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Anthro-botanical investigations from the studio, by Daniel Slåttnes

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EDITORIAL

Staying with "the new normal"

By Roger A. Søraa

This new fall issue of NJSTS still finds itself in the middle of the global COVID-19 pandemic, which is continuing to uproot lives across the globe at a worrying speed. As of this writing, well over a million people have died from this small, but significant virus. STS scholars, who have for decades investigated how non-human actors have both agency, interpretative flexibility, and world-shaping powers, are perhaps less surprised by it. As Haraway (2016) proclaims, we—the human species—need to learn how to better co-exist with and through other parts of nature from bats and minks to microscopic viruses. The front page of this issue ("Anthro-botanical investigations from the studio") is a nice illustration of this interplay, highlighting the artistic collaboration between humans and houseplants—perhaps a more constructive and uplifting human/nature assemblage than the one that is currently on everyone's mind.

How can we as scholars learn to live in, with, understand and investigate this "new normal" that we've suddenly found ourselves in—as well as prepare for new disruptions? We need scholars who critically research the futures, their imaginaries, and how to live with and in a nature that holds both grave consequences and near endless possibilities. Although the COVID-19 virus might be the largest "world-shaper" many of us have experienced in our lives, it won't be the last. NJSTS is therefore glad to provide this new issue, with excellent scholarly contributions.

This issue features three articles, with the first being "Citizen science: Co-constructing access, interaction, and participation" by Per Hetland, University of Oslo. Hetland investigates how civic educators and citizen communities co-construct access, interaction, and participation and bridge contributory and democratized citizen science—in the case of the Species Observations System—Norway's largest citizen science project.

The second article is titled "Energy efficiency in Norwegian news media: A glitch in the discourse-as-usual." Written by Jens Petter Johansen, Jens Røyrvik & Håkon Fyhn at NTNU Social Research, the article investigates how energy efficiency features in Norwegian news media discourses and rhetorical connections to energy savings and reductions.

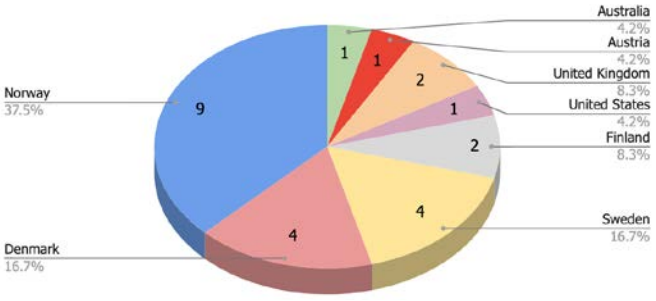
The third article by Oliver Tafdrup of Aarhus University is titled: "How imaginaries mediate sociotechnical practices: A case study of an educational robot in a Danish school context" and looks at how sociotechnical practices involving educational robots in Danish schools are mediated and thus shaped by visions of the future through investigating teachers and policy documents.

Lastly, we have a book review of Warren Sack's 2019 book *The Software Arts* conducted by Ragnhild Solberg, University of Bergen, focusing on the book's excellent contributions of historical connections between computer science and the liberal arts.

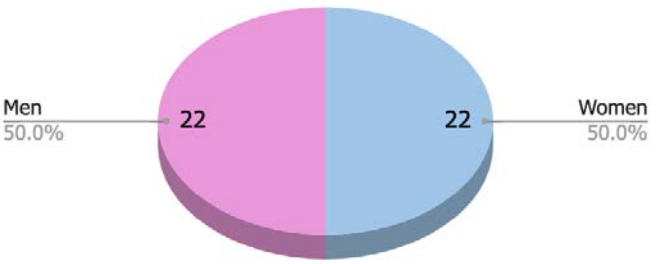
This issue also marks my final issue as Chief Editor for NJSTS. I would like to take the opportunity to thank the amazing Editorial Board who has worked with me from 2017's fall issue to this 2020 fall issue. It's been three great years, and I am especially proud of how we have accomplished to streamline the whole process of NJSTS paper submissions, the revitalization of our social media channels, and the revamping of our websites and guidelines. Submitting to a journal should not be an overly complicated a process, let's leave the complexity for the papers themselves.

During these three years, we have published 42 double-blind peer reviewed articles—fully open-access (of course!). As can be seen below, the authors of these excellent pieces are primarily from Norway (9), followed by Denmark (4), Sweden (4), Finland (2), and the UK (2). We've also seen single entries from a wide variety of countries like Australia, Austria, and the US. The articles have been written by a 50/50 balance between men and women scholars, with a tendency of men co-authoring more, and women more often submitting single-authored papers.

Articles per country



Gender of authors



The most cited paper during these years has been Frennert & Östlund's (2018) article "Narrative review: Technologies in eldercare". In reaching out to Frennert (now at Malmö University), the lead author of this excellent piece on how their work has proceeded after publication, we have received the following information:

> "The article was published as an initial article (review) of a series of articles regarding welfare technology. The process with NJSTS was smooth and professional. Excellent reviewers with constructive feedback. I am happy that people read the article."

I recommend those who have not read the piece to give it a go, as well as other fascinating pieces of scholarly work that have also been published in the Journal. Being Editor in Chief has taught me many valuable lessons regarding publishing, and I would particularly like to highlight four important points for writers to consider when submitting their papers to journals:

1) Editors work in their own spare time. We do not get paid, and all editorial work comes in addition to our 200%+ work week. That means things (sadly) often take longer than we wish, especially when we need to be super-focused to sit down and read, assess, and comment on papers.
2) Your paper might be great, even though it is not the best fit for a particular journal. We do not wish to discourage anyone from academic writing, but sometimes your article just doesn't fit with the scope of the journal. Read the journal's aim and scope *carefully* prior to submitting it.
3) Peer-review is increasingly difficult as a managerial process. This relates to the general point 1 above, both editorial work and peer-review work are unpaid labor that we as scholars volunteer to do because we have a desire to advance research and knowledge. However, getting reviewers is increasingly difficult and is one of the hardest struggles we face in academic publications moving forward. Although I encourage reviewing at least a couple of papers each year, this does clog up the process.
4) Despite all this, editorial work is fun and quite the learning experience. It is a key cornerstone in academia, and should have the highest academic rigor in its practices. It takes time to move an article through the whole review process, but it is worth it when the final result emerges.

Going back to the title of this editorial, how can smaller journals like NJSTS navigate the "new normal" where tiny viruses disrupt whole societies, infrastructures, and systems? Although we would all prefer to be without it, perhaps reframing this disruption as a learning experience could point to some new practices. Compared to the years prior to the pandemic, we see that resources, time, and energy are stretched thin—but with patience and fair reviews, we can get through this. Keep calm, carry on, research, write, and wear a mask.

It has been a great journey, and I wish the next Editor in Chief, Associate Professor Kristine Ask, Centre for Technology and Society, NTNU, the best of luck in steering the ship. I know it's in excellent hands, and look forward to reading the next issue.

So long and goodnight,

Dr. Roger A. Søraa
Editor in Chief, NJSTS 2017-2020

& NJSTS' Editorial Board
Martin Anfinsen, Kristine Ask, Maria Hesjedal, Lina Ingeborgrud, Ingvild Firman Fjellså, Marius Korsnes, Tanja Plasil, Antti Silvast.

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NORDIC JOURNAL
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CITIZEN SCIENCE:

Co-constructing access, interaction, and participation

by Per Hetland

How do civic educators and citizen communities co-construct access, interaction, and participation and bridge contributory and democratized citizen science? This study builds on interviews and observations with amateur naturalists, professional biologists, and public authorities about their participation in the Species Observations System (SO)—Norway's largest citizen science (CS) project.

Over more than twenty years, CS has been understood as either contributory (contributing with data) or democratized (emancipating the pursuit of science). Following these models, CS studies has developed a number of classifications of CS projects. The present article aims to bridge contributory CS and democratized CS by using the access, interaction, and participation (AIP) model outlined by Carpentier, without extending the number of classifications.

Access and interaction signify contributory CS. Well-functioning technology is a precondition for joining the ranks of records, contributors, validators, and institutional actors. Interaction is the second founding stone of participation, and organizations are crucial to facilitating interaction. Participation signifies democratized CS. The choice of technology involves important dimensions of power, as technology structures actions. However, the ability to build and sustain the technological infrastructure also illustrates that participation is organizational power, enacted both from the bottom-up and top-down.

