harvard University Press.

Leahey E (2008) Methodological Memes and Mores: Toward a Sociology of Social Research. *Annual Review of Sociology* 34: 33–53.

Lepianka D, Oorschot van W and Gelissen J (2009) Popular Explanations of Poverty: A Critical Discussion of Empirical Research. *Journal of Social Policy* 38(3): 421–438.

Lippert I and Mewes JS (2021) Data, Methods and Writing: Methodographies of STS Ethnographic Collaboration in Practice. *Science & Technology Studies* 34(3): 2–16. DOI: 10.23987/sts.110597.

Loehlin JC and Beaujean AA (2017) *Latent Variable Models: An Introduction to Factor, Path, and Structural Equation Analysis*. New York, NY: Taylor & Francis.

Loveland MT and Popescu D (2016) The Gypsy Threat Narrative: Explaining Anti-Roma Attitudes in the European Union. *Humanity & Society* 40(3): 329–352. DOI: 10.1177/0160597615601715.

Lynch M (2013) Ontography: Investigating the production of things, deflating ontology. *Social Studies of Science* 43(3): 444–462.

Mair M, Greiffenhagen C and Sharrock WW (2016) Statistical Practice: Putting Society on Display. *Theory, Culture & Society* 33(3): 51–77.

Manning N (2004): Diversity and Change in Pre-Accession Central and Eastern Europe Since 1989. *Journal of European Social Policy* 14(3): 211–232. DOI: 10.1177/0958928704044620

Mauthner N (2015) 'The past was never simply there to begin with and the future is not simply what will unfold': a posthumanist performative approach to qualitative longitudinal research. *International Journal of Social Research Methodology* 18:3: 321–336, DOI: 10.1080/13645579.2015.1022298

Mauthner N S and Doucet A (2003) Reflexive Accounts and Accounts of Reflexivity in Qualitative Data Analysis. *Sociology* 37(3): 413–431. DOI: 10.1177/00380385030373002

Mudde C (2005) Racist Extremism in Central and Eastern Europe. *East European Politics and Societies* 19(2): 161–184. DOI: 10.1177/0888325404270965.

Oblath M (2006) A "cigány" kategória diszkurzív és történeti konstrukciója. *Anthropolis* 3(1): 51–60.

Orosz G, Bruneau E, Tropp LR, Sebestyén N, Tóth-Király I and Bőthe B (2018) What predicts anti-Roma prejudice? Qualitative and quantitative analysis of everyday sentiments about the Roma. *Journal of Applied Social Psychology* 48: 317–328. DOI: 10.1111/jasp.12513

Pickering A (2017) The Ontological Turn: Taking Different Worlds Seriously. *Social Analysis* 61(2): 134–150. DOI: 10.3167/sa.2017.610209.

Ploder A and Hamann J (2021) Practices of Ethnographic Research: Introduction to the Special Issue. *Journal of Contemporary Ethnography* 50(1): 3–10. DOI:10.1177/089124162097910Saris WE and Gallhofer I (2004) Operationalization of Social Science Concepts by Intuition. *Quality & Quantity* 38: 235–258. DOI: 10.1023/B:QUQU.0000031328.25370.e9.

Simmel G (1908) Der Arme. In: *Soziologie: Untersuchungen über die Formen der Vergesellschaftung*. Leipzig: Dunker & Humblot, pp. 454–493.

Sismondo S (2015) Ontological turns, turnoffs and roundabouts. *Social Studies of Science*, 45(3): 441–448. DOI: 10.1177/0306312715574681.

Stewart M (2002) Deprivation, the Roma and 'the underclass'. In Hann C (ed) *Postsocialism: Ideas, ideologies and practices in Eurasia*. London, New York: Routledge, pp 133–155.

Vajda R (2020) Kategóriák szorításában. A tudományos romareprezentációk politikai dimenzióiról. In Szabari V (ed) *(Disz)kontinuitások. A magyar szociológia 1960 és 2010 között*. ELTE-Napvilág, pp. 90-132.

Notes

1 A practice to be avoided, as we have learnt from the Strong Programme.

2 In choosing this approach, I am aware of voices claiming that studies of ontology in STS, based on empirical observations about how realities are made or enacted in practices (Aspers, 2014: 2), do not fundamentally differ from constructivist accounts about how science works. Sismondo (2015: 2) argues that STS has always looked at the plurality of actualities, and we can talk of ontological turns only because explicit references to ontologies have been added to otherwise often more traditional lines of inquiry.

3 The questions were (in my translation): "We collected different opinions regarding the reasons behind poverty. Do you agree with these statements? People are poor when they: do not have sufficient education; do not like to work; live in disadvantaged areas; are physically or mentally disabled; do not do anything for themselves and expect everything from society; have many children; live irresponsibly; do not have job opportunities; cannot take care of their money; were born in poor families.

4 The questions were: "We collected different opinions regarding the reasons behind the disadvantaged situation of Roma. Do you agree with these statements? Those are in a disadvantaged situation who: do not have sufficient education; do not want to assimilate; live in disadvantaged areas; do not like to work; were born in poor families; live irresponsibly; cannot take care of their money; are the victims of prejudice; do not do anything for themselves and expect everything from society; have bad health; have many children.

5 The question was this: "Let us think about the health of the people. Do you think that the Roma have better or worse health than the others? And what about the level of education?" Other questions planned were related to income, unemployment, career chances, housing situation

6 I do not assess in my article whether these latent variables are "true" or "correct".

7 Just to be clear: I am not trying to assess here whether such a hypothesizing or such a derivation of latent variables is "correct" or not. The literature about such assessments is vast. I am trying to show how the formulation of latent variables is shaped by knowledge elements that are independent of the research results of this specific project under study, and which, therefore, influence both the wording of the questionnaire and the collection and interpretation of data.

8 Neither here – nor elsewhere in this text — do I suggest that the methods of the researchers from the USA were in any way 'better' or 'more objective' than those of the other team.

9 Again: I do not discuss here at all whether researchers' knowledge about these latent variables is 'true' or 'false'.

University Campus Living Labs: Unpacking Multiple Dimensions of an Emerging Phenomenon

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Abstract

Universities and their changing role in society is a source of perennial debate. In this article, we examine the emergent phenomenon of *University Campus Living Labs (UCLL)*, the set of practices by which universities use their own buildings, streets or energy infrastructure as experimental settings in order to support applied teaching, research and co-creation with society. While most existing studies of UCLLs focus on them as sustainability instruments, we explore the UCLL phenomenon from an open-ended and fresh angle. Using living labs in five European universities as exemplary cases, we demonstrate the breadth and variability of this emerging phenomenon through five analytical dimensions to unpack the multiple forms and purposes that UCLLs can have. We furthermore consider aspects of inclusiveness and situatedness of living lab co-creation and testing and what the UCLL phenomena may come to mean for the continuously changing university, calling for future studies to substantiate these aspects.

Keywords: University Campus Living Lab, co-creation, sustainability, science communication, Quadruple Helix, public engagement

Introduction

The changing societal role of modern universities has been debated for decades (Martin, 2012; Trencher et al., 2014). Almost thirty years ago, Gibbons et al. (1994) pointed to the new production of 'Mode 2' knowledge, while Etzkowitz and Leydesdorff (1995) coined the 'Triple Helix' concept, with its increased collaboration between university, private industry and government, and Clark (1998) hailed the emergence of the entrepreneurial university. More recently, Trencher et al. (2014: 152) have argued that "the emergence of this entrepreneurial 'species' [is] not ... the last chapter in the ever-evolving modern university". Instead, a "broader and more ambitious function has emerged: that of a societal transformer and co-creator" (Trencher et al., 2014: 152), which entails a collaboration between universities and local government, industry and civil society to drive the physical and sustainable transformation of, for example, the region.

Within this broader area of interest in universities' evolving missions and contribution to society and sustainability, a literature is emerging that looks specifically at how universities are embracing the much hyped 'living laboratory' concept to promote sustainability in various ways (e.g., Evans et al., 2015; König, 2013). As Evans et al. (2015: 1) write, "[t]he living lab approach is increasingly popular with universities, who recognise that their campuses offer amenable real world locations in which to conduct applied research [and teaching]. […] Living labs promise to bring researchers, students, external stakeholders […], and university estates and facilities staff together to co-produce knowledge about new sustainability technologies and services in real world settings".

In brief, living labs can be defined as an "experimentation environment in which technology is given shape in real life contexts"[1] (Schuurman et al., 2013: 2). They foster collaborative work between various stakeholders to generate innovative solutions. Key to the living lab concept is processes of co-creation, the coming together of different actors in a joint activity that leads to a mutually beneficial outcome (Ramaswamy and Ozcan, 2014). Universities employ the idea of living labs for several related reasons, as will be evident from the above: to co-create sustainable regional change, to enhance applied teaching and research about sustainability, to foster social learning and the co-production of sustainability science, or simply to make campus operations more energy-efficient (Trencher et al., 2014; Evans et al., 2015; König, 2013; Filho et al. 2017, 2020).

Universities either engage in urban living lab partnerships in their region or host them on their own campus. In this paper we explore the latter phenomenon, which we term University Campus Living Labs (UCLL), by studying five cases in which universities have turned their own campuses into living labs, that is, spaces where the university utilizes its own buildings, streets or energy infrastructure as real-life experimental settings. In doing so, we contribute a fresh perspective on universities and living labs. Despite rich insights from several interesting cases of living labs on university campuses (see e.g., Evans et al., 2015; König, 2013; Filho et al. 2017, 2020), we argue that a *shift in attention* to how they are explored is needed. While universities used to build designated laboratories to run experiments under controlled conditions, they are now using their campuses, staff and students as part of the experiment. Universities are no longer spaces that *contain* laboratories, but *are* themselves laboratories, entangled in co-creative relations. While the literature on universities employing the concept of living labs focuses its attention on various aspects of how these living labs can be the movers of sustainable development, we aim to go beyond this sustainability framing to illustrate a broader diversity of aims and modalities in this phenomenon, employing a Science and Technology Studies (e.g., Felt et al., 2017) lens that pays critical attention to knowledge politics, power and technoscience-society relations, and foregrounds an explorative approach. Thus, we are interested in understanding the *breadth* and *variability* of this phenomenon, motivated by the following research question: *Many forms of living labs have emerged on campuses in recent years, but what are the stated purposes of UCLLs, and what forms do they take?*

Our primary contribution is the examination of five analytic dimensions that discriminate the UCLL phenomenon's many shapes and purposes. However, we are also interested in the broader shift towards co-creation within the university. Our analyses of living labs constituted within the socio-material milieu of a university campus therefore also motivates a discussion around co-creation in UCLL's and in living labs more broadly, as well as what the UCLL phenomenon may come to mean for the way universities develop – as something that has importance for "transformations in the inner organisation of the 21st century university system" (Tuunainen and Kantasalmi, 2017: 5). In doing so, we hope to inspire future papers to substantiate this agenda and discussion and continue the exploration of UCLL's as a multifaceted phenomenon.

We structure the article as follows: in the following section, we present and discuss the core concept of living labs, as well as their previous applications on university campuses. In the subsequent section, we outline our methodology and present our five cases, which have been chosen to represent variety in national contexts, university settings and initial arrangements. In our analysis, we identify five key dimensions along which our cases differ and use them to structure our analysis. We end the article with a concluding discussion.

Living labs on university campuses

As mentioned above, the idea that universities increasingly collaborate with external actors to facilitate technology transfers and co-produce knowledge to solve complex, transdisciplinary social challenges (Gibbons et al., 1994, Etzkowitz and Leydesdorff, 1995; Clark, 1998) has been richly described. Recently more attention has been placed on universities' role in not only contributing to, but enabling the sustainable transformation of a locality, as exemplified in Trencher et al.'s (2013, 2014) description of a fourth mission of 'co-creating for sustainability'. As such, this work extends a longstanding interest in understanding the "significant alteration [that] has taken place in science and university organization" (Tuunainen and Kantasalmi, 2017: 3).

As pointed out in the introduction, one of the co-creation tools that universities as well as industry and the public sector have embraced, and which has attracted academic attention (Leminen and Westerlund, 2019), is the 'living laboratory'. The European Network of Living Labs (ENoLL) defines living labs as "real-life test and experimentation environments that foster co-creation and open innovation among the main actors of the Quadruple Helix Model, namely: Citizens, Government, Industry, Academia" (ENoLL, 2022). While there is some attention to how universities can use this instrument to e.g. facilitate technology transfer and boundary spanning (Van Geenhuizen, 2013, 2018), most often the focus is on the ability of living lab partnerships to promote urban or regional sustainable change (Bulkley et al. 2016; König and Evans, 2013; Evans and Karvonen 2014; Voytenko et al. 2016). Living labs are indeed generally becoming a political priority (Evans et al. 2015). Over the last ten years, living labs have emerged globally as a popular innovation instrument, to the extent that innovation scholars are labelling the ongoing phenomenon as 'the living lab movement' (Leminen and Westerlund, 2019: 250), while others capture the current trend in the notion of a 'Pilot Society' (Ryghaug and Skjølsvold, 2021).

In this paper, we focus particularly on living labs employed *on* university campuses, and we noted above how these living labs are almost exclusively explored in terms of sustainability – in their capacity to foster the co-production of sustainability science and offer applied and interdisciplinary teaching and research opportunities, and in their ability to aid green campus operations and foster social learning and change (Evans, 2015; Cole and Srivastava, 2013; König and Evans, 2013; Filho et al., 2017; 2020). According to Evans et al. (2015: 2), university living labs have the advantage that "consulting users and stakeholders allows complementary sets of projects to be strategically planned that offer holistic solutions to sustainability challenges". Moreover "by emphasizing the iterative process of experimenting and learning from year to year they provide a more coherent basis for action over time" (Evans et al., 2015: 2). This interest in living labs on university campuses as tools for sustainable change is also reflected in the increasing popularity of the 'International Sustainable Campus Network' (ISCN) and in the work of Verhoef and Bossert (2019), who published a practical guide to help universities setting up living labs on campus. The uniqueness in a campus as a sustainability living lab, they point out, is the transdisciplinary approach, the ability to combine campus operations with the universities' primary functions of teaching and research, and the fact that universities are active at several scales of the experimentation and implementation of sustainability solutions. According to König and Evans (2013: 12), a university campus's living lab is a "site for social interaction and engagement resulting in knowledge production across organizational and disciplinary boundaries".

Although universities have increasingly embraced them, living labs have a history that extends well beyond their recent applications by universities and public governance institutions, and they have for many years also been used as tools for private actors to help commercialise their products (Voytenko et al., 2016). Living labs are thus applied in a multitude of ways and have been used to develop, for instance, health care, ICT products, smart cities (e.g., Hossain et al., 2019) and renewable energy transitions (Ryghaug and Skjølsvold, 2021; Nyborg and Røpke, 2013), as well as for driving sustainable urban transformation (Bulkeley et al., 2016). Their outcomes can be everything from concrete designs, products, prototypes and systems to scenarios, processes, concepts and ideas, and they draw upon a variety of methods such as behavioural data analysis, ethnographic research and focus groups (Hossain et al., 2019; Evans et al., 2015). In terms of user involvement, living labs can be either closed, i.e. involve pre-selected users (for instance a user panel), or they can be open to everyone who wants to participate (for instance a local community in a city) (Dell'Era and Landoni, 2014).

Recent STS scholarship highlights how living labs and test beds do not simply perform controlled experiments under presumably realistic conditions, but rather test entirely new socio-technical arrangements (Engels et al., 2019). Moreover, the experiments and tests reconfigure relations not only in the lab, but in wider society – in other words, real life experiments are often infrastructurally configured and seamless as they are no longer "spatially and temporally separate from the environment", but most importantly, they "operate on social relations" (Marres and Stark, 2020: 438). As living labs intervene across entire social orders, they may require changes to local laws and regulations and therefore share ideas with the notion of regulatory sandboxes (Engels et al., 2019: 2), or with what transition theory scholars call 'niches', i.e., protected spaces for experimentation (König and Evans, 2013) that can later be scaled up, e.g., to the entire city. Thus, the living lab concept brings with it several tensions and paradoxes: a core value proposition of living labs is their ability to conduct controlled experimentation (the 'lab' bit) while simultaneously allowing testing in real-world conditions (the 'living' bit). In such real-world environments, uncontrolled, 'messy co-creation' is often a more accurate description of activities in living lab sites (Engels et al., 2019: 8). Moreover, living labs and test beds play on the duality between being both protected and 'exceptional places' that are relieved of various constraints (legal, for example) to foster 'free' innovation and experimentation, yet they also claim 'representativeness', as they take place in real life (Laurent et al., 2021).

Taken together, the current literature on UCLLs have a distinct focus on them as tools for sustainability, whereas we claim they have a multitude of other aims, agendas and purposes that deserve more attention, and which come to light via a grounded and situated approach to studying UCLLs. In unfolding the UCLL phenomenon through five analytical dimensions of '*organizational anchoring*', '*industry collaboration*', *'sustainability & student involvement'*, *'experimental ethos'*, and *'visibility, self-identity & communication',* which emerged inductively during our analysis of the empirical material, we also aim to point out issues around co-creation in UCLL's that deserve more attention. Furthermore, we tentatively explore the potential importance of the UCLL phenomenon for the way universities develop, i.e., for changes in both scientific practices and the transformation of the university organization (Tuunainen and Kantasalmi, 2017: 6). These issues are currently understudied and should be further substantiated in future studies. In the following, we will shed light on these aspects of the UCLL phenomenon, but first we present our methods and data.

Methods and data

This article builds on an interpretive case study approach (e.g., Walsham, 2006) using material from five European universities that have integrated living lab activities into their campuses. The examples were selected out of a larger pool of living lab cases being studied in the Horizon2020-funded project SCALINGS (SCALINGS, n.d.). Our five cases were chosen to provide contrasts on the UCLL phenomenon in Europe, focusing on our research question of purpose and form to include as many understandings of the UCLL phenomenon as possible. They are affiliated with universities in Denmark (Technical University of Denmark, DTU), the Netherlands (Technical University of Eindhoven, TU/e), Poland (Wrocław University of Economics and Business, UEW), United Kingdom (University of the West of England, UWE Bristol) and Germany (HFT Stuttgart)—see Table 1, which provides basic information on each case study, with facts about the university, as well as the origin and special characteristics of each UCLL.

Originally, these cases were in a group of 36 cases produced for the entire SCALINGS project, following a shared protocol with the aim of understanding diverse forms of situated co-creation. The case studies were conducted in 2018–2019 and drew upon various materials such as semi-structured interviews with a wide range of stakeholders (researchers, students, operations staff and administrative personnel), as well as desk research and participatory observation in various events connected to the cases (see Table 3 in appendix). Since our aim is to investigate the UCLL phenomenon across a set of different cases, in order to unpack the many aims and forms UCLLs may have, we have focused on the comparisons between the cases, rather than describing each case in its own context, just as we have been forced to leave out a wealth of interesting detail. Furthermore, as the cases continue to develop since we ended our data collection, our case studies necessarily present instances of them as they were performing during the time we studied them.

Our analysis for this article took place in two separate phases. First, we identified a set of themes and asked the authors of the five cases to use these themes as a structure for describing the particularities of their case (that is, the origin of the living lab, the main idea, how the campus is mobilized for this, etc.; see Table 2). We developed the themes based on our study of the literature referred to above, which informed us about different core characteristics of living labs we could focus on to unpack their differences. The development of themes was also based on preliminary observations from our cases, which in an iterative process with the literature review also informed us about what aspects of living labs that were relevant to investigate in the context of this paper. Secondly, we conducted an interpretative analysis by comparing these themed descriptions across the five cases. This analysis process resembled an 'immersion/crystallization' (Borkan, 2022) process, characterised by a "process wherein researchers immerse themselves in the data they've collected" and a process of reflection "on the analysis experience and attempt[ing] to identify and articulate patterns or themes noticed during the immersion process." (Borkan, 2022: 787). The author group thus first spent time delving into the data by producing the case descriptions of their own cases and then reading the other case descriptions multiple times. This was followed by an analysis workshop, where emerging themes or dimensions of UCLL's were developed from these case descriptions and which were refined in multiple iterations in the group. The comparison thus resulted in *the identification of five analytical dimensions* that structure our empirical analysis in the next section.

Table 1. Basic information on each case study, i.e., facts about the university, origin and special characteristics of each UCLL.

	DTU	TU/e	UWE Bristol	HFT Stuttgart	UEW
History and characteristics of university	Founded in 1829 as a polytechnic and became a self-governing institution in 2001, with ownership of buildings and its own utility supply. Campus operations staff are very innovative.	Founded in 1956 by industry, government and academia. Has close ties to high-tech companies and e.g., Philips, which has its main seat in Eindhoven. Campus is integrated in the city.	Founded as a Technical College in 1595, but a public research university since 1992. UWE Bristol values collaboration with their community, industry and doing applied research.	Founded in 1832 as a winter school for craftsmen, now an inter-disciplinary modern University of Applied Sciences in e.g., architecture, civil engineering and physics.	Founded in 1950, with a focus on training in economics and management sciences. UEW's strategy emphasizes sustainable development and social and ethical responsibility.
UCLL origin	The 'DTU Smart Campus' project was initiated in 2015 by DTU's Office for Innovation & Sector Development (OIS) and Campus Service (CAS), mainly to support student innovation.	University policy to develop living labs in 2008. In 2009 the Intelligent Lighting Institute was established in the Atlas building. In 2019 the Atlas Living Lab was opened, one of 14 official research facilities.	The living lab was originally built in an ad-hoc manner in the mid-2010s by a senior researcher inside Bristol Robotics Lab to test assistive robots and monitoring systems together with older people.	The EnSign Living Lab was established in 2015 to enable a climate-neutral campus by 2030. It is one of 14 living labs funded by the State of Baden-Württemberg (€18 m)	In 2017 Green Team was established as a bottom-up grassroots initiative by researchers to support the sustainability agenda in Poland. Aim for an innovative "green campus."
UCLL characteristics	Entire campus infrastructure is test platform. Students, start-ups and staff can test concepts in real life, and set up prototypes, mock-ups or sensors in streets, in buildings or in the supply infrastructure, or they can be given access to consumption data from the supply system. Plans to test autonomous buses in the streets of Cam-pus.	Lighting and indoor climate in Atlas building is intelligent. Students and staff can innovate measurement technology and enquire into the effect of lighting systems on issues such as winter depression or well-being. The latter is compared before and after the move to Atlas. Other buildings/streets on TU/e also test light + PV systems.	The Anchor Care Homes Assisted Living Studio resembles an apartment home. It has an open-plan living, dining and kitchen area, as well as a bathroom and a bedroom. It is instrumented with a network of wireless sensors linked to a smart home-controller hub, cameras and the university's internet connection.	The aim of Ensign was focused on developing a new sanitation refurbishment pathway for public estates and to scale it up to the city. It also aims to foster "science for sustainability" and interdisciplinarity. The LL allowed the testing of technologies developed in a master project: the ecoGIS app (improve environmental facility management).	UEW has committed itself to switch to green energy on campus by 2030. It has reduced energy consumption of heating/cooling and lighting through e.g. new windows and insulation, LED technologies, new thermostats and selective waste management. Also PV on roofs, aim for ground heat pumps and water-saving installations.