Keywords: Citizen science, access, interaction, participation, AIP model

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Introduction

Over the last twenty years, CS has been understood as either contributory (contributing with data) (Bonney, 1996) or democratized (emancipating the pursuit of science) (Irwin, 1995). Recently, there have been several attempts to bridge the two approaches (Cavalier & Kennedy, 2016; Ceccaroni & Brenton, 2017; Hecker et al., 2018; Hetland, 2020; Shirk et al., 2012; Woolley et al., 2016). However, several of the attempts have only partially managed to include democratized CS. Studying Norway's largest CS project, this article aims to use the AIP (access, interaction, participation) model (Carpentier, 2012, 2015) to study how we may build bridges between contributory and democratized CS. Carpentier understands access as presence, for example in an organizational structure or a community, interaction emphasizes the social-communicative relationships that are established with other humans or objects, and participation is defined by power relations in decision-making processes. Consequently, participation is something more than the rather loosely defined concept in everyday language. Even if most participants only contribute with data and are less interested in becoming involved in other roles, participation is crucial to how we study CS's ability to facilitate co-deciding—either by personal involvement or by representatives. Only by including power in the study of CS will one be able to study CS as "a form of science developed and enacted by citizens themselves" (Irwin, 1995, p. xi).

The term "CS" is used here to refer to public participation in scientifically founded knowledge production. The participants in the study are referred to as either amateur naturalists, professional scientists, or public authorities. The study also emphasizes that, primarily, the activity is mutually beneficial to both the amateur naturalist, professional scientist and public authorities. The amateur naturalist benefits from taking part in large projects that contextualize individual and local activities and provide added value for participants—either through objects such as private diaries, ranking lists, and maps or, more generally, through partaking in knowledge production—while professional scientist and public authorities benefit by mobilizing a large crowd of contributors (Hetland, 2020). What distinguishes the participants is that the first group (i.e., amateur naturalists) conduct their activities mostly without pay and often as a hobby, while the members of the second group (i.e., professional scientists and public authorities) conduct their activities as part of their paid occupation. The concept "amateur" has its roots in Latin (*amator*—lover) and is here used for persons practicing an activity without having this as a livelihood, even if some are highly skilled and hold science degrees. Science communication is a core activity of organized science, and earlier studies have identified four major constructions of publics: the general public, the pure public, the affected public, and the partisan public (Hetland, 2019). Amateur naturalists are part of the affected publics, while public authorities are part of partisan publics. In this case study, public authorities are a crucial group running the technological infrastructure and the activities necessary to maintain the quality of its content (Bowker, 2000; Bowker & Star, 1999; Karasti et al., 2016a, 2016b). Within both amateur naturalists, professional biologists, and public authorities one finds individuals that take on the role as civic educators, either as advocates or experts or both (Ceccaroni et al., 2017).

Background of the case

The Species Observation System (SO)[1] provided a new opportunity for amateur communities to participate in national biodiversity mapping activity and expedited new ways of bridging activities between science and the public. The Norwegian Biodiversity Information Centre (NBIC) was established in 2005 as a public service biological diversity bank, and it provides a number of services such as the Red List, the Alien Species List, the Species Names, the Species Map Service, and the SO. It also offers internet services including taxonomy, identification keys, and ecological data to describe the species, as well as a national typification and description system for the ecosystems, habitats, and ecological variations of the different kinds of Norwegian environments. Furthermore, the NBIC began the Norwegian Taxonomy Initiative in 2009 to focus on generating new knowledge about poorly known species-groups in Norway. These services use a body of standards called the Darwin Core.[2]

The Norwegian Biodiversity Network (Sabima)[3] was formed when nine non-governmental organizations (NGOs) organized themselves to lobby for improvements in environmental policies and the education of their members. With more than 19,000 members, these NGOs embrace both the professionals and the most skilled amateur naturalists in Norway. The NGOs aimed for a mutual database for both amateur naturalists, scientists, and

1 For more information on the Norwegian Biodiversity Information Centre, see https://www.biodiversity.no/Pages/135580
2 For more information on the Darwin Core, see http://rs.tdwg.org/dwc/
3 https://www.sabima.no

public authorities. However, they were not completely satisfied with the registration system chosen by scientists; therefore, they argued that the NBIC should copy the very successful Swedish Artportalen. Artportalen is fairly easy to use, but it does not cater to all the needs of the scientists. In 2007, the Minister of the Environment, Helen Bjørnøy, decided to implement a solution that should increase public participation in biodiversity mapping. The new service was launched in May 2008. Sabima, together with five amateur organizations (the Norwegian Ornithological Society, the Norwegian Botanical Association, the Norwegian Foraging and Mycology Society, the Norwegian Zoological Society, and the Norwegian Entomological Society), are collaborating partners with the SO. Consequently, and building on the Artportalen, the SO tries to combine "top-down" and "bottom-up" approaches. The NBIC is responsible for running the SO on an everyday basis and has organized validation with the help of national coordinators and several interactive services. Furthermore, the establishment of the Global Biodiversity Information Facility (GBIF) connects Norwegian records with an increasing number of international records.[4]

As of September 2020, the SO has more than 12,000 contributors and about 24 million records and generally increases by more than 5,000 records every day. As one of the services linked to the SO, the Species Map Service is composed of species occurrence data collected on the same map interface and provides access to about 34 million Norwegian records, including a number of datasets from different scientific institutions.[5] Consequently, more than two thirds of the records comes from SO. The SO builds on the following general principles:[6]

- Everyone may contribute, regardless of their skills.
- Some records are always validated, such as the ones found on the Red List (threatened species) and the Alien Species List (invasive species).
- In general, all records are open. However, for some vulnerable species, there are different ways of hiding some of the recorded information. The main idea is that openness in itself leads to protection.
- Validation is partly organized by the NBIC, and partly by amateur naturalists themselves. Sabima recruits volunteers to validate species of national observation interest. Roughly 100 volunteers participate in the validation of birds, while 60 participate in the validation of the remaining species. They are comprised of both skilled amateur naturalists and professional biologists.
- The SO has an environmental and political impact through such services as the Species Map Service, the Red List, and the Alien Species List.

The primary aim of this article is theoretical by examining how to bridge contributory CS and democratized CS by studying the case of the SO. The case study seeks to answer one question through an examination of the emerging actors, processes, and institutions: How do civic educators and citizen communities in a large CS project co-construct access, interaction, and participation and bridge contributory and democratized CS? My claim is that one needs to facilitate a better understanding of participation within CS. Consequently, the AIP model will be an important tool in this respect.

Theory

Engagement and participation are central themes in science communication studies (Rowe & Frewer, 2005), as well as in CS studies. A number of sub-models of CS are identified in the literature (Ceccaroni, Bowser, & Brenton, 2017; Shirk et al., 2012). Three classification schemes organized around different features are often referred to: a) the nature of the activities participants engage in (Bonney et al., 2016), b) the extent to which different publics participate in parts of the scientific process (Shirk et al., 2012), and c) the level of participation between professional scientists and amateurs (Hakley, 2013). Consequently, there are a number of different definitions of CS. Ceccaroni et al. (2017) provide one definition that aims to bridge contributory and democratized CS:

> Citizen science is work undertaken by civic educators together with citizen communities to advance science, foster a broad scientific mentality, and/or encourage democratic engagement, which allows society to deal rationally with complex modern problems. (p. 10)

Shared technological infrastructure also fosters shared ontological commitments that distinguish the participants as a broad citizen-science community of practice (Ceccaroni et al., 2017). Two earlier studies have mapped the participatory turn in CS research as well as a growing number of more complex typologies identifying this turn (Hetland, 2017; Hetland & Schrøder, 2020). Consequently, this article's claim is that CS studies needs a simple but powerful analytical model that can accommodate both flexibility and a growing complexity without extending the number of models and typologies ad infinitum.

The three concepts—access, interaction and participation—have developed into important concepts describing how and which spaces citizens access, how citizens interact with each other socially

4 https://www.gbif.org
5 https://artskart.artsdatabanken.no/
6 Sourced from https://www.artsobservasjoner.no/Home/Fundamentals

and communicatively, and how we think about participation (Carpentier, 2012, 2015). Carpentier claims that "access becomes articulated as presence, in a variety of ways that are related to four areas: technology, content, people and organizations" (2012, p. 173), while interaction "has a long history in sociological theory, where it often refers to the establishment of socio-communicative relationships" (2012, p. 174). Finally, the "difference between participation on the one hand, and access and interaction on the other is located within the key role that is attributed to power, and to equal(ized) power relations in decision-making processes" (2012, p. 174). In the final discussion, we will use Carpentier's AIP model (2012, 2015) to explore the bridge-building between contributory CS and democratized CS.