Table 2. Initial themes to be described for each case

Initial themes used to describe cases
1. *Genesis: What made the living lab(s) happen—what key actors and structures aligned to make it come into being?*
2. *What is the core idea, principle, goal or value creation of the living lab projects, and according to whom?*
3. *In what concrete ways is the university campus mobilized in order to reach these goals?*
- *What technologies and infrastructure are available for experimentation? (Fx data, energy, streets?).*
- *What do the living lab activities look like?*
- *What are the challenges experienced in going from idea to practice?*
4. *Is the living lab "open" or "closed"?*
- *Who is "the user"? How do these take part?*
- *What are the "boundaries" (e.g., is it a "room" on campus, a building, an open street, an innovation space etc.)?*
- *What makes the activities "living lab activities" and not e.g. test beds?*
5. *What does it mean for the shaping and form of these living lab activities that they are taking place on (this specific) university campus? Is the campus setting an advantage for co-creation and the living lab activities and if so, how?*
6. *Conversely, in what ways are the living lab(s) an advantage for the university in terms of a) its core activities (teaching, research, technology transfer) and b) its self-identity?*

Five dimensions of university campus living labs

Five analytical dimensions emerged inductively from our analysis of the case studies. These are dimensions that they particularly differ on, for instance, in respect of how the UCLL was initiated or how it caters to industry relations, thus illustrating the breadth and variability of the UCLL phenomenon.

The five dimensions are concerned with:
1. Initiative and organizational arrangement of the Living Labs (*Organizational Anchoring*)
2. Living Labs as a mediator for industry collaboration (*Industry Collaboration*)
3. Encouraging students to support the university's sustainability agenda (*Sustainability and Student Involvement*)
4. Integration of the Living Lab's experimental ethos into the university (*Experimental Ethos*)
5. Living Labs as providers of visibility and identity formation (*Visibility, Self-identity and Communication*).

Organisational Anchoring

Our first axis of analysis focuses on how the living labs have emerged, and how they are anchored in the university and are funded and "kept alive." Our cases demonstrate how the initiation and place of each living lab in the different university organisations varies significantly. Firstly, the cases differ in terms of who or where in the organisation the initiative came from. For instance, in the Polish case (UEW), the living lab activities were started as a bottom-up initiative in 2017 by 'the Green Team'—a group of academics devoted to sustainability and co-creation. Initially, the team had no separate budget or formal organisation, but spent time describing the movements' goals and tasks and recruiting supporters. In 2018, the University Rector signed the international "100% committed campaign" (The Climate Reality Project, 2021), which formalized the university's commitment to the sustainability agenda, and a separate budget of €10,000 was allocated for the Green Team. Subsequently, the teams' work brought EU funding for the renovation of campus buildings and the mobilization of, for example, the University Entrepreneurship Incubator InQube. In contrast to UEW, the University of Stuttgart's living lab, Ensign, was designed and driven top down, as it was initiated within a much larger regional framework: the State of Baden-Württemberg had invested €18 million in fostering real-world laboratories, of which half were associated with a university. A coterie of two to three professors were instrumental in developing EnSign, receiving support and attention from top management, and fully-paid positions were allocated to support the project.

Secondly, the cases differ in how centralized or decentralized the UCLL activities are, both organisationally and geographically. Some universities have a centralised, coherent and strategic approach to the living lab which is anchored in a 'living lab team' and supported by the university's senior management, involving the entire campus area, or at least very public parts of it (e.g., Stuttgart, UEW). At UWE Bristol, on the other hand, the living lab initiative is more decentred and run by an independent researcher and department. They also vary in terms of their temporality. Sometimes the living labs have a permanent character, as seen in the cases of DTU and UWE Bristol, where the utility infrastructure (DTU) or a 'model apartment home' (UWE Bristol) is the permanent platform for multiple (sometimes minor) unconnected projects. In contrast, other UCLLs are temporary, as the Ensign project illustrates, where the transformation of campus is part of a project that received one-time funding.

In short, university campus living labs have very different beginnings and can be funded and anchored in their universities in multiple ways, varying from being driven by a volunteer bottom-up movement of researchers and financed through e.g., the EU to being born out of top-down state funding and framing.

Industry Collaboration

As indicated in Table 1, the universities' collaboration with industry (e.g., TU/e's history with Philips) and other external private partners (e.g., Anchor Care Home Charity's support of UWE Bristol) is a core driver for the development of some UCLLs. For Bristol Robotics Laboratory (BRL) researchers, the purpose of the lab is to bring together different forms of expertise to co-create pragmatic robotics solutions and reduce the time to market, and it is co-funded by the private Anchor Care Home Charity. Located in an old industry building on campus, the lab materializes long-term collaborations between the university and the private sector in and around Bristol. UK research councils and Horizon 2020 robotics projects have also contributed to the continued use and further investment in the built architecture of the lab. In this sense, the living lab is a means by which to sustain collaborative relations over and throughout multiple projects. At UWE Bristol (and several other cases), the lab is also a means to convene networking and funding as they are in situ, durable manifestations of successful collaborations with external actors, and they give visibility to the research groups affiliated with them (Michalec et al., 2021).

The case of TU/e similarly demonstrates entwining with external private partners, in this case well-established industries in the southeast Netherlands. TU/e was established sixty years ago at the initiative of, among others Philips, a leading producer of lighting solutions. As one of the interviewees indicated, TU/e has a self-identity of being "no. 1" in Europe in terms of collaborating with the industry. Philips play a major role in Eindhoven, having driven the development of the university, as well as several public services such as shops, housing development and sports clubs. The majority of living lab activities at TU/e are about developing lighting technologies for improved human health—for instance, by focusing on developing lighting systems that reduce winter depression (seasonal affective disorder).

In comparison, living lab activities at DTU do not cater only to one specific industry, but have an entrepreneurial "start-up focus". The city of Lyngby does not have a history of being an industrial hub as Eindhoven does, and the start-up culture at DTU was emphasized by an interviewee in the Office for Innovation and Sector Development (OIS), who finds that students idealize "the entrepreneur as a rock star" (Interview). More than TU/e and UWE Bristol, the DTU Living Lab speaks to SMEs in the region and was developed as a means to cater for the student start-up environment at DTU.

Thus, to sum up, the living labs seem to be supporting technology transfers and mediating industry–university relations, but with a varying focus. Whereas TU/e and UWE Bristol have living labs that are oriented toward long-term industry and private-sector collaboration, the DTU living lab is oriented towards SMEs and student entrepreneurship.

Sustainability and Student Involvement

With the exception of UWE Bristol, our living lab cases also contain a focus on environmental sustainability. This means both supporting sustainability science by offering applied teaching and research opportunities, but also a policy of 'practicing what we preach', for instance, by lowering the energy consumption of their own university buildings. However, the cases differ in the role students play in the UCLLs: that is, whether living lab activities support *student innovation and entrepreneurship*, or whether the students are *social movement activists* who help universities to '*be* the sustainable change' by publicly demonstrating how sustainable change in all its socio-technical complexity can be done (see also Trencher et al., 2015).

For DTU, the main reason for making the energy and data infrastructure of the campus buildings available for experimentation was initially to support student innovation and offer students (and staff) the ability to test their concepts in real life by providing access to money (approximately €650) to purchase the equipment necessary for experimentation. This goal was combined with Campus Service's (CAS) focus on greening campus operations. The CAS manager, for instance, considered devising a competition for students—the student who created the biggest energy saving in their department would win a mountain bike or something similar. For UEW, student entrepreneurship also motivated some experimental activities, as when a student project used data from the integration of PV on campus roofs in computer simulation games. In this way, students have been cast as entrepreneurs.

However, the students also have a different role. In the case of UEW, the primary function of the living lab was not sustainable science or applied teaching opportunities, but to allow the university to *be* the motor of change. For cases such as UEW and Stuttgart, the students are seen as change agents and social movement activists whose involvement in the living lab activities of their university campus shape their attitudes towards having more responsibility. As the Vice Rector of UEW states, "our activities also involve creating the right attitudes among students, we shape youth, future elites… Who, if not a university, should also promote these attitudes?" (Interview)

In summary, UCLLs typically serve two agendas in involving students: first, providing applied teaching opportunities to innovative, entrepreneurial students; and secondly, shaping the 'sustainability leaders of tomorrow' (Verhoef and Bossert 2019) and involving students in 'practicing what we preach' as social movement activists.

Experimental Ethos

A fourth dimension relates to the inherent tension between "controlled experimentation vs. messy co-creation" in living labs (Engels et al., 2019: 8). Among the UCLL cases there is a difference between living labs that conduct experimentation in a "closed, controlled, laboratory" that sits apart from the rest of the university and living labs that are integrated with the entire university organization. This tension manifests itself in a triple comparison of UWE Bristol, TU/e and DTU. In UWE Bristol, the living lab is a confined (simulated) apartment situated within the Bristol Robotics Lab. Although the living lab is open to visitors, by default people on campus (staff, students, external collaborators) are *not* part of the lab: They perform their daily activities in support of the university's functions, unaffected by the presence of the living lab. The lab is detached from the general life and function of the institution. It serves particular and delineated purposes like other labs in the university and could have been placed elsewhere than on campus and in the university organization.

In comparison, the corresponding lab's placement *on* and *in* DTU is a central part of the design of the 'DTU Smart Campus' living lab, where its primary goal is to feed into the teaching mission, start-up culture and tech-transfer activities. The DTU Smart Campus project was developed in synergy with an ambitious renovation plan for DTU's campus, the aim being an architecture that nurtures the meeting of minds and co-creation and which ensured that DTU would be able to 'use its own supply infrastructure to an even greater extent for experimental teaching and research'" (Transforming DTU, 2021).

The DTU living lab could potentially become deeply integrated within the university organization and require a more fundamental change to university practices, relations and identity, so that the entire university becomes the living lab. Such a living lab is perhaps as much an "organisational experiment" (Kleinman et al., 2018: 553) as it is a technical facility. It demands that the entire university organisation is open to novel ways of doing teaching, learning, managing operations, administrating and so on. For those universities that use their own land, buildings, streets, wires and tubes for experimentation, the physical university can also be seen as an integrated practice, rather than simply a container for research, education and innovation activities.

At TU/e, on the other hand, the living labs are formally registered as one of the fourteen laboratories on campus, and the expectations are that they resemble more traditional, controlled laboratories. TU/e has a strong focus on the method of building a living lab, emphasising seeking consent and ethical issues related to the actors involved (staff, students), such as their possibilities to opt out and their having control over the collection of data. Thus, in contrast to the Assisted Care Home Studio at UWE Bristol and the living labs at TU/e, which are both controlled—either in terms of seclusion (UWE Bristol) or methodological rigour (TU/e)—the living lab at DTU is less controlled and in a sense ubiquitous; the entire energy infrastructure, buildings and streets are always open as an experimental setting. It is not gated like the UWE Bristol living lab, and everyone in the university organisation, as well as external collaborators, are invited to utilise the infrastructure as a test bed. Moreover, staff, students and guests are constant sources of data, without necessarily knowing they are being involved in tests or that the data they produce is being used. These data could consist of, for instance, consumption data from the use of electricity, water, heating, lighting, or other digital data giving information on movement patterns, either of pedestrians or users of autonomous buses.