The different meanings attributed to access, interaction, and participation is structured on the basis of the four areas of their application. Access is articulated as the presence of first production technology, here exemplified by illustration from the SO: a) machines to produce and distribute content (the SO portal), b) the presence of previously produced content (the SO archives), c) the presence of people to co-create (amateur naturalists, professional biologist, and public authorities), and, not the least, d) organizations such as amateur societies and their collaborative partners. The activities of amateur naturalists have a long history in the field of natural sciences (Conniff, 2011; Harris, Wyatt, & Kelly, 2013; Jardine, Secord, & Spary, 1996; Secord, 1994; Kohler, 2002, 2006). The motivations of participants for engaging in CS activities are widely studied (West & Pateman, 2016), as they are often perceived to be acting for the benefit of others. Motivation to participate varies; Batson, Ahmed, and Tsang (2002) identify four categories of motives in general: egoism, altruism, collectivism, and principalism.

> Egoism relates to motives that pertain to one's own welfare. Altruistic motives are related to increasing the welfare of others. Collectivism refers to increasing the welfare of a group. Principalism includes motives related to upholding a moral principle (e.g. justice, equality, caring for the environment). (Land-Zandstra et al., 2016, p. 47)

Reviewing previous research investigating motivation in CS, Jennett et al. (2014) find that motivations include interest in the research topic, learning new information, contributing to original research, enjoying the research task, sharing the same goals and values as the project, helping others and feeling part of a team, and finally, receiving recognition and feedback. However, the perspective provided on motivation in this article is somewhat different, as it is approached as a quest for reciprocity or a form of gift exchange (Carrier, 1991; Harris, Wyatt, & Kelly, 2013; Mauss, 1950/2002; Sahlins, 1972, Sherry, 1983; Hetland, 2020). Reciprocity highlights a crucial element of CS: a personal relevance for different publics participating in CS (Frewer et al., 1999). Mauss (1950/2002, p. 50) describes three crucial obligations in a gift economy: "to give, to receive, to reciprocate." Sahlins' typology of reciprocity includes generalized reciprocity (i.e., altruistic transactions), balanced or symmetrical reciprocity (i.e., the direct exchange of customary equivalents), and negative reciprocity (i.e., to get something for nothing) (Sahlins, 1972). A comfortable and respectful atmosphere is important in facilitating opportunities for reciprocity (Kramer & Wells 2005).

Interaction describe socio-communicative relationships: a) using the SO to produce content in a prioritized manner, b) producing new content, c) co-producing as a group or community giving priority to certain tasks, and, d) co-producing meta-content in an organizational context. At the same time, it is important to remember that unstructured CS databases (i.e., records collected in an arbitrary manner) can be problematic when used for research purposes; e.g., they contain different forms of biases. These biases might lead to important long-term population declines (or increases) not being detected (Kamp et al., 2016). However, more structured CS databases (i.e., records collected in a systematic manner) provide important inputs for science (Jonzén, 2006). Furthermore, Nieto-Galan points out that, decades ago, Ludwick Fleck stressed that "scientists become experts through a long process of learning in which for years they have been students, laypeople, audiences and active agents in classroom culture, in the exchange of opinions between teachers and students" (Nieto-Galan, 2016, p. 118). Consequently, interaction is fundamental to understand the learning process and the sociocultural context where informal learning and the production of scientific knowledge take place. Fleck introduced the concept of *Denkkollectiv* (thought collective) to describe how scientific knowledge is produced under certain conditions of collective thought, often driven by reciprocity. He also introduced the concept of *Denkstil* (thought style), which describes a particular style of thinking (Fleck, 1935/1979). Fleck outlines his collective scientific thinking in four circles, where the two inner circles are known as esoteric and the two outer ones as exoteric. In the first inner circle, one finds a small group of research experts; in the second inner circle, one finds professionals. The third circle contains a large group of scientific laypeople, while the fourth and outermost circle contains the general public. Most importantly, Fleck conceives the operation of these circles as a system based on a democratic exchange:

> The most characteristic operational feature is a democratic exchange of ideas and experience, going outward from the esoteric circle, permeating the exoteric circle, and then feeding back upon the esoteric circle. The work of the mind thus conveyed undergoes a process of social consolidation and becomes thereby a scientific fact. (Fleck, 1935/1979, p. 161)

Public participation in biodiversity mapping creates large amounts of data in a short time, and the concept of apomediation represents a new strategy of validation (Eysenbach, 2008). Apomediation is a socio-technological term used to describe the third way for users to identify trustworthy, credible information and services. *Apo*

is derived from the Latin word for "stand by," and apomediation refers to the ability of Internet users—even those not considered experts—to bypass gatekeepers and intermediaries to go directly to sources when accessing information. In this way, the expert stands by the user.

Thus, democratic exchange is fundamentally concerned with understanding participation. Participation describes a) co-deciding on the technological infrastructure, b) co-deciding on the content, c) co-deciding with people following certain rules, and d) co-deciding on or with organizational policy. Consequently, the aim in the present article is to ecologize participation and thus provide a relational co-productionist perspective on participation (Chilvers & Kearnes, 2019; Hetland, 2017).

In the present study, access, interaction, and participation, as defined by Carpentier (2012, 2015), are used to study the bridging of contributory CS (e.g., the instrumentalist point of view) and democratized CS (e.g., the capacity-building point of view) and thereby also deal with how to handle controversial issues between different actors doing CS and between CS and professionalized science (Meyer, 2018).

Method

The study of biodiversity mapping presented here both utilizes semi-structured interviews with participants about CS access, interaction, and participation and the ethnography of online communities (Hetland & Mørch, 2016)—studying dialogues on the SO web site and on Facebook-pages belonging to different groups of amateurs naturalists, to study how controversial issues, e.g. validation and collecting and preserving specimens, have been handled. Eight amateur naturalists and four professional biologists, one of them also representing public authorities, were selected for the interviews. As super users, all of the interviewees were acting as civic educators in collaboration with citizen communities. The eight amateur naturalists were recruited from three amateur societies: The Norwegian Entomological Society, the Norwegian Botanical Association, and the Norwegian Ornithological Society.[7] The four professional biologists were: two from Sabima, one from the GBIF Norway,[8] and one from the NBIC. The semi-structured interviews explored three main topics: 1) access, 2) interaction, and 3) participation. More detailed questions included their roles in CS activities, their activity over time, who they collaborated with, their CS communities, their training and experience in science, their motivation to partake in CS, and how the SO influenced CS activities. By including amateur naturalists, professional biologists, and public authorities partaking in the SO, the present research results have greater credibility.

Table 1 provides an overview of activities and experience of the eight amateur naturalists who were selected for interviews.

TABLE 1.

Interviewee number:	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Species-groups (10 possible at time of interview)	1	9	9	9	5	9	7	3
Validator	Yes	No	No	Yes	No	Yes	Yes	Yes
Engaged in collecting objects	Often	Seldom	Seldom	Some-times	Seldom	Some-times	Seldom	Some-times
Experience collecting structured data	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes

Table 1. Amateur Naturalist Interviewees

Table 1 specifies how many species-groups the amateur naturalists recorded, whether they themselves had been validators, whether they had collected physical objects, and whether they had experience with collecting structured data. At the time of the interviews the SO allowed records of the following 10 species-groups (as defined by them): vascular plants, mosses, lichens, fungi, invertebrates, birds, amphibians and reptiles, mammals (excluding bats), bats, and fish. (After these interviews were conducted an 11th sub-species, algae, was added.) For the sake of anonymity, the details regarding which specific species were recorded by the participants and their exact numbers are not revealed here. However, information about the variety of species is included

7 The members of these three societies are among the most active on the SO portal (Hetland, 2020).
8 https://www.gbif.no/

(there are between one and nine species-groups). Five of the interviewees participate in validation. Fewer collect objects during the season—one does so often (several times per week), three sometimes (1–3 times per month), and four seldom (less than once per month). All except one have experience with collecting structured data, either because they have assisted professional teams or because they belong to a group of amateur naturalists that sometimes collect structured data.

The participants were selected with the help of the Sabima, which is very familiar with the number of amateur naturalists through validation activity. All of the selected amateur naturalists were super users of the SO. As an indicator of their activity, these participants have, on average, collected 1,575 different species and submitted 58,000 records each during the entire time they have been involved in the SO; this represents around 2.4% of the total records at the time of the interviews. The participants' educational levels were generally high. Both the contributors and their contributions have a heavy-tailed distribution (heavy-tailed distributions tend to have many outliers with very high values). The records in the database come from more than 12,000 contributors. At the "head" end, roughly 1% of the contributors have provided more than 40% of the records, while at the "tail" end, roughly 80% of the contributors have recorded approximately 1% of the records. All interviewees were among the "head" end. That participation can be very skewed is well known from other studies (Haklay, 2018), some even refer to the 90-9-1 rule[9] i.e. 90% or more contribute with almost nothing, 9% or more contribute infrequently or fairly little, while the last 1% contribute most of the information. Even if the SO has a heavy-tailed distribution, it is not as extreme as the 90-9-1 rule; the mid-group consists of 19% providing 59% of the records. One limitation of the study is that none of the many at the "long tail" were interviewed. Quite likely they would have been more involved in contributory CS and less in democratized CS. Furthermore, four of the eight amateur naturalists interviewed have training in science, from BSc level to PhD-level, two of them within the field in which they are involved as amateur naturalists. Consequently, the eight amateur naturalists selected represent extreme or deviant cases acting as civic educators. Extreme cases often reveal more information "because they activate more actors and more basic mechanisms in the situation studied" (Flyvbjerg, 2006, p. 229).