In summary, living labs can range from resembling more traditional, closed and controlled laboratories that have no influence on the 'normal' practices, missions and identity of the university, or they can be more widely integrated into the university, requiring more fundamental participation and a willingness to change on the part of staff and visitors.

Visibility, Self-Identity and Communication

The final dimension concerns how UCLLs make research and innovation processes visible and engage the public in the inner workings of the university. It teases out the cases' differences in terms of the porosity of the boundary between the university and society, between 'inside' and 'outside'. The living labs' activities on campus potentially open up the universities to society and raise their public profiles, as well as supporting an identity as pioneering, future-oriented, innovative and co-creative universities. Their openness makes UCLLs tools for communicating scientific processes and engaging people in science, but also for branding the university as (socially) sustainable and responsible (Horst et al., 2017).

Notably, the self-image, identity and visibility universities can gain from living lab activities seem to be key factors for creating them. For UEW, for instance, the activities of the Green Team are used by senior management to create an image of a university that is open to the non-academic environment and one which values social responsibility. The HTF Stuttgart Ensign project's interviewees mention how the living lab fosters a sense of collective identity and how members of the lab were reportedly seen as the 'cool ones' on campus, those who carried the torch for a 'pioneering institution' and 'innovative university' and who are equipped with 'soft skills' and the ability to engage in co-creative activities. In the same vein, the UWE Bristol Lab values co-creating with users and self-identifies as a transdisciplinary, 'multi-professor' lab, showing the public how roboticists at BRL are concerned with social issues such as health and well-being. Equally, TU/e researchers emphasize the visibility that the living labs give the research groups that are affiliated to them. Finally, DTU's Smart Campus stresses that the living lab's activities conducted in the campus's public areas display the university's research and experimentation to a wider audience.

The university campus living labs thus seem to be connected to ideas about *identity*, *visibility*, *branding, openness, public engagement* and *responsibility*. Moreover, whereas most science communication is about communicating a scientific *result* (to brand universities), living labs are also about communicating the ongoing research *process* to society. As a result, they invite 'outsiders' to witness, and potentially shape, the messy process of knowledge production, rather than seeing only the successful, polished results.

However, the society–university boundary has different degrees of porosity across each case. As already mentioned, the UWE Bristol Lab is visible to all visitors to the Bristol Robotics Laboratory and is often the first stop on tours given to guests at BRL, itself a major destination for high-profile campus visits. However, the lab lies in a closed-off building on campus, access to it is restricted, and all visits have to be coordinated, while visitors are not allowed to take photographs, among other things due to IPR concerns. The lab carefully curates a specific image of what goes on there.

The DTU Smart Campus living lab also stresses demonstrating its research. As stated in an internal memo from CAS and OIS to the top management in 2018, "Smart Campus can become another 'lighthouse project' where DTU's campus… is included as one large test facility. The big vision may be that when you walk around campus you meet robots, see flying drones, and in general meet DTU's research in 'real life'". However, contrary to the UWE Bristol case, the DTU living lab is 'always open', and the performances relating to it are unedited, uncontrolled and uncodified. Visitors can come anytime and watch experiments that are succeeding as well as failing—such as when students are in the process of testing a rocket or smart rubbish sensors in the street. The DTU living lab lets in the outside world to take part in the research process, whereas in the UWE Bristol lab the communication resembles more classical branding exercises. The invitation is, strictly speaking, less open, and the boundary less porous.

To recapitulate, the UCLLs are important branding tools for universities and for opening up to society, but with different degrees of porosity. This difference can be illustrated by Erving Goffman's (1959) concept of front-stage behaviour, which is controlled according to how you want others to perceive you, and backstage behaviour, where you let your guard down (Goffman, 1959: 70). In this perspective, the BRL Lab has a frontstage form of openness, while DTU's vision might let the visitor see more of the backstage.

The multiple modalities and dimensions of the UCLL phenomenon

Our paper has unpacked five dimensions on which our UCLL cases differ markedly: *Organisational Anchoring*, *Industry Collaboration*, *Sustainability and Student Involvement*, *Experimental Ethos* and *Visibility, Self-identity and Communication.* In unpacking the UCLL phenomenon by describing the many purposes, logics and forms that living labs can have on university campuses, we depart from the majority of studies that focus on UCLLs as instruments for the green transition; instead we study them in their own terms and as a phenomenon that has other implications, perhaps even for how the universities themselves develop. Some of our findings are aligned with those of other recent studies on living labs on university campuses, which have, for instance, noted how UCLLs are an opportunity to educate and mobilize students as "potential future sustainability leaders" (Verhoef and Bossert 2019: 11) or how UCLLs have additional benefits beyond providing applied research and teaching opportunities, such as "additional funding, real-life data, results display and exposure" (Verhoef and Bossert, 2019: 43; Evans et al., 2015). Moreover, the empirically rich accounts of how living lab activities are entangled in very different university organizations, strategies and practices lend support to arguments that emphasise how universities around the world are far from homogenous institutions (Horst and Irwin, 2018).

However, our analysis is also unique. We have contributed rich empirical accounts of the multiple modalities of UCLLs, underlining the wide range of ways this phenomenon can be played out, and ways in which the UCLL phenomenon is interesting beyond its role in promoting sustainability. The five dimensions show that UCLLs mobilise other agendas in various ways. For instance: to change the world, to facilitate user-oriented innovation and technology transfer, to improve higher education and student innovation, to conduct human health and robotics research, to heighten the universities' public visibility and funding opportunities, and so on. In this way, for instance, we engage with and unpack Evans' et al.'s (2015: 4) observation that living lab projects have wider implications and should not only be seen as "disjointed sustainability initiative[s] but … part of a wider drive towards applied learning and employability skills". As we demonstrate, the UCLLs can indeed have an educational (or technology transfer, branding, science communication etc.) logic that precedes, or is entangled with, their function as 'sustainability initiatives'. Thus our analysis shows how UCLLs are co-constituted and co-shaped by several agendas simultaneously. In DTU, for instance, the 'student innovation agenda' was the most dominant starting point for the living lab, but it could not be disentangled from the agenda of 'the greening of campus operations'. In UEW, the sustainability agenda was broader than 'a green campus' and more focused on 'changing the world' through bottom-up activism. This agenda was merged with an institutional desire to showcase to the 'outside' that the university was open to collaboration with the non-academic actors and valued social as well as environmental responsibility. In TU/e, the living labs were clearly tied to industry relations, but also shaped by a strong institutionalised commitment to methodological rigour and ethics, among other things. In HTF Stuttgart, the ambitions for a sanitation refurbishment pathway were not clearly dissociable from ambitions to be a future-oriented, pioneering institution that catered for 'soft co-creative skills'. As for the BRL Bristol's roboticists, they were not only concerned to bring technology closer to market, but also saw their living lab as equally an opportunity to acquire funding and as an expression of concerns with social issues such as health and well-being.

Our analysis of the dimensions of 'visibility, self-identity and communication' and 'experimental ethos' perhaps most clearly exemplify what we add to existing literature on UCLLs. First, concerning the dimension of 'visibility and communication', which focuses on university-society boundaries, we suspect that the role of UCLLs as science communication and branding tools, and as anchors for project proposals and funding, may play a more important role for universities than the 'university living lab' literature has so far discussed, with its dominant attention to sustainability. While e.g. Trencher et al (2014: 154) emphasise that living labs are one of several 'research & social engagement paradigms' that are employed by universities in the co-creation for sustainability mission, alongside, for example, 'technology transfer', 'transdisciplinarity', 'cooperative extension systems', etc., our analysis show that their role for universities extends beyond the co-creation for sustainability framework.

We also believe that our analysis on how UCLLs 'open up' to society and collaborate with external actors contributes an epistemic politics that extends Evans' et al.'s (2015: 5) remark on "the ability of the living lab framework to [merely] facilitate engagement with non-academic stakeholders". Insights from STS are invaluable in revealing these politics: UCLLs, as well as living labs in general, encompass a wide range of knowledges and epistemic cultures (Knorr Cetina, 1999) – e.g. both engineering and 'softer skills'. Moreover, these are sites at which different forms of knowledge and expertise has different legitimacy (Collins and Evans, 2007; Callon et al., 2009), sites at which some 'lay-knowledges' may be considered inferior to expert knowledge (Wynne, 1992), notably expert knowledge that is dominated by 'matters of fact' (Latour, 2004). For UCLLs that engage with non-academic actors and encompass both natural and social sciences, reflecting on the a priori skewed power relation between these different knowledge cultures, often revealed through which methods are selected and who does the selecting, is important to remember.

A common feature of the UCLLs we assessed is the diversity of modes but also ideas, interests and driving imaginaries not only between each of the sites, but within each living lab. As we wrote above, the UCLL's were co-constituted by several agendas simultaneously. Yet a curious aspect of this diversity is that difference often goes unacknowledged. Take sustainability, itself a usefully ambiguous imaginary that can, for instance, at once compel competing visions of progress, from eco-modernist technological innovation to communitarian re-imaginations of public services

(Beck et al., 2021). Experiments at UCLLs that have sought to transition the status quo towards these visions have often been marked by contention and even outright conflict over which and whose version of sustainability should win out (Torrens et al., 2019; Yuana et al., 2020). The danger here then is that despite widespread commitments to openness, UCLLs that ignore difference risk backgrounding the politics and power relations of knowledge production and ultimately foreclosing mechanisms that might allow certain participants negotiate or actively shape competing agendas through translation for instance (Callon, 1986) or democratic processes of steering the direction of innovation (Stirling, 2009).

Secondly, our discussion of the UCLL dimension of 'experimental ethos' provides new perspectives with our focus on how 'ubiquitous' living labs may become integrated into the university campus and –organisation, requiring a more substantial willingness to change on the part of staff and visitors compared to more traditional, closed and controlled laboratories. The university's physical campus as a living lab may become an 'integrated practice', rather than being just a container for research, education and innovation activities. How are established power relations between various epistemic cultures and university hierarchies reconfigured in these processes? Issues may also pertain to, for instance, if some of the living lab data is collected by a private company. This was for instance the case for the UCLL at DTU and it created tensions, because it mattered for the type of projects that could be done. Without comparison, imagining a situation where the interests of e.g. private companies are literally built into the physical campus infrastructure and UCLL, it would be relevant to consider what that may mean for the development of research and teaching.

Hence, these points lead us to two aspects of the UCLL phenomenon that we find very interesting, and which we provide tentative observations on, before we conclude our paper, hoping that they can inspire future research. These relate to, first, co-creation dynamics on university campuses and, second, what role UCLL's may play for the ongoing evolution of university practices and organisation and relations with wider society.

Unpacking situated living lab co-creation on university campuses

Co-creation is very often mentioned as one of the main *activities* of living labs alongside, e.g., 'testing' and 'validation' (Hossain et al., 2019). Yet, several things about co-creation in living labs remain taken for granted and understudied in much living lab literature (see e.g., Hossain et al., 2019). Here, we specifically discuss aspects of inclusiveness and situatedness of living lab co-creation, which provides some points for reflection about knowledge politics and co-creation in general, but also about specific aspects of UCLL co-creation that is worth enquiring further into, in our view.

As we wrote in the introduction, co-creation is an umbrella term that generally denotes the coming together of different actors in a joint activity that leads to a mutually beneficial outcome. Van Geenhuizen (2018: 1283) emphasises co-creation as the learning process in living labs, which "ideally, encompasses joint problem-definition and problem-solving using improvisation and experimentation – this in designing, implementation and testing of solutions in an iterative way". What the co-creation outcome can be in a living lab is extremely diverse, given the wide variety of ways living labs are employed, ranging from being tools for industry to co-create with the users to being governance instruments for cities. In the context of universities, we also locate very different modes and outcomes of co-creation. While the co-production of knowledge in terms of sustainability science and interdisciplinarity was a central aim for the Stuttgart UCLL case (and e.g., Evans et al., 2015), the examples in the present article also include the co-design (Sanders and Stappers, 2008) of material stuff, and broader social visions and their real-life demonstration. For instance, we can see co-creation reflected in the "participative methods and user-centered design" in the UWE Bristol case, where assistive robot technologies are developed together with the elderly, or as the co-creation of a demo society in the case of UEW.

In line with our discussion in the last section about the importance of reflecting on knowledge politics, power relations and inclusiveness, we think it is crucial to consider collaboration dynamics in living labs in terms of who is involved, how, in what actor role and with what agency. This has been explored by e.g., Hakkarainen and Hyysalo (2013, 2016), Hyysalo and Hakkarainen (2014), Leminen (2013) and Nyström et al. (2014), but deserves more research focus and STS attention, in our opinion.

In most of our UCLL cases, the students are involved in living labs, but in very different roles. The literature on campus living labs for sustainability often mentions students as powerful change agents. However, the ethical review board at TU/e is attentive to potential issues such as the university hierarchy and power relations between students (who may be eager to get their degrees) and their teachers (who may want quick results), which could make it difficult for vulnerable students to opt out of a living lab setting, and TU/e also actively seeks consent from students and other actors involved in living lab co-creation. Conversely, at DTU, although some students knowingly engage in the living lab and are acknowledged as competent innovators, most students (and staff) are automatically and unknowingly involved in the boundless living lab, for instance, by producing consumption data (see also Marres and Stark, 2020). Therefore, although we previously suggested that the TU/e case resembled a controlled lab and that DTU allowed messy co-creation, it may be the other way around: mutually beneficial co-creation implies that actors know they are participating, are able to "speak back" (Engels et al. 2019: 8) and can negotiate their own role and interests in the design process (Elkjær et al., 2021). Otherwise, they are enrolled as passive objects following a more standard testing or laboratory-like paradigm, which is the case for DTU when, for example, energy consumption data from campus is used. Thus, although TU/e has a more controlled lab approach, TU/e is also more reflexive about methods and the stakes involved for all actors and thus more conscious that co-creation is happening.

Situatedness of co-creation

Finally, studying living lab co-creation at UCLL's provide a good opportunity to discuss *situatedness* of co-creation, and how co-creation processes are contingent upon 'place' and the socio-material space they develop in. Indeed, STS emphasise that knowledge production and innovation is always situated in specific cultural, organizational, socio-political and regulatory settings (Haraway, 1988; Jasanoff, 2005). Although the literature on university living labs is concerned with 'locally situated knowledge' and 'place-based needs' (König and Evans, 2013; Trencher et al., 2014), little attention is paid to whether the living lab is placed on campus or in the city, and what that means for co-creation processes and outcomes. However, we could ask, for instance, whether the university campus space supports freer, more innovative or responsible living lab experimentation and co-creation compared to other, e.g., urban, spaces[3]. In this context – although all UCLL configurations lead to unique modes of co-creation – the institutional capacity and history of universities is relevant to highlight as factors that may shape UCLL's in certain ways compared to other urban labs. An exploration of the role of the university as a supposedly 'interest free' living lab space, for instance, would be interesting to do. What has previously been discussed in the literature is whether UCLLs are a particularly 'neutral' anchor for responsible innovation. König and Evans (2013: 1) argue that, because of "their considerable resources and durability, universities have a pivotal role to play in addressing sustainable development." Similarly, Verhoef and Bossert (2019: 11) emphasise that universities are "trustworthy institutions" that can create long-term strategies, as they are not "connected to election periods or annual sales." In comparison to this, our cases might underline that universities are indeed bound by interests that shape those of the living labs', as our cases show (Anchor Care Home Charity, Philips, etc.). Nonetheless, although our empirical material does not merit an extended discussion of universities as a 'neutral anchor', it does point to socio-material aspects of the 'exceptional' university campus space that may shape UCLLs, making them differ from other types of living labs in distinct ways.

In arguing that university campuses are 'special' compared to other urban living lab spaces, we could also draw on Laurent et al. (2021). They point to how islands have become popular living lab sites as they are places of both exception and representativeness and these characteristics may also apply to university campuses. Although it is debatable whether university campuses can be considered 'islands' in the surrounding city, one could argue that a university is a 'place of exception' in many senses. They are sometimes, for instance, referred to as a 'mini city in the city', and they do share traits with other regulatory sandboxes; they often have ownership over their own infrastructure and buildings, and are thus in a sense able to 'lift restrictions' and enable unique and organizationally facilitated co-creation between operations staff, students, researchers, the municipality and industry. What the universities' institutionally captured collaboration and self-ownership of the experimentation platform means for innovative processes would be interesting to enquire further into, as our cases tentatively suggests that these features makes UCLLs very flexible living labs that are conducive to early concept development[4]. Our cases also suggest that it is easier to recruit test people in UCLL's (staff and students and allegedly 'pro' technology), and that it is an advantage for researchers to have the test site close by and "on their doorstep" (Evans, 2015: 3).

Integration of UCLLs in university practices

These perspectives brings us to questions relating to how living labs at campus are co-developing with the societal role and day-to-day practices of universities. Living labs on university campuses can be interpreted as new ways of continuing university–industry–society relations and 'hybrid experiments' (Kleinman et al., 2018) and as instruments in the emerging mission of 'co-creation for sustainability' (Trencher et al., 2014). As others have observed, UCLLs synthesise universities' core business of research, teaching and social responsibility and provide frameworks for the co-production of knowledge (Evans et al., 2015: 6). Our cases suggest that living labs are an easy way for industries to collaborate with universities via small-scale projects: companies have easier access to students, and living labs give students access to real-life problems to solve, such as lowering energy use in buildings. The UCLLs are boundary objects (Star, 2010) that organise and mediate new relations between companies, students, researchers, operations staff, neighbours, municipality or city officials and university management. In our view, however, what seems particularly interesting about these new UCLLs is that they have the potential to reconfigure these relations—and the university's identity, role and practices—on a more substantial level, because of their potentially substantial integration into the 'everyday life' of the university. The socio-material integration in the setting of the university campus is key to this: the university as an organisation not only facilitates co-creation in the region, but might *itself* become the experiment.

Our discussion of the experimental ethos and visibility dimensions bear witness to this, suggesting that having ubiquitous or pervasive living labs on campus may require more fundamental changes to the myriad of day-to-day practices carried out at a university, configure new roles and relations between staff and students, and open-up its hitherto closed areas of backstage experimentation, thus revealing processes and unpolished results. As opposed to other organisational features of mediation (science shops, tech-transfer offices, public science communication events or industry-oriented projects), these UCLLs are perhaps more deeply entangled with the everyday socio-material practices performed at universities. As noted in König and Evans (2013), deeply integrating operational and academic sustainability requires an institutional culture change. Thus, UCLLs potentially reconfigure the university from the inside, materially and through knowledge production, and these new relations may foster and enable new identities, narratives and public images of the university as something that is sustainable, participatory and co-creative. However, as noted before, important question concern whose interests are translated in living labs and, for instance, what kind of knowledge and objects are the outcome of new actor configurations in UCLLs, and what it means for teaching practices. UCLLs that do not acknowledge the politics and power constituted by methodology and privileged access risk merely conforming to incumbent interests rather than genuinely transforming transdisciplinary relations and practices of universities, science, industry and society that might yield more sustainable as well as more equitable and just ways of doing and being in the world (Smith and Raven, 2012).

The UCLLs also beg a discussion of their role as science communication tools, beyond their role in mediating innovative relations and co-creation, as we also pointed out earlier. An important feature of living labs is their role as instruments to showcase and *demonstrate* to a public audience certain desirable socio-technical futures and research agendas (Engels et al., 2019; Ryghaug and Skjølsvold, 2021). In this sense, UCLLs also seem to reflect some of the responsibility and openness heritage from the science shops that arose in the 1970s and 1980s to allow the public free access to scientific knowledge as a response to concerns that research had become elitist and that researchers in their ivory tower (Shapin, 2012) had lost touch with social problems (Dickson, 1984; Irwin, 1995). Thus, the UCLLs are perhaps replacing the crumbling ivory tower figure with the public image of the university as a sandbox in which everyone is invited to play.

Conclusions

To conclude, in this exploratory study, we have described the UCLL phenomenon through five analytical dimensions, unpacking the breadth and variability in the UCLL phenomenon, and showing the multiple purposes UCLLs have beyond being drivers of sustainability. Instead, UCLL's promote student innovation and cater for industry relations, science communication and public visibility, among many other things. We have furthermore considered how these dimensions illuminate the many forms of co-creation that the UCLL space caters to, and we have identified several aspects around living lab co-creation as well as UCLL co-creation in particular, that merit further attention. Moreover, we have started an exploration of the UCLLs' entanglement with their host universities, although it remains an open empirical question as to whether UCLLs will substantially change universities.

This study nuances our understanding of the UCLL as an empirical phenomenon, but also contributes to broader STS debates about co-creation (e.g., Pfotenhauer et al., 2021; Müller et al., 2021), public engagement with science and science communication (e.g., Horst et al., 2017), as well as knowledge politics, transdisciplinarity and the relationship between science, university and society (e.g. Gibbons et al., 1994; Nowotny et al., 2001; Tuunainen and Kantasalmi, 2017). Our study also taps into important issues concerning the notion of test beds and living labs, such as those raised by Engels et al. regarding the co-production of social and technical orders, democratic accountability and regulatory control, and "the responsible use of test beds as vehicles for innovation" (Engels et al., 2019: 2). Marres and Stark similarly draw our attention to the current test bed hype, calling for a new sociology of testing and arguing that "something more radical is happening … than simply attempts to move tests from the laboratory into social settings" (Marres and Stark, 2020: 423), in that engineering "tests the very fabric of the social" (Marres and Stark, 2020: 425), and conflate engineering tests and social experimentation. In this paper, we have touched upon such issues in our discussion of the ubiquitous DTU Smart Campus living lab, which potentially changes a myriad of day-to-day practices at the university and becomes just as much an organisational experiment as a technical facility. What is more, such pervasive living lab settings where "anything can be a test situation" (Marres and Stark, 2020: 434) leave little space to 'opt out of the experiment', posing important questions as to who participates and how, as well as who is able to initiate such tests (Marres and Stark, 2020: 434). What remains underexplored in STS studies of living labs and test beds, however, is what this radical – and sometimes infrastructurally configured and seamless (Marres and Stark, 2020) – mode of testing means if it is situated in a university campus, thus 'operating on', governing and modifying the social environment *here* and not the environment in other urban spaces. This paper takes the first steps toward addressing what happens when new, ubiquitous testing environments move into the very heart of universities – a crucial site for research and innovation in society – and what such reconfigured socio-material relationships mean for how universities and knowledge practices develop and for the co-production between the 'exceptional' university campus space and living lab configurations.