All of the semi-structured interviews were conducted over the phone by the author, since the participants were located in regions throughout Norway. They varied from 27–49 minutes in length, with an average interview lasting 37 minutes. All of the interviews were recorded by a dedicated voice recorder and transcribed by the author. The transcribed interviews were coded by the author with the help of the HyperRESEARCH software for computer-assisted qualitative data analysis. HyperRESEARCH allows the researcher to perform analytical induction on emergent code categories. HyperRESEARCH was selected because of user friendliness. Each interview was coded several times to test interpretations and facilitate a repeated comparison of the gathered data focusing on central elements, and picking out representative quotes (Hesse-Biber & Dupuis, 2000).

Findings

The presentation of the results follows the AIP-model; results related to access are presented first. The results related to interaction and participation will then be presented.

Access is, according to Carpentier (2012, 2015), understood as presence (e.g. in an organizational structure or a community) related to four areas: technology, content, people, and organizations. More general data on access is presented above in Section 2. Previously, direct contact between the different museum curators and amateur naturalists was an important element for access, interaction, and participation. Now this direct contact is partly replaced by using the SO. The SO is frequently updated to ensure that all participants, including amateur naturalists, are behaving in as disciplined a manner as possible while also simultaneously including as many participants as possible. The amateur communities, as scientifically oriented groups, are rather skewed when it comes to interests in the different aspects of natural history. The skewing of biodiversity mapping is central to how we understand the world around us. When they were interviewed, the mappers had 10 different species-groups they could chose to map. Among these groups, bats had the fewest records and birds the most. Interestingly, the establishment of the SO has slightly reduced the skewing of reported observations over time. However, skewing is still a crucial issue.

There are several reasons for skewing among amateur naturalists. When amateur communities in natural history form, it is reasonable to assume that skewing occurs in favor of the species-groups that individuals in the group are especially interested in. However, skewing may also be caused by how the amateur naturalists move across geographical areas and identify their favorite locations for observations. The majority of mappers have two or three favorite patches close to their home, vacation spots, or places where they go in their spare time.[10] "When you look at a specific species on the Species Map, what you see is not necessarily

9 https://www.nngroup.com/articles/participation-inequality/

10 Approximately one half of all Norwegians have access to at least one cabin, while one third of all Norwegians have access to two or more cabins (Lien & Abram, 2019).

the geographic distribution of the species, but the geographic distribution of the observers" (Interviewee 6). However, skewing is not solely caused by favorite places or species; some species are simply avoided by mappers for a number of reasons: "I keep away from difficult species, for example, ants; they are so angry and more or less impossible to take a photo of" (Interviewee 3). In general, the SO records unstructured data. However, there might also be structured data in the SO from specific places, such as certain bird observatories. Of course, "If you collect on the same spot year after year, that is a kind of structure, and you will have a time series that might be interesting in biology" (Interviewee 6).

Interaction is, according to Carpentier (2012, 2015), understood as social-communicative relationships that are established with other humans or objects and related to four areas: technology, content, people, and organizations. The SO offers its participants different resources to aid them in their recording activities. Several Facebook pages also appeared shortly after the establishment of the SO, and these are now used extensively to confirm the correct identification of specimens. Many people now ask for confirmation on these pages before they register a record in the SO to ensure that they have made a correct identification. "It is no fun to get comments when you have identified the species incorrectly" (Interviewee 6). The fact that one species might have different Latin names for historical reasons also fosters a need for a species thesaurus and a standardized biological nomenclature. These synonym lists can change over time leading to frustration, as one user described: "When the Norwegian Biodiversity Information Centre changes names all the time, it is frustrating" (Interviewee 3).

Among the services that the SO offers its participants are ranking lists that cover several dimensions including the name of the observers, localities, and photos. These ranking lists are intended to encourage participation, but all of the amateur naturalists interviewed had a negative opinion of them. "I don't care about competition; I want to learn new species" (Interviewee 2). "There are a lot of trigger-happy people out there. They enter a lot of nonsensical information—garbage in, garbage out" (Interviewee 8). "Some people think it is more important to have their name attached to a rare species than to be sure it is correctly identified" (Interviewee 1). Thus, while it can be concluded that the group of amateur naturalists interviewed for this study think that the ranking lists put too much focus on competition, they also think that they encourage interaction.

Collecting specimens was once a crucial activity for amateur naturalists, as natural history research museums used to depend on them for obtaining material for their collections. Today, however, collection is not viewed with the same importance by amateur naturalists. First, photos have become a ubiquitous resource, and second, there is a growing reluctance to display dead animals which discourages potential collectors:

> I am active on several Facebook groups where people ask for assistance identifying a given specimen. If you post a nice picture of a beautiful collected specimen, you will quickly get critical comments: "How are you able to kill such an innocent and beautiful creature?" I think people are reluctant to collect physical specimens since there are a lot of strong opinions about animal collectors; they don't understand the scientific value of collections. (Interviewee 6)

As several of the professional scientist state, the quality of the data erodes much faster when physical specimens are not available. Taxonomic work may suddenly split one species into three species, and, for that, pictures are of almost no value. Research museums, therefore, prefer physical specimens. Additionally, specimens are crucial for DNA analysis.

Opinions on collection also differ among those who collect. "Those who think they don't need the concrete specimen, that pictures are enough, have misunderstood. Anyhow, Red Listed insects are not threatened because of human collection, but by losing their habitats" (Interviewee 1). One participant noted that engaging in collection is important because, "It is not possible to decide correctly which insect it is without taking a specimen, doing DNA analysis, and comparing it with reference collections" (Interviewee 1). Furthermore, one participant claims to be "able to validate 85–90% by pictures; the rest, I need the actual specimen in hand" (Interviewee 6). Some still send their collected material to the natural history research museums, while others state that they "collect privately; however, I will donate my collection to the museum before I die" (Interviewee 1).

Amateur naturalists usually begin their activities at an early age. They don't necessarily follow a rigorous scientific method when recording: "I record in an arbitrary manner, just taking what I find" (Interviewee 3). However, several participants note a love of systems like the SO for several reasons: "I use [the] SO as my own field diary" (Interviewee 6). With the help of the Species Maps, the amateur naturalists can identify "white spots" to help fill in data. All of the interviewees stated that they do not keep their old field diaries. They use either the field diary option in the SO or simply use the SO system as their field diary. These different versions of field diaries are important in their learning process: "I am very careful to document everything, and I am learning a lot through recording" (Interviewee 3). Some have also "digitalized a large amount of historical data" (Interviewee 4).

The interviewees have dual perspectives concerning validation: "I now comment on our Facebook group, but in the past, I emailed people since public comments might be experienced as a pillory" (Interviewee 5). In addition, the interviewees think that many of the SO participants, especially younger amateur naturalists, do not have all of the necessary skills: "Some are not able to read a map" (Interviewee 8). Documentation is also perceived as crucial: "I take

photos the whole time and also through a microscope to document as thoroughly as possible. Some take the documentation more easily, then the value decreases" (Interviewee 3). Documentation is not only about correctly identifying the specimen but also about identifying its sex, geographic location, and activity. Understanding the significance of locality is especially important. "A Red Listed species might fly over a parking lot; however, it is not the parking lot that is valuable" (Interviewee 8).

An important cause of skewing can be both the observer's interest in rareness and the politics of knowledge, which give a certain priority to mapping rare species and invasive species. Of all the observations recorded so far in the SO, 15.5% are on the Red List, and 1.2% are on the Alien Species List. One interviewee commented that the SO is certainly an inspiration to "re-find rare species" (Interviewee 5). However, focusing on a rare species also leads to multiple records of the same specimen: "If a rare bird stays in the same place for a month, you might get hundreds of records of the same bird. It should be easier to just merge all those records into one" (Interviewee 8). Validation of a rare species can also be difficult: "If they have recorded one species that belongs to the Red List, I email them and ask for a picture. If they have no picture and no co-observer, I can't validate [it]" (Interviewee 1). Validation is not always a smooth process; "Sometimes, people are quarreling, more or less. I think SO should stop that" (Interviewee 3).

The Species Map Service ensures that information is available as soon as possible—the SO publishes first and validates thereafter—because "The most important [thing] is that public authorities use the knowledge we provide" (Interviewee 5). Nonetheless, Sabima highlights that they work primarily with environmental authorities and much less with scientific organizations. Some of the interviewees state that the SO should be more explicit about how the data are used, both today and in the future. In terms of how to make the SO more valuable by designing ways of structuring the data, several of the interviewees noted that an easy solution would be to follow specific localities in a more systematic way.

According to Carpentier (2012, 2015) participation is defined by power relations in decision-making processes related to four areas: technology, content, people and organizations. The general principles that the SO follows are presented above in Section 2. Some participants find the openness of the SO to be problematic because some species like the "hazel grouse that are very local" (Interviewee 4) might become vulnerable to hunting as a result. One interviewee does not "record golden eagles since they are vulnerable to being hunted by farmers" (Interviewee 8). Protecting information that relates to vulnerable species is legitimate. However, not everyone trusts that this is done in the right manner within the database.

Knowledge is temporary, which is why validation in the SO is a never-ending activity. This temporality is also emphasized by changes that move a lot of the activities within biodiversity mapping from the field to the laboratory. Floristic and faunistic knowledge is built on the morphological tradition stemming from, among others, Carl Linnaeus (1707–1778), while twentieth-century science is strongly linked to the molecular tradition that uses DNA and similar forms of new knowledge. Amateur naturalists are still mostly dependent on morphology, while professional scientists work with new technologies and methods, potentially weakening knowledge about the ecological contexts that accompany traditional methods.

Validation activity was a topic that was most frequently discussed by the amateur naturalist interviewees, and it was also the activity that provoked the strongest feelings. A certain shared belief exists that "In the SO, they overlook the human factor; they try to do with machinery what usually is best done by man" (Interviewee 8). The validators are often recruited from among the most skilled amateur naturalists. All of the interviewees who participated in validation made statements such as: "The only way to professionalize validation is to pay the validators—to validate all in my group would have been a full-time job" (Interviewee 6). It's OK that people contribute their own observations voluntarily; however, validation is a job.

As noted, five of the eight interviewees participate in validation activity, and all eight of the interviewees have experience with validation in one way or another. They had many thoughts concerning validation: "Some think that it is better to have a large volume than to ensure it is absolutely correct" (Interviewee 5). "It is not possible to validate in a cost-efficient manner" (Interviewee 8). "In the old system [before 2015], we [validators] had the authority to correct the wrong information. Now you have to enter into a dialogue with the observer. It is really time consuming" (Interviewee 8). One example of the time-consuming nature involves the validation of an observation of a species on the Red List, where the validators "expect documentation, like description from a competent observer, photos, sound files, or biological material" (Interviewee 8). If such information is lacking, the validator might ask for it, and "If they don't have a picture and have not communicated with an expert, then I can't validate [the observation]" (Interviewee 1). According to the NBIC, there is no reason to believe that the quality of the data in the SO is lower than that of the databases of professional research institutions. All the validators mentioned examples of "hopeless people" who mess around and should be stopped, but they find this to be difficult. While people do receive certain restrictions, they are seldom expelled. According to the NBIC, fewer than 10 users have misused the system, and they are in the process of excluding one misuser after a long process.[11]

11 Please see https://www.artsobservasjoner.no/Home/DeviatingReports

Discussion

First of all, the present study focuses on super users to study the co-construction processes. The aim is not to conclude that all individual participants partake on all three levels within the AIP model, but that the participants as a group do so. As mentioned earlier, a study of access, interaction, and participation was conducted to attempt to answer the following research question: How do civic educators and citizen communities in a large CS project co-construct access, interaction, and participation and bridge contributory and democratized CS? The main aim with this article is theory building by studying the usability of the AIP model within CS studies. In this section, I discuss how access, interaction, and participation are co-constructed.

Access is a crucial condition for the possibility of interaction and participation. Consequently, all CS activities has access as the first foundation stone facilitating presence. However, access may be achieved in many different ways, either by bottom-up processes involving a large group of actors—including amateur naturalists and their organizations—or by top-down processes where the experts designs a relevant system. In building the SO, amateur naturalists and their societies, together with scientists and public authorities, have acted as strategists, formed alliances, mobilized resources, and built a technological infrastructure (Bowker, 2000; Bowker & Star, 1999; Karasti et al., 2016a, 2016b) for contributory CS. Access through well-functioning technology is a precondition for joining the ranks of records, contributors, validators, and institutional actors. NGOs like the amateur organizations, including Sabima, public authorities like the NBIC, and scientific institutions like natural history museums and the GBIF take on the role of civic educators developing and implementing educational resources. The recent work is part of a long history where uncredentialed naturalists have made greater contributions to science than many academic biologists (Kohler, 2006). Natural history research museums and their collections are now enjoying a second, molecular scientific life supported by this long history.

Furthermore, the development of interesting content is necessary to maintain the interests of all relevant actors, be it amateur naturalists and their societies, public authorities that are paying for the maintenance of the system and using the results, or scientific research that benefits from large-scale biodiversity mapping activity. One important aim is to motivate as many people as possible to participate to avoid skewing in data collection. The participants are able to access the content in a growing number of ways, facilitating both individual projects following the individual amateur naturalist's own interests and nationwide projects of national interests. Two important consequences of all the mentioned activities is first that the participants experience how amateur naturalists' contributions matter through building a database that facilitates a number of new services of national importance, and, second, how civic education in the form of capacity-building improves the participants as a group. As a group they take on the role of both expert and advocate.

Co-construction took place among organizations like the amateur societies who argued strongly for a service like the SO (using the Swedish Artsportalen as their exemplar) and convinced the public authorities that such an infrastructure would be mutually beneficial. Hence, to secure stability and innovation, it was important to secure long-term funding by enrolling public authorities. At the same time, the contextual circumstances were favorable, and biodiversity concerns were placed on the agenda by a heterogeneous group of actors. By facilitating co-construction as an ongoing process, one also avoids one crucial pitfall of many participatory projects: that what is co-constructed may end up as transient CS activities that are dissolved as soon as the interest (and/or money) of the initiators end.

Interaction is the second cornerstone of participation, and interaction implies some degrees of reciprocity (Carpentier, 2015). Over time the technology opens up for a growing number of species groups, and the SO may be used to plan recording activities identifying unmapped places or "white spots." The primary content added to the platform may also be used to produce secondary content like private diaries, ranking lists, maps, etc. The movement in science from the field to the laboratory widens the gap between professional scientists and amateur naturalists. Nonetheless, amateur naturalists continue to contribute much local knowledge. The hierarchal structure of professional scientists and amateur naturalists is also different. Professional scientists consider being a respected researcher within her discipline to be important, while amateur naturalists consider being a respected amateur naturalist as important and have limited tolerance for ignorance within biodiversity mapping. Furthermore, the individual knowledge strategies of the amateur naturalists emphasize local patches and favorite species-groups (Conniff, 2011). However, over time the establishment of the SO has slightly reduced the skewing of reported observations. One important reason for this is quite likely the mobilization of a large number of amateur naturalists and that the digital infrastructure of the SO has improved transparency. Another reason is the move from emphasizing dyadic person-to-person dialogues to emphasizing polyadic dialogues on social media. These polyadic dialogues also imply a shared ontological commitment that distinguishes the participants as a broad citizen-science community of practice (Ceccaroni et al., 2017). From the interviews we know that the shared ontological commitment within the two inner esoteric circles of Fleck are drawn from the language of science, while the two outer exoteric circles are drawn from everyday language. However, a growing number of highly skilled amateur naturalists are able to move between the two worlds, partaking both in a broad citizen-science community of practice and in a narrower scientific community.

Sahlins (1972) uses the reciprocity concept to develop an understanding of the domestic mode of production, even if market relations also contain crucial elements of reciprocity. Among the validators, there is a general claim that contributing one's own records and validating the records of others are very distinct enterprises, especially since validators also take on a crucial educational role, being in the frontline of knowledge mobilization. When one is contributing one's own records it is fun and interesting, and it is quite all right that the work is voluntary. However, it is important that the contributions are taken seriously and reciprocated (Harris, Wyatt, & Kelly, 2013). Examples of such reciprocation include digital diaries, resources to aid recording activities, ranking lists (even if they are much debated), learning opportunities, new collection strategies, and a system of validation. All of these examples have a high personal relevance (Frewer et al., 1999) that improve the quality of biodiversity mapping. When validating the records of others, one is doing a necessary job for the community. According to the interviewees, it is somewhat boring in the long run and takes time away from doing what they like the most. Consequently, the activity should be looked upon as a traditional market relationship—it is a job for which one should be paid. Thus, while the SO reciprocates to the amateur naturalists in a highly relevant manner, it does not do so for its validators.