Indeed, ubiquitous test environments involving unknowing experimental subjects are not the only types of living labs on universities, and we have seen that several of the cases – and much of the living lab literature (Hossain et al., 2019) – focus on co-creation and on active participation. We have called for more STS attention to what co-creation could and should mean in the specific setting of UCLL's, and who participates and in what ways. What is important to note in this connection is that co-creation only fosters socially inclusive and responsible innovation if explicit efforts are made to include all relevant stakeholders in the process, be they university students, partners or otherwise (Müller et al., 2021) and on terms that are appropriate and equitable. Moreover, co-creation in UCLLs is not a substitute for democracy - if co-creation is to achieve its more radical participatory goals, it requires institutional and structural support (Smallman and O'Donovan, 2023). Pragmatically, this means that socially inclusive co-creation at UCLLs must be supported by institutional levers with which the power and politics of knowledge production within these spaces can be acknowledged and addressed. As we wrote earlier, a critical eye towards whose knowledge and interests are translated in UCLL's is thus needed. Indeed, as Turnhout et al. argue, knowledge co-production settings comes with unequal power relations, with 'elite actors' having more time, skills and resources available to "shape these processes to serve their interests" (Turnhout et al., 2020: 16). It remains to be seen whether universities or their industry partners are willing to cede decision making power and governance in ways that are enduring and reach beyond the spatially, temporally and institutionally boundaries of UCLLs. But without this, it is not clear how structural features of the wider world such as social inequality may be altered or reproduced.

As we have acknowledged earlier, some of our observations need further substantiation. What our unique comparative methodology gains in terms of breadth of understanding of the UCLL phenomenon, it lacks in terms of the depth of understanding of some of the dynamics we describe. We hope that future work can continue the exploration of what UCLLs are, what they mean for universities and society, and the threats they pose as well as the promises they hold for responsible research and innovation.

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References

Beck S, Jasanoff S, Stirling A and Polzin C (2021) The governance of sociotechnical transformations to sustainability. *Current Opinion in Environmental Sustainability* 49: 143-152. https://doi.org/10/gkpsjp

Borkan J (2022) Immersion-Crystallization: a valuable analytic tool for healthcare research. *Family Practice* 39: 785-789.

Bulkley H, Coenen L, Frantzeskaki N et al. (2016) Urban Living Labs: Governing Urban Sustainability Transitions. *Current Opinion in Environmental Sustainability* 22 (October): 13–17.

Callon M (1986) Some Elements of a Sociology of Translation: Domestication of the Scallops and the Fishermen of St Brieuc Bay. In: J Law (ed.) *Power Action and Belief: A New Sociology of Knowledge?* London: Routledge & Kegan Paul, pp. 196-233.

Callon M, Lascoumes P, and Barthe Y (2009) *Acting in an Uncertain World: An Essay on Technical Democracy*. Cambridge, MA: MIT Press.

Clark BR (1998) *Creating Entrepreneurial Universities: Organizational Pathways of* Transformation. Oxford, UK: IAU Press and Pergamon.

Clausen C and Gunn W (2015) From the Social Shaping of Technology to the Staging of Temporary Spaces of Innovation: A Case of Participatory Innovation. *Science and Technology Studies* 28(1): 73-94.

Cole C and Srivastava C (2013) Energy Blitz Leads to Measured Reductions on Campus: Students Embrace Campus as a Living Lab at Yale. *Sustainability: The Journal of Record* 6(1): 5.

Collins HM and Evans R (2007) *Rethinking expertise*. Chicago, IL: University of Chicago Press.

Dell'Era C and Landoni P (2014) Living Lab: A Methodology between User-Centred Design and Participatory Design. *Creativity and Innovation Management* 23(2): 18.

Dickson D (1984) 'Science Shops' Flourish in Europe. *Science* 223 (4641): 1158-60.

Dorland J, Clausen C and Jørgensen MS (2019) Space configurations for empowering university-community interactions. *Science and Public Policy* 46(5): 689-701.

Elkjær LG, Horst M, and Nyborg S (2021) Identities, Innovation, and Governance: A Systematic Review of Co-Creation in Wind Energy Transitions. *Energy Research & Social Science* 71 (January): 101834.

Engels F, Wentland A and Pfotenhauer SM (2019) Testing Future Societies? Developing a Framework for Test Beds and Living Labs as Instruments of Innovation Governance. *Research Policy* 48(9): 1-11.

Etzkowitz H and Leydesdorff L (1995) The Triple Helix. University-Industry-Government Relations: A Laboratory for Knowledge-Based Economic Development. *EASST Review* 14: 14-19.

European Network of Living Labs (ENoLL) (2022) What is ENoLL? Webpage. Available at: https://enoll.org/about-us/ (accessed June 15, 2022).

Evans J, Jones R, Karvonen A, Millard L and Wendler J (2015) Living Labs and Co-Production: University Campuses as Platforms for Sustainability Science. *Current Opinion in Environmental Sustainability* 16 (October): 1-6.

Evans J and Karvonen A (2014) 'Give me a laboratory and I will lower your carbon footprint!'– Urban Laboratories And the Pursuit Of Low Carbon Futures. *International Journal of Urban and Regional Research* 38(2): 413-430.

Felt U, Fouché R, Miller CA and Smith-Doerr L (eds) (2017)*The Handbook of Science and Technology Studies*, Fourth Edition. Cambridge, Massachusetts: The MIT Press.

Filho WL, Mifsud M, Shiel C and Pretorius R (eds) (2017) *Handbook of Theory and Practice of Sustainable Development in Higher Education*. World Sustainability Series. Cham: Springer.

Filho, WL, Salvia AL, Pretorius R, et al. (eds) (2020). *Universities as Living Labs for Sustainable Development: Supporting the Implementation of the Sustainable Development Goals*. World Sustainability Series. Cham: Springer.

Gibbons M, Limoges C, Nowotny N, Schwartzman S, Scott P and Trow M (1994) *The New Production of Knowledge: The Dynamics of Science and Research in Contemporary Societies.* Thousand Oaks, CA: Sage.

Goffman E (1959) *The Presentation of Self in Everyday Life*. Garden City, NY: Doubleday.

Hakkarainen L and Hyysalo S (2013) How do we keep the living laboratory alive? Learning and conflicts in living lab collaboration. *Technology Innovation Management Review* 3(12): 16-22.

Hakkarainen L and Hyysalo S (2016) The evolution of intermediary activities: broadening the concept of facilitation in living labs. *Technology Innovation Management Review* 6(1): 45-58.

Haraway D (1988) Situated Knowledges: The Science Question in Feminism and the Privilege of Partial Perspective. *Feminist Studies.* 14(3):575-599.

Horst M, Davies SR and Irwin A (2017) Reframing Science Communication. In: Felt U, Fouché R, Miller CA and Smith-Doerr L (eds) *The Handbook of Science and Technology Studies*, Fourth Edition, Cambridge, Massachusetts: The MIT Press, pp. 881-907.

Horst M and Irwin A (2018) *Hvad vil vi med universiteterne?* Copenhagen: Informations Forlag.

Hossain M, Leminen S and Westerlund M (2019) A Systematic Review of Living Lab Literature. *Journal of Cleaner Production* 213 (March): 976–88.

Hyysalo S and Hakkarainen L (2014) What difference does a living lab make? Comparing two health technology innovation projects. *CoDesign.* 10(3-4): 191-208.

Irwin A (1995) *Citizen Science: A Study of People, Expertise and Sustainable Development*. London: Routledge.

Jasanoff S (2005) *Designs on Nature: Science and Democracy in Europe and the United States*. Princeton, NJ: Princeton University Press.

Kleinman DL, Feinstein NW, Downey G, Peterson S and Fukada C (2018) Hybrid Experiments in Higher Education: General Trends and Local Factors at the Academic–Business Boundary. *Science, Technology, & Human Values* 43(3): 540–569.

Knorr Cetina K (1999) *Epistemic Cultures: How the Sciences Make Knowledge*. Harvard University Press, Cambridge, Massachusetts.

König A and Evans J (2013) Introduction: Experimenting for Sustainable Development? Living Laboratories, Social Learning and the Role of the University. In: König A (ed) *Regenerative Sustainable Development of Universities and Cities: The Role of Living Laboratories*. Cheltenham, UK and Northampton, Massachusetts: Edward Elgar, pp. 1-24.

König A (2013) *Regenerative Sustainable Development of Universities and Cities. The Role of Living Laboratories*. Cheltenham, UK and Northampton, Massachusetts: Edward Elgar.

Latour B (2004) Why Has Critique Run out of Steam? From Matters of Fact to Matters of Con-cern, *Critical Inquiry* 30: 225-248

Laurent B, Doganova L, Gasull C and Muniesa F (2021) The Test Bed Island: Tech Business Experimentalism and Exception in Singapore. *Science as Culture* 30(3): 367-390.

Leminen S (2013) Coordination and participation in living lab networks. *Technology Innovation Management Review.* November 2013: 5–14.

Leminen S and Westerlund M (2019) Living Labs: From Scattered Initiatives to a Global Movement. *Creativity and Innovation Management* 28(2): 250-264.

Marres N and Stark D. (2020) Put to the Test: For a New Sociology of Testing." *The British Journal of Sociology* 71(3): 423-443.

Martin BR (2012) "Are Universities and University Research under Threat? Towards an Evolutionary Model of University Speciation." *Cambridge Journal of Economics* 36(3): 543-565.

Michalec O, O'Donovan C and Sobhani M (2021) "What Is Robotics Made of? The Interdisciplinary Politics of Robotics Research." *Humanities and Social Sciences Communications* 8(1): 65. https://doi.org/10.1057/s41599-021-00737-6.

Müller R, Ruess AK, Eisenberger I, et al. (2021) Co—Creating European Futures. Innovation, Participation, Co–Creation. Europe 2030. SCALINGS. Available at: https://scalings.eu/wp-content/uploads/2021/07/SCALINGS_Roadmap.pdf (accessed 5.6.2023)

Nowotny H, Scott P and Gibbons M (2001) *Re-Thinking Science: Knowledge and the Public in an Age of Uncertainty*. Cambridge: Polity Press.

Nyborg S and Røpke I (2013) Constructing Users in the Smart Grid—Insights from the Danish eFlex Project. *Energy Efficiency* 6(4): 655-670. https://doi.org/10.1007/s12053-013-9210-1.

Nyström AG, Leminen S, Westerlund M and Kortelainen M (2014) Actor roles and role patterns influencing innovation in living labs. *Industrial Marketing Management* 43(3): 483-495.

Pfotenhauer S, Laurent B, Papageorgiou K and Stilgoe J (2021) The politics of scaling. *Social Studies of Science* 52 (1): 1-32.

Ramaswamy V and Ozcan K (2014) *The Co-Creation Paradigm*. Stanford, California: Stanford Business Books, An Imprint of Stanford University Press.

Ryghaug M and Skjølsvold TM (2021) *Pilot Society and the Energy Transition: The Co-Shaping of Innovation, Participation and Politics*. Cham: Springer International Publishing.

Sanders E B-N and Stappers PJ (2008) Co-Creation and the New Landscapes of Design. *CoDesign* 4(1): 5-18.

SCALINGS (n.d.) Scaling Up Co-creation: Avenues and Limits for Integrating Society in Science and Innovation. Website. Available at: https://scalings.eu/ (accessed 6 June 2023)

Schuurman D, Mahr D, De Marez L and Ballon P (2013) A Fourfold Typology of Living Labs: An Empirical Investigation amongst the ENoLL Community. *2013 International Conference on Engineering, Technology and Innovation (ICE) IEEE International Technology Management Conference*, pp. 1-11.

Shapin S (2012) The Ivory Tower: The History of a Figure of Speech and Its Cultural Uses. *The British Journal for the History of Science* 45(1): 1-27.

Smallman M and O'Donovan C (2023) Co-creation in social innovation. In: Howaldt J and Kaletka C (eds) *Encyclopaedia of Social Innovation*. Cheltenham, United Kingdom: Edward Elgar Publishing.

Smith A and Raven R (2012) What is protective space? Reconsidering niches in transitions to sustainability. *Research Policy* 41(6): 1025-1036. https://doi.org/10.1016/j.respol.2011.12.012

Star SL (2010) This Is Not a Boundary Object: Reflections on the Origin of a Concept. *Science, Technology, & Human Values* 35(5): 601-617.

Stirling A (2009) Direction, Distribution, Diversity! Pluralising Progress in Innovation, Sustainability and Development. *SPEPS Working Paper* 32, STEPS Centre.

The Climate Reality Project (2021) 100% Committed Campaign. Available at: https://www.climaterealityproject.org/100-committed#:~:text=Join%20Climate%20Reality%E2%80%99s%20100%25%20Committed%20campaign%20and%20pledge,is%20100%20percent%20doable.%20THE%20FUTURE%20IS%20RENEWABLE (accessed July 7, 2021).

Trencher G, Yarime M and Kharrazi A (2013) Co-creating sustainability: cross-sector university collaborations for driving sustainable urban transformations. *Journal of Cleaner Production* 50: 40-55.

Trencher G, Yarime M, McCormick KB, Doll CNH and Kraines SB (2014) Beyond the Third Mission: Exploring the Emerging University Function of Co-Creation for Sustainability. *Science and Public Policy* 41: 151-179.

Trencher G, Terada T and Yarime M (2015) Student participation in the co-creation of knowledge and social experiments for advancing sustainability: experiences from the University of Tokyo. *Current Opinion in Environmental Sustainability* (16): 56-63.

Torrens J, Schot J, Raven R and Johnstone P (2019) Seedbeds, harbours, and battlegrounds: On the origins of favourable environments for urban experimentation with sustainability. *Environmental Innovation and Societal Transitions* 31: 211–232. https://doi.org/10/gkrbp9

Transforming DTU (2021) Website. https://transforming .dtu.dk/vision-og-strategi/forsyning (accessed April 21, 2021).

Turnhout E, Metze T, Wyborn C, Klenk N and Louder E (2020) The politics of co-production: participation, power, and transformation. *Current Opinion in Environmental Sustainability* 42: 15-21.

Tuunainen J and Kantasalmi K (2017) Advancing Understanding about the Relationship between Science, University and Society: An Introduction. *Science & Technology Studies* 30(2): 2-13.

Van Geenhuizen M (2013) From ivory tower to living lab: accelerating the use of university knowledge. *Environment and Planning C: Government and Policy* (31): 1115-1132.

Van Geenhuizen M (2018) A framework for the evaluation of living labs as boundary spanners in innovation. *Environment and Planning C: Politics and Space* 36(7): 1280-1298.

Verhoef L and Bossert M (2019) The University Campus as a Living Lab for Sustainability. A Practitioner's Guide and Handbook. *Delft University of Technology, Hochschule für Technik Stuttgart*. Available at: https://campusaslivinglab.org/wp-content/uploads/2019/06/new_RZ_Living_Lab_handbook_9.5.19.pdf (accessed 5.6.2023).

Voytenko Y, McCormick K, Evans J and Schliwa G (2016) Urban living labs for sustainability and low carbon cities in Europe: towards a research agenda. *Journal of Cleaner Production* 123: 45-54.

Yuana SL, Sengers F, Boon W, Hajer MA and Raven R (2020) A dramaturgy of critical moments in transition: Understanding the dynamics of conflict in socio-political change. *Environmental Innovation and Societal Transitions* 37: 156-170.https://doi.org/10/gkq33g

Walsham G (2006) Doing Interpretive Research. *European Journal of Information Systems* 15(3): 320-330.

Wynne B (1992) Misunderstood misunderstanding: Social identities and public uptake of science. *Public Understanding of Science* 1: 281-304. doi:10.1088/09636625/1/3/004

Notes

1 Engels, Wentland and Pfotenhauer (2019) find that terms such as 'real-world laboratories,' 'test beds' and 'living labs' are often used interchangeably, both in literature and by actors engaged in such activities. Although a difference between the concepts of e.g. 'test beds' and 'living labs' can sometimes be located in the increased focus on 'co-creation with users' in living labs compared to e.g. test beds, as Schuurman et al. (2013) also note, the boundaries between living labs and other similar innovation approaches such as prototyping, field trials, test beds, societal pilots and market pilots is not clear cut and often fuzzy in practice. In this article we use the term 'living lab' for consistency.

2 However, since the Ensign project ended it has served as a platform for follow-up flagship projects to continue Living Lab activities on campus (e.g. iCity, M4Lab).

3 For an elaboration on the concept of spaces of innovation, see e.g. Clausen and Gunn (2015), Dorland et al. (2019).

4 This discussion is inspired by the webinar "Three perspectives on Living Labs and climate targets for 2030," at which the DTU Smart Campus case was discussed together with other Danish Living Lab cases, held May 20, 2020.

Appendix 1.

Table 3. Case study empirical material

DTU (DK)	11 interviews (campus service, OIS, researchers, LKT science city), participant observation, desk research
TU/e (NL)	9 interviews (campus service, teacher, researchers, data management, ethical review board), desk research
UEW (PL)	9 interviews (student, researcher, staff union, campus renovation, etc.), 2 workshops with stakeholders
UWE Bristol (UK)	11 interviews, extended site visits and participant observation and desk research
HFT Stuttgart (DE)	19 interviews (researchers, managers)

Prasad Amit (2023) Science Studies Meets Colonialism. Cambridge: Polity Press. 232 pages. ISBN 978-1-5095-4441-7

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For over three decades, science studies have grappled with the impact of postcolonial scholarship and the role of China, Egypt, and India as entangled in shaping the history of modern European science. As the postcolonial theory began encroaching on Euro-Western academia, questions about the roots of Western scientific knowledge and its colonial consequences made two things clear: the claim for universal science needed to be turned on its head, and the implications needed to inform political action beyond academia. Many Science and Technology Studies (STS) scholars have calibrated postcolonial historicism. However, as the critical debates deepened, the narrative exercises seemed at times to have lost sight of the postcolonial purpose and the "decolonization of imagination" (Prasad, 2008: 44).

Prasad's intriguing new book contributes to these debates on defining and situating the genealogies of postcolonial science studies (Prasad, 2023) and their various interpretations of the history of science that usually ventured into Eurocentric temporalities (i.e., first in Europe, then elsewhere). Early in the book, he claims to chart a Foucauldian genealogy of colonialism and its presence in today's science. What kind of 'science' is present in our daily lives, how is it instrumentalized to include and exclude, and how can it reinforce misinformation and conspiracy? These are some of the intriguing questions the book engages with as it "excavates the history of present" (p. 119). As the book develops through three chapters and a conclusion, Prasad makes clear that his ambition in the book is to "merely" show how, despite the profound advancement of the postcolonial scholarship in STS, many influential works shaping these very schools preserved and reinforced the Euro/Western ideals of science and its study. To this end, he uses three examples: the anti-science movement during the COVID-19 pandemic, Eurocentric historicism, and postcolonial desires in more recent works of Western/European STS scholars.

The COVID-19 pandemic case is a compelling account of how different strands of knowledge and public perception of the pandemic-related health measurements and their politics served to delineate science vs. anti-science. In this context, the universal claim of Western scientific knowledge(making) has been utilized to 'other' particular public groups and render their political beliefs as "anti-science" and, hence, anti-West. This line of thought is situated in a broader political discussion of the US-China relationship and the general worry in the West about China's rising economic power.

Extending this idea into historical accounts of the Scientific Revolution in the second chapter, Prasad spends considerable time revisiting Sarton's, Butterfield's, and Needham's views as the core debates informing the de/postcolonial literature on science studies, and herein also offers a critical examination of Eurocentric preservations in the works by Shapin, Chakrabarty, and others.

Although likely stemming from the fact that this book is an extension of Prasad's earlier works on postcolonialism, the use of the central terms such as colonial, postcolonial, and decolonial and the distinctions among these schools of thoughts appear undefined throughout the book. Making it less nuanced in definitions and, hence, the semiotic influences of these periods on science studies, concepts such as 'Western' and 'European' also appear interchangeably, albeit Prasad's primary focus is on the effects of European science in the historical context. At times offering transient analysis, Prasad nevertheless captures a niche of lacking engagement with decolonizing some of the foundational methodologies and thinking in STS.

Prasad is careful in reminding the reader that the book does not intend to undermine these influential works that shaped the second wave of Western postcolonial thought (see Go, 2016), nor does it aim to develop an alternative model of thinking, whether in postcolonialism or STS. In its promise of tracing genealogies, the book synthesizes different historical episodes by some of the fundamental STS scholars, and in that, arrives at a carefully interwoven critique where one still "can map the genealogies of entangled exchanges that cut across these boundaries" (p. vii). Keen to reveal the underlying colonial thinking and 'othering' inherent in the Western analytical approach, the third chapter draws a nuanced critique of the works of Lin and Law, de Laet and Mol, particularly those works engaging Actor-Network-Theory (ANT). The chapter scrutinizes four articles in particular: "Where is East Asia in STS?" (Lin and Law, 2019), "Provincializing STS: Postcoloniality, Symmetry, and Method" (Law and Lin, 2017), "We Have Never Been Latecomers!? Making Knowledge Spaces for East Asian Technosocial Practices" (Lin and Law, 2015) and "The Zimbabwe Bush Pump" (de Laet and Mol, 2000). The thread connecting these articles, namely, the actor-network, argues Prasad, is West-centric and relegates the core ANT principle of reflexivity "to a blind spot" (Morita, 2014: 230), where concerns are mentioned but quickly brushed off again. The book also raises several concerns around the works of Anderson, Mol, and Harding, pointing out how their works have, perhaps unintentionally, maintained colonial thinking in the very ways they championed post/decolonial school by trying to embed it in the already existing Western scientific principles such as reflexivity and objectivity (Harding, 1998).

In the book's final part, Prasad draws on his personal intellectual genealogy, bringing into conversation his teachers and inspirations. Prasad's academic advisor, JPS Uberoi, an Indian sociologist of modernity, and Bruno Latour, a French philosopher of science, are the center of this chapter's science and culture discussion. The two thinkers exemplify opposite yet interlinked analytics in science studies, one who has to reconcile producing universal (and hence Western) modern science but do so from the standpoint of the colonized (Uberoi) and one who is "unencumbered by different elements of "othering"" (Latour) yet rejects the concept of universal science (Prasad, 2023: 163). Perhaps somewhat divergent from the book's critical agenda, Prasad concludes by self-reflexively defending Latour's works and position in molding the alternative for postcolonial thinking, including his own.

As a lecturer in cross-cultural STS engagements with health and illness and with a multicultural and interdisciplinary academic identity, the book harks back to the core of my work and scholarly career that strives for different and 'othered' ways of knowing. This book is a valuable reminder that scientific knowledge has deep colonial roots, and their animation in our world today shapes how political and social structures respond to global 'problems,' innovations, and scientific knowledge-making practices through, even if critical, Western scholarship. "Science Studies Meets Colonialism" will be of particular interest to those interested in postcolonial and decolonial politics of the present as well as the technoscientific futures and the historical accounts that are dragged into and kept up in narrating and making (post-)postmodern science. In this regard, the book is nuanced enough and fine-tuned in the grand scheme of *colonialism shaping the modernity* debates.