Balanced or symmetrical reciprocity is the most apparent version of reciprocity when studying biodiversity mapping. On average, each of the interviewees collected 1,575 different species and submitted 58,000 records. Generally, such work is not done solely for the common good. More often it is done for personal reasons—such as instilling order among their own observations or making use of the SO as their own field diary—which in turn makes them visible to the community of fellow amateur naturalists and helps them achieve status as a knowledgeable and experienced amateur naturalist. Consequently, reciprocity also facilitates long term engagement. Personal relevance here is crucial. This knowledge may be useful in assisting others in validation work. The SO practices a form of openness that is sometimes experienced as problematic and, consequently, several Facebook pages have appeared facilitating apomediation (Eysenbach, 2008). The main purpose of the Facebook pages is to establish an arena for communication and learning which participants experience as informal and comfortable, as promoting a respectful atmosphere is important for facilitating opportunities for reciprocity (Kramer & Wells, 2005).

Sahlins (1972) also explored the concept of negative reciprocity, which is characterized by the attempt to get something for nothing. Many of the interviewees concerned with negative reciprocity think of it as a form of theft. According to the interviewees, some harvest data from the SO for their own gain, unconcerned about giving something back. One example of this is the illegal hunting of protected species. (Such hunting sometimes becomes legal, however, since public authorities allow their hunting if a protected species attacks domestic animals or appears outside of their zone of protection.)

Organizations are crucial to maintaining the general principles that the SO has established. "Unskilled" amateur naturalists or "hopeless people," according to several of the interviewees, do not contribute, and several of the interviewees desire an easier way of expelling them. However, expelling participants violates the most important general principle guiding the SO, which is that everyone may contribute, regardless of their skills. Consequently, it is sometimes difficult to maintain a comfortable and respectful atmosphere within the SO, and this frustrates some of the participants (Kramer & Wells, 2005). However, controversies are also an important part of science, be it among professionals or amateur naturalists (Meyer, 2018). The heterogeneity that Secord (1994) finds among amateur naturalists is still there, even if the class aspect is downplayed; skills are currently growing in importance. In this respect, one finds circles of interaction similar to those Fleck describes (1935/1979). The establishment of the SO has increased a large group of participants' knowledge of complex modern problems and how these problems may be addressed through science and policy like e.g. the Red List and the Alien Species List. Furthermore, participation quite likely contributes to an increased understanding of how science changes over time as the participants experience these changes, e.g., how the synonym lists change over time. The interviews also made apparent that the advocate role is of great significance to civic educators (Ceccaroni et al., 2017).

Access and interaction "within a participatory process are necessary requirements for the participatory process to exist" (Carpentier, 2015, p. 24). While access and interaction signify contributory CS, participation signifies democratized CS. Democratized CS is not better than contributory CS, but democratized CS adds the study of power to CS (Irwin, 1995). Most amateur naturalist only contribute; they do not participate in co-deciding. However, the study of CS needs to include power as a crucial dimension, even if power is only openly played out at an organizational level among representatives. The choice of technology involves important dimensions of power, as technology structures actions. Consequently, new versions of the system is not only to modernize the technological infrastructure (Bowker, 2000; Bowker & Star, 1999; Karasti et al., 2016a, 2016b), but also to enhance user experience. Most amateur naturalists understand that they are partaking in a huge communal undertaking producing new content and that the value of their contribution is quantifiable, as they can provide a map of Norwegian biodiversity both across time and space. However, the quality of this map rests on their ability to avoid skewing and collect well-validated data. The difference between participants is primarily a question of different collection strategies and validation methods. Both professional scientist and amateur naturalists emphasize that knowledge should be correct and validated. However, the methods for collecting unstructured

and structured data are quite different. One reason for this not being an overly problematic situation is the difference in goals between the scientists and amateur naturalists. While scientists aim to provide something of scientific value to biodiversity, most amateur naturalists are more concerned with environmental citizenship. Simply put, their *Denkstil* (Fleck, 1935/1979)—their particular style of thinking—may be different. However, their ability to help build and sustain the infrastructure also illustrates that participation is organizational power, enacted both from the bottom-up and top-down. The inclusive style of participation and co-production also underlines important democratic traditions. Organizations are crucial when it comes to democratized CS. They link practitioners, stimulate innovation, address common challenges, and, together with professional biologists and public authorities, they develop shared ontological commitment, norms, and standards. This work increases the visibility of citizen-science community of practice to society at large. From more quantitative studies we also know that many participants appreciate the advocate role, even if they don't perform this role within the citizen-science community of practice (Hetland, 2020). Finally, co-deciding is not only performed within the citizen-science community of practice; it is, even more importantly, part of democratic engagement in the larger society. As Kohler (2006) underlines, biodiversity is a lively issue, mainly because of the number of species that are going extinct, and the different NGOs stemming from the amateur communities also work to place biodiversity on the political agenda.

Conclusion

Civic educators in the form of leading amateur naturalists, scientists and public authorities work together with citizen communities to advance biodiversity mapping, foster a broad scientific mentality, and encourage democratic engagement. This allows society to deal rationally with complex modern problems like loss of biodiversity both across time and space. The AIP model has strong analytical capacities, providing a framework for understanding the rather vague concept of participation in a more systematic manner that differentiates between access, interaction, and participation. Access is grounded in well-functioning technological infrastructures like the Species Observations System, interaction is promoted by civic educators that foster a broad understanding of biodiversity mapping, and, finally, participation is encouraged by organizations that aim to deal rationally with complex modern problems like loss of biodiversity. As a crucial theoretical contribution, the AIP model ecologizes the study of CS, building bridges between contributory CS (e.g., the instrumentalist point of view) and democratized CS (e.g., the capacity-building point of view). This bridge-building increases the relevance of both models of CS to society at large and secures resources for a long-lasting activity.

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ENERGY EFFICIENCY IN NORWEGIAN NEWS MEDIA:

A Glitch in the Discourse-as-Usual

by Jens Petter Johansen, Jens Røyrvik and Håkon Fyhn

This article investigates how energy efficiency features in Norwegian news media discourse. Based on an analysis of 309 news articles, we explore the objectification of energy efficiency and its rhetorical connections to energy savings and reductions. Energy efficiency is surrounded by positive overtones and used flexibly to include different meanings as well as effects. As a discursive object, the term wields significant rhetorical and legitimizing power, producing consensus across conflicting narratives and controversies in what we call the "discourse-as-usual". We argue that energy efficiency shares characteristics with boundary objects, conveying an interpretive flexibility to bridge otherwise incommensurable perspectives on the need to decrease or increase absolute energy consumption. However, there are a few instances where controversy turns toward energy efficiency itself, revealing different views on absolute limits to energy consumption. By scrutinizing one of these glitches in consensus, we examine the normal through the anomaly to pinpoint the moral prerogative of energy efficiency in the discourse-as-usual. By black-boxing the complex relationship between efficiency and reductions, the term allows for avoiding the question of absolute limits to energy consumption in news media debates. Rather than translate between climate change and economic stability and growth narratives, we assert that energy efficiency as a discursive object conceals opposition between them. We discuss this concealment as a form of system dependency, as it is by black-boxing the effects of energy efficiency that it can unite adversaries and ensure ongoing activity.

Keywords: Energy efficiency, media discourse, boundary object, objectification, explanatory principle.

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Introduction

Energy efficiency has become a key political strategy to reduce carbon emissions in Norway and is promoted as a solution with multiple benefits, such as mitigating climate change, boosting local economies, increasing economic competitiveness, and reducing dependency on energy imports (Enova, 2020; European Commission, 2016). The lack of controversy surrounding this strategy stands in stark contrast to the increasing contention and polarization of specific climate policies and technologies, as illustrated by the Yellow Vests movement in France and demonstrations against wind parks in Norway. Such controversies are highly visible in media discourses, where fundamentally different views on the need for societal change feature in competing narratives. Energy efficiency can be part of such disputes on both sides of the argument (e.g., for or against wind parks), but controversy is rarely directed toward the concept itself. Strategies to promote energy efficiency are seemingly without contention and provide a common ground to merge otherwise opposing positions. In this article, we examine the specific logic inscribed in the concept of energy efficiency in Norwegian media discourse.[1] That is, our main concern is *not* to discuss what energy efficiency really means, but to *understand its usage* in Norwegian news media discourse and the *underlying logic* founding this use.

Throughout this article, we show how concepts such as energy efficiency and energy savings are used interchangeably in media discourse, often so that one term is included in the other. Independent of media discourse, our understanding agrees with Oikonomou et al. (2009) in that *energy efficiency* concerns the technical ratio between the quantity of primary or final energy consumed and the quantity of energy services obtainable, while *energy saving* addresses reductions in final energy consumption through behavioral changes. However, delving into the expansive energy efficiency literature, it is clear that the energy efficiency concept is ontologically ambiguous (Dunlop, 2019, p. 9). Therefore, as its meaning changes depending on context, so does its perceived utility. Wilhite and Nørgård (2004) contend that energy sustainability discourse suffers from self-deception, which revolves around equating efficiency with *reduction* (p. 992). This self-deception partly springs out of concealment of—or refusal to acknowledge—absolute planetary limits (Jackson, 2017). It is also connected to the complex relationship between energy efficiency and energy demand, most commonly framed as rebound effects counteracting energy efficiency gains (Herring, 2006; Wei & Liu, 2017). Jackson (2017) summarizes the rebound critique regarding passive energy efficiency policies as the implication of driving growth forward, where *relative* decoupling sometimes has the perverse potential to *decrease* the chances for absolute decoupling (p. 111).[2] Sorrell (2015) argues that similar comments apply to behavioral change, or *sufficiency*, since this can also have unintended consequences and necessarily involves swimming against a strong tide (p. 78). However, as Jackson (2017) claims, even if we leave the economic growth paradigm, efficiently using energy and materials remains a core foundation of the economy of tomorrow. Thus, almost regardless of the perspective on societal change, energy efficiency is a solution that either fuels continued green growth (European Commission, 2016; Sakai et al., 2019) or serves as a component in a future (non-growth) economy and provides necessities while respecting planetary limits (Jackson, 2017; Wilhite & Nørgård, 2004).

Energy efficiency's seeming ability to bridge, or at least be part of, these otherwise incommensurable visions of the future has gained attention from critics arguing that energy efficiency policies promote the status quo, essentially legitimizing ongoing energy-intensive practices (Shove, 1998, 2010, 2018) and hegemonic discourses of economic growth (Ruzzenenti & Wagner, 2018). Lutzenhiser (2014) notes that the dominant view of consumption and energy savings works as a legitimizing logic, offering energy efficiency activities some degree of protection from political opponents and other potential critics (p. 143). Thus, energy efficiency and savings are not only scientific concepts used to describe machine performances and optimize consumer products and industry processes, nor behavioral changes reducing energy consumption. They feature in modern language, political strategy documents, and discourses as taken-for-granted concepts legitimizing narratives about the state of the world. Following this line of thought, we investigate public narratives and media events about energy efficiency and savings.

Our investigations are based on a media analysis of 309 articles in a selection of Norwegian newspapers containing the term "industrial energy efficiency," spanning 2013–2018. We specifically examine how the concepts of energy efficiency and savings are used in Norwegian media discourse. The objective of this paper is twofold. First, we set out to investigate these concepts' framings in media discourse. Through an empirical and theoretical exploration of the objectification of energy efficiency, we show how the concept's interpretive flexibility stems from black-boxing what energy efficiency is and what it can *do*. While we focus on energy efficiency, we explore how it is associated with energy savings and other outcomes by analyzing the explicit and implicit meaning of the concepts in use. We claim that energy efficiency draws legitimacy from a repertoire of *possible and non-excluded* associated interpretations. Within science and technology studies, objects that translate across social worlds are often referred to as *boundary*

1 A first draft of this article was published as a conference paper presented at the European Council for an Energy Efficient Economy (ECEEE 2019) Conference (Johansen et al., 2019).
2 Jackson (2017) distinguish between *relative* and *absolute* decoupling. The former refers to any decline in the material (or energy) intensity of economic output. Absolute decoupling refers to the situation when resource use (or emissions) decline in absolute terms, even as economic output continues to rise (p. 84).

objects (Star & Griesemer, 1989); similarly, we assess how energy efficiency as a concept in a media discourse produces consensus across social worlds.

Second, we investigate how narratives, controversies, and positions are legitimized by employing energy efficiency rhetoric. Our analysis shows how the concept appears 1) as a strategy to reduce emissions by minimizing energy consumption, 2) as a solution to ensure a competitive Norwegian industry and therefore economic stability and growth, and 3) in narratives of green growth by explaining how emissions and economic prosperity can be decoupled. While we assert that the "discourse-as-usual" revolves around consensus, there are a few examples where consensus temporarily dissipates and the inherent conflict between actors fronting different narratives and positions becomes visible. We conceptualize these media events as *glitches*[3]: anomalies where consensus toward a concept temporarily breaks down before returning to normal. Glitches provide an analytical opportunity to investigate what happens when concepts no longer function as boundary-spanning, allowing the exploration of the discourse-as-usual's underlying structure and logic. This paper examines one glitch of particular interest to illustrate energy efficiency's function in Norwegian media discourse: a media event where six consecutive articles debate the meaning and effects of energy efficiency. Drawing on Bateson (2000) and the notion of black boxes as explanatory principles, we investigate the production of consensus surrounding energy efficiency, and how it breaks down in the glitch.

We start with a contextual description of energy efficiency as a concept and political instrument in Norway. Then, we provide an overview of our theoretical and methodological approach. Our analytical section outlines the objectification of energy efficiency in Norwegian media discourse and how the multitude of meanings and assumed effects are black-boxed. Further, we show how energy efficiency produces consensus across different social worlds and opposing positions. Finally, we show how consensus surrounding energy efficiency breaks down during a media event we conceptualize as a glitch. We conclude by discussing the importance of the glitch being temporary and not a lasting breakdown of consensus discourse. This not only provides insight into the discursive structuring but also the inherent interests behind preserving this discourse-as-usual.

Energy Efficiency and Savings

In this article, we discuss various views, interpretations, and usages of the terms *energy efficiency* and *savings* as found in our empirical data from Norwegian news media. Before presenting and discussing the empirical findings, we clarify our understanding of the key concepts included in the empirical material through other actors.

Energy efficiency and savings refer to two different microeconomic situations. As a technical term, energy efficiency refers to using less energy to produce the same amount of services or input (Patterson, 1996, p. 377). The European Commission (2016) adopts a similar definition: "the ratio of output of performance, service, goods or energy, to input of energy." Drawing on Kempton and Montgomery's (1982) notion that energy and energy use are essentially invisible to consumers, Lutzenhiser (2014) argues, "If it were possible for something to be doubly invisible, that something would be energy efficiency – the invisible, unnotable, generally imprecisely estimable phenomenon that did not occur" (p. 142). Yet, this invisible phenomenon is made visible in objects or representations of energy efficiency, taking the form of numbers, models, and ratios (Patterson, 1996). Further, as Patterson (1996) notes, energy efficiency is a generic term, for it has no unequivocal quantitative measure (p. 377). Along similar lines, Shove (2018) tells that even technical definitions of energy efficiency are permeated by normative assumptions of what is regarded "same service" or "useful output." In other words, ideal machine performance is not always a known state nor an appropriate unit of comparison when the system boundaries expand to an organization, industry sector, or country. Critique is also directed to the upper side of the energy efficiency divider, namely, energy. As illustrated by Shove (2018), energy efficiency discriminates contextually situated methods of knowing energy (e.g., manpower) in favor of contemporary generic metrics (e.g., kWh, joules), which are more easily aggregated. The connection between technical efficiency and reduced energy demand is not straightforward, as illustrated in studies on the interconnection between household efficiency and demand (Gram-Hanssen, 2014). The efficiency of technology and related infrastructures is merely one of several elements constituting the practices behind energy consumption (Gram-Hanssen, 2014, p. 104).

Energy saving, meanwhile, refers to the actual reduction of energy use without reference to output produced (Erbach, 2015). Energy saving (or conservation) also includes behavioral changes to promote energy conservation (Oikonomou et al., 2009; Steg, 2008) by using smaller quantities of energy services (Svensson & Paramonova, 2017). The clarity of this concept also suffers from various system boundaries on "where energy supposedly is saved" to demonstrate that it is not used "elsewhere." For example, as Sorrell (2015) argues, further reductions in energy demand may be achieved by reducing the demand for the relevant energy services ("sufficiency"; p. 78). However, growing incomes create strong pressure in the opposite direction. This is somewhat in line with Shove's (2010) claim that the dominating focus on individual attitudes and behaviors disregard the stabilizing powers of practices and infrastructures.

While energy efficiency and savings are different concepts, their meaning content often overlaps, even in academic discourses

3 This concept is inspired by *technical glitches*, referring to small, fleeting, and temporary errors in a system that occur due to unknown causes.

(Dunlop, 2019). Furthermore, it is important to distinguish the technical intentions and foundations of engineering and economic notions of efficiency in a particular organizational field from larger cultural currents (Lutzenhiser, 2014, p. 143). Technical definitions aside, this study's objective is to uncover these concepts' framings and use in media discourse. Rather than examine the empirical connections between efficiency and savings, we explore the rhetorical and associative connections between them and how they legitimize different policies, financial incentives, moral positions, power, and stakeholder legitimacy in Norwegian news media discourse.

Energy Efficiency in the Norwegian Context

In Norway, 93% of electricity production is hydropower, which has resulted in historically low electricity prices compared to the rest of Europe (NVE, 2019). This poses a challenge to realizing energy-saving potential (Westskog & Winther, 2014, p. 100). Despite this, energy efficiency (and economization)[4] has been central in Norway's political agenda to enable an economically and environmentally sustainable energy system (Norwegian Ministry of Petroleum and Energy, 2016). This is demonstrated by significant public funding for energy efficiency projects (Enova, 2020), voluntary agreements with the energy-intensive industry (see Cornelis, 2019), and university/industry research projects on energy efficiency (The Research Council of Norway, 2018). The Norwegian government agency for energy efficiency, Enova, has increased funding for industry projects considerably. In the last three years (2017–2019), the agency has contributed over 10 billion NOK in subsidies to energy efficiency and renewable energy projects, with reported energy results of 5182 GWh (Enova, 2020). In addition, significant government funding is directed at energy efficiency research projects through the Norwegian Research Council. The most prominent is the research program Centers for Environmentally Friendly Energy, which seeks to develop expertise and promote innovation through long-term research in selected areas of environmentally friendly energy (The Research Council of Norway, 2018). The largest research center in the program is the one focusing on industrial energy efficiency.

Norwegian discourse on energy efficiency also engages with climate policies characterized by more controversy. Plans for expanding the transmission capacity of electricity to accommodate increased peak demand due to electric vehicles (EV) and energy exports to European countries are permeated by conflicting logics (Westskog & Winther, 2014). A related discussion about Norway joining the Agency for the Cooperation of Energy Regulators (ACER) has divided NGOs, unions, industries, and politicians with differing opinions on the consequences for electricity prices. Similarly, there is resistance to increased renewable energy production (e.g., Solli, 2010). Efforts to establish new wind or hydro parks to increase renewable energy production are applauded by some environmental NGOs, but meet resistance from others insisting on wildlife and nature concerns. Other examples include controversies surrounding the electrification of offshore oil production and carbon capture and storage (Røyrvik et al., 2012). In contrast, there is little contention regarding utilizing energy more efficiently in industry processes and buildings. Environmental NGOs, as well as industrial trade organizations, front energy efficiency as a key climate policy. However, perspectives on the desired effects of these policies diverge. For example, in a report by the Federation of Norwegian Industries (2016), energy efficiency is essential to projecting a future sustainable energy system where total energy consumption increases:

> Energy consumption in the EU will most likely increase by 2050. Renewable energy will replace fossil fuels to a larger degree, and there will be increased energy efficiency. (p. 78, authors' translation)

Similarly, the Norwegian NGO the Norwegian Society for the Conservation of Nature/Friends of the Earth Norway (2018, authors' translation), which focuses on nature preservation in addition to mitigating climate change, draws on the prospects of energy efficiency to reduce total energy consumption:

> All energy production affects the environment. The best choice will always be to reduce the consumption of energy. With the technologies that are available, it is completely possible to spend less energy to solve the same tasks. In fact, energy efficiency is a better word than energy saving.

These contradictory views (and wants) on increase or decrease in absolute energy consumption speak to the essence of the discourse we unpack in the media narratives explored in this paper.

Theoretical and Philosophical Approach

To address energy efficiency's function in media discourse and its associated connections to energy savings, we explore the concept as an explanatory principle and that of boundary objects. While the former highlights the black-boxing of the mechanisms behind an entity's explanatory power, the latter focuses on the interpretive flexibility of objects that enables them to translate across social worlds.

4 Energy economization, or ENØK, refers to policies aiming to use and produce energy more *profitably*, a strategy that gained momentum in Norway after the energy crisis in the 1970s (Skjølsvold et al., 2013).

Systems of Dependency

While energy efficiency's technical definitions are equivocal and rely on normative assumptions, the concept has entered modern language and policy documents as a malleable generic term. Its usage can be understood in terms of what Bateson (2000) calls an *explanatory principle*. An explanatory principle emerges through a process of objectification, implying that the phenomena gathered into an object gain a certain gravity (Larsen, 2010) and become increasingly self-sufficient. At this point, the object achieves the qualities of an explanatory principle, explaining something without itself being in need of explanation (Bateson, 2000, p. 39). However, at the same time that the concept gains its object qualities, it conceals its ambiguous nature. Thus, an explanatory principle is likened to a black box:

> It's a word that comes from the engineers. When they draw a diagram of a complicated machine, they use a sort of shorthand. Instead of drawing all the details, they put a box to stand for a whole bunch of parts and label the box with what that bunch of parts is supposed to do. (Bateson, 2000, p. 41)

The explanatory principle indicates that there is no need to explain a thing further. While the input and output of a black box are known, the mechanism inside is concealed. It does its job whether one knows the mechanism inside or not. This aspect of concealment is highlighted in the term *black-boxing* (e.g., Latour, 1999). Keeping with Bateson's cybernetic take on black boxes and explanatory principles, their roles in larger systems are important. In an engineering drawing, the black box plays an essential role that can be seen as a system of explanation. The parts make up a whole, which has certain qualities one cannot derive from the individual parts. However, the whole system depends on the individual parts. If you remove one black box, the machine will not work, and the engineering drawing loses its explanatory power. As this illustrates, Bateson's systems theory is cybernetic and highlights the ontological relation between the parts and the whole (Bateson, 2000).

The nature of dependency is particularly relevant in this respect, and it is possible to see explanatory principles in the same way.[5] As larger systems of explanation are built on black boxes, they cannot be removed since so much is invested in them. The concept of energy efficiency also seems to be weaved into larger systems that have become dependent on it, including explanatory, political, and economic systems.[6] The concept and the system are mutually dependent on each other: the concept, as an explanatory principle, legitimizes the larger system, and the larger system legitimizes the explanatory principle. As energy efficiency also figures into scientific arguments and systems of explanations, it can be seen in light of Heidegger's (1977) *Gestell,* which can shed light on certain aspects of Bateson's systems of explanations. Specifically, Heidegger (1977) points to how certain objects are gathered as "facts" that legitimize an "explanation" while they themselves are confirmed by the same explanation.

Boundary Objects

In this article, we analyze energy efficiency as a media object able to unite adversaries across different discourses and social groups. Thus, we assess its characteristics as a boundary object. Star and Griesemer (1989) introduce the boundary object concept to characterize museum artefacts used differently by experts and amateurs, translating between groups:

> Objects which are both plastic enough to adapt to local needs and constraints of the several parties employing them, yet robust enough to maintain a common identity across sites. They are weakly structured in common use, and become strongly structured in individual-site use. They may be abstract or concrete. They have different meanings in different social worlds but their structure is common enough to more than one world to make them recognizable, a means of translation. The creation and management of boundary objects is key in developing and maintaining coherence across intersecting social worlds. (p. 393)

Boundary objects are rarely neutral, as there is a risk of them favoring perspectives that are more easily articulated by the objects (Carlile, 2004). The concept is also used in studies of interdisciplinary cooperation, emphasizing the boundary object's role in connecting experts through collaboration (Wenger, 1998). Here, the boundary object is typically a technical model on which different experts can work and thus articulate their perspectives in the collaboration. Boundary objects have also been explored as concepts transcending social worlds on a macro level (e.g. Brand & Jax, 2007). As such, we examine the characteristics of the concept of energy efficiency in the discourse with the function of a boundary object.

Discourse Analysis

In this article, we focus on the discursive patterns in public communication that include the term *energy efficiency* and associated concepts. First treated as a formal and administrative *concept*, energy efficiency turned into a word used in spoken conversation and increasingly in newspaper media articles. Discourse analysis examines the conditions of knowing by questioning discursive objects (Foucault, 1977), revealing power and their regimes of knowledge as expressed in public communication. As a result, a core idea within critical discourse analysis is that knowledge is always situated and legitimizes power (Foucault, 1977). Thus, by focusing on the patterns in public communication, what is taken for granted, natural, and seen as the natural order of things is questioned. While Foucault (1977) refers to discourse as "ways of constituting knowledge" that govern the way a topic

5 Bateson (2000) describes, for example, how society as a system became "addicted" to the pesticide DDT.
6 See, for example, Lutzenhiser's (2014) discussion of the energy efficiency industry.

can be meaningfully talked and reasoned about, Bourdieu (1977) treats it as a "structuring, structured, structure." This implies a kind of power that is non-personal in that it is a structuring of the thinking that is already structured by what was possible to think and express—a continuing reification of thought, structure, and power.

In our text corpus, such reification is expressed by the generic use of concepts where the relations between *energy efficiency, reduction,* and *sustainability* are not clear. To analyze the concept of energy efficiency, we observe how it is constituted as a word, that is, how a techno-social phenomenon is assigned certain object qualities, gathered, and separated from other phenomena and related as either cause or effect in the discourse of explanations (Bye et al., 2016; Heidegger, 2001; Røyrvik