References

Go J (2016) *Postcolonial Thought and Social Theory*. Oxford: Oxford University Press.

Harding S (1998) *Is Science Multicultural?: Postcolonialisms, Feminisms, and Epistemologies*. City of publisher: Indiana University Press.

de Laet M and Mol A (2000) The Zimbabwe Bush Pump: Mechanics of a Fluid Technology. *Social studies of science* 30(2): 225–263.

Law J and Lin W-Y (2017) Provincializing STS: Postcoloniality, Symmetry, and Method. *East Asian Science, Technology and Society: An International Journal* 11(2): 211–227. doi: 10.1215/18752160-3823859.

Lin W-Y and Law J (2015) "We Have Never Been Latecomers!? Making Knowledge Spaces for East Asian Technosocial Practices. *East Asian Science, Technology and Society* 9(2): 117–126. doi: 10.1215/18752160-2883872.

Lin W-Y and Law J (2019) Where is east Asia in STS? *East Asian Science, Technology and Society*. 13(1): 115–136. doi: 10.1215/18752160-6995634.

Prasad A (2008) Science in motion: what postcolonial science studies can offer. *Reciis* 2(2): 35-47.

Prasad A (2023) *Science Studies Meets Colonialism*. Cambridge: Polity Press.

Bruun Maja Hojer, Hasse Catherine, Hoeyer Klaus, Wahlberg Ayo, Douglas-Jones Rachel, Kristensen Dorthe Brogaard and Winthereik Brit Ross (eds) (2022) Palgrave Handbook of the Anthropology of Technology. London: Palgrave MacMillan. ISBN 978-981-16-7083-1

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with a response by Klaus Hoeyer and Brit Ross Winthereik

This review was written as a spoken comment for the launch of the handbook at an event during the 2022 EASST conference in Madrid. Imagine yourself in the audience listening to Wyatt's voice as she reflects on the book. As you will see, Wyatt raised some questions to the editors present, and their responses feature below.

About a month ago, I received an email from Brit (with Klaus in the cc), asking me if I would be willing to provide a "five to ten minute meditation" on this truly remarkable achievement, a comprehensive handbook about the anthropology of technology, during the Madrid conference.

I could lead you in a guided meditation, perhaps inviting you to imagine yourselves in one of the extraordinary fieldwork locations. The ethnographic work of Joe Dumit and Emilia Sanabria might be appropriate. They studied the psychedelic clinical trials and ceremonial uses of an Amazonian herbal brew in Brazil. Just thinking about it might bring on an altered state of consciousness.

But I am a much more boring person, also constitutionally unsuited to conducting ethnographic work. That could also be an interesting meditation, between methods and personalities, how methods choose us rather than we choose methods.

When I tentatively accepted, I pointed out that I am not an anthropologist. Klaus replied very quickly, assuring me that what they wanted was for me to, and I quote "offer the STS community your reflections as to whether it makes sense to have a book focused on anthropology of technology – does it add anything to STS, may it serve as a bridge to STS for anthropologists, or is it basically STS?" And that is what I will try to do, through a very particular lens. I'll end with some questions for them.

But first a few words about the book itself. I am assuming you are at this launch because you already know something about it. It weighs in at 809 pages, 5 parts, 39 chapters, 7 editors, about 45 authors, largely from Denmark and elsewhere in northern Europe, but not exclusively. Congratulations to the editors. I have edited books in the past but never anything so ambitious. There is sometimes criticism (on social media) of the proliferation of handbooks, but they are important. I trust this one will be so.

I have not had time to read all 809 pages, but Klaus and Brit were kind enough to send me three chapters that I asked for: the overall introduction by Maja Hojer Bruun and Ayo Wahlberg; Klaus and Brit's introduction to the section 'Knowing, Unknowing and Re-knowing'; and the chapter by Dumit and Sanabria I just mentioned about randomized clinical trials of indigenous people's medicine. The main introduction by Bruun and Wahlberg is incredibly useful and will be great for teaching.

I started with the chapter by Klaus and Brit. Full disclosure – I live with Hans Radder, philosopher of technoscience. He is best known in STS for his criticism of the cryptonormativity of STS, published in a couple of articles in *Social Studies of Science* back in the day (1992 – critique of lack of normativity in constructivism, and then again in 1998 as part of the debate on the special issue about the politics of STS). We quite often read each other's work. I correct the occasional comma and marvel at Hans' sentences in English, sentences I could never write myself. He reads my work and often gets stuck on the first paragraph, wanting me to be more precise about x or y. I try to encourage him to go with the flow, think of concepts as companions. Maybe I have absorbed Hans' philosophical precision, and maybe I've lived in the Netherlands too long. Please don't misconstrue what I am about to say as nitpicking.

I started reading Klaus and Brit's chapter and actually got stuck on the first sentence, and even the first six words. These are: "most technologies are knowledge-intensive". The rest of the sentence goes on to say, "and contemporary knowledge production is often technology-intensive". I'm good with that part, and I like the symmetry between the two parts of the sentence, symmetry (from the Strong Programme, an important STS approach from the 1970s and 1980s) being something that STS people like a lot. But "most technologies are knowledge-intensive"? Really? Which technologies? Which knowledge? In design, production, selling, use, repair, disposal? We can discuss that, and I would like to reassure you, I did read the rest of the chapter, and was struck also by the lovely description on p.221 about how to study 'knowing' is also to be open to 'unknowing' or 'ignorance' (though ignorance doesn't get much attention here). All of which are socially embedded, materially entrenched. But maybe we could think about how to combine this with other classifications of knowing or reasoning, such as those put forward by medical historian John Pickstone and STS scholar Chunglin Kwa. Pickstone distinguishes between the following: Deductive (classical Greece), Experimental, Taxonomical, Analogical-hypothetical, Statistical, and Historical-evolutionary (not mutually exclusive). I would add that we are now living through the emergence of a computational style.

The first chapter, the overall introduction, does a wonderful job of tracing the history of the notion of technology in anthropology. I really recommend it – for teaching, for all of the non-anthropologists. It is also a topic that can keep STS people busy, and there are lots of points of connection between them. Donald MacKenzie and Judy Wajcman in their introduction to the *Social Shaping of Technology* back in 1985 define technology as:

1. Sets of physical objects – cars, vacuum cleaners, computers;
2. Human activities needed to make technologies work – doing;
3. What people know – technology is knowledge – those physical objects are useless without the "know-how to use them, repair them, design them and make them." (p.3)

So Klaus and Brit are spot on, and MacKenzie and Wajcman also go on to talk about visual, tactile knowledge as well as formalized knowledge. This was a reminder to me that there are indeed lots of points of overlap between STS and anthropology.

Where has this meditation taken me? Reminder to keep reading outside one's own particular field, reminder to keep talking about definitions because what might seem like nitpicking to some has important analytic, methodological and normative consequences. It also has important political consequences. I loved the first note of Dumit and Sanabria: "arguing for a better definition of technology does not change the ongoing effect of the category of the standard view of technology." I can really relate to that. Arguing against technological determinism which I (Wyatt, 2008) and pretty much all of STS have done really doesn't stop powerful social actors from imposing their technologies and their views of the technology-society relationship onto the world.

I would like to end with some questions to Brit and Klaus.

1. What does STS offer to the anthropology of technology?
2. What is the anthropology of technology origin story? This is a genuine question. Constructivist STS (from the late 1970s and '80s) was a response to analytic philosophy of science and its focus on knowledge claims, and also a response to normative perspective of Mertonian sociology of science and its focus on stratification of science, emergence of new fields, visible and invisible networks of scientists. What is the question to which anthropology of technology is the answer?

Thank you again for the invitation to say a few words today, and congratulations on this impressive volume.

References

Kwa C (2011) *Styles of Knowing. A New History of Science from Ancient Times to the Present*. Pittsburgh, PA: University of Pittsburgh Press.

MacKenzie D and Wajcman J (eds) (1985) *The Social Shaping of Technology*. Milton Keynes: Open University Press.

Pickstone J (2000) *Ways of Knowing. A New History of Science, Technology and Medicine*. Chicago, IL: University of Chicago Press.

Radder H (1992) Normative Reflections on Constructivist Approaches to Science and Technology. *Social Studies of Science* 22: 141-173.

Radder H (1998) The Politics of STS. *Social Studies of Science* 28: 325-331.

Radder H (1998) Second Thoughts on the Politics of STS: A Response to the Replies by Singleton and Wynne. *Social Studies of Science* 28: 344-348.

Wyatt S (2008) Technological Determinism is Dead. Long Live Technological Determinism. In: Hackett E, Amsterdamska O, Lynch M and Wajcman J (eds) *Handbook of Science and Technology Studies*. Cambridge, MA: The MIT Press, pp.165-180

Response by Klaus Hoeyer and Brit Ross Winthereik

Thank you, Sally, for making time to engage with the Handbook! We are grateful that you recommend it to STS scholars, despite the possible vagueness of first sentences. Thanks also for the really nice questions. They both, in a sense, turn our initial question to you back on us, as you are asking us to explain the reasons for, and benefit of, a handbook for the *anthropology* of technology – granted that we already have several for STS. Are there any differences worth exploring between anthropology and STS? Admittedly, when embarking on the project, we quickly realized that we ourselves rarely make any distinctions between anthropology and STS in our own citation practices and collaborations. The work with the book therefore became a reason for thinking about the distinctly anthropological heritage. And while we do not suggest policing any sharp disciplinary boundaries, we do believe there is something to be gained by exploring different linages of thinking. Which brings us to your two questions:

1. STS offers to anthropology a keen interest and expertise in how materiality in the broadest possible sense shapes realities and how technology impacts on 'the human condition'. STS, to a larger extent than anthropology, engages the actual artifacts and scientific modes of reasoning as elements of the analysis. STS has at hand a wide variety of ways in which the field makes technology an object of research and a matter of concern more broadly. While STS has borrowed research methods from a number of fields including anthropology, STS has contributed to thinking about technologies as elements of large technological systems, assemblages, or infrastructures. STS knows how to foreground materiality without automatically 'backgrounding' the social and the political.
2. Why is there a need for the anthropology of technology? What is the origin story of this book? One answer to the question is that Maja Bruun saw that many anthropologists were working with technology, but often outside traditional anthropology departments. She saw a need for something bringing together people who might be on the fringes of their original discipline but who did not see themselves as fully belonging to the STS field. This handbook may serve as a bridge between these communities and help STS scholars feel more at home in anthropology and anthropologists relax about being traversed enough in STS. Then comes the question of the origin story of the anthropology of technology. This is largely told in the introduction. When you then ask us: "What is the question to which anthropology of technology is the answer?" the answer revolves around what we felt we gained from focusing on the anthropological heritage. First, to never lose sight of 'anthropos': human hopes and concerns, also those that may have been silenced. Second, to think of technologies as part of a much longer history than what typically preoccupies STS. Pottery making and fishing nets, for example, make you think more clearly about the habitual, bodily, elements of knowing. This is why we do not think the sentence 'most technologies are knowledge-intensive' is in any way too vague or all-encompassing. It reminds us that even pottery making is knowledge-intensive (but different types of knowledge than those used in a laboratory). Working on this book directly inspired our own work as we began seeing the relevance of, for example, Levi-Strauss' book on *The Savage Mind* for current big data practices. By looking into the anthropological heritage, we gained new inspiration for contemporary STS problems. There is not *one* problem for which anthropology is the answer, but the related disciplines of anthropology and STS bring different repertoires of conceptual thinking along with them, and we hope this introduction to the anthropology of technology will inspire new ideas, new linkages, and allow us to identify new problems…also in STS.

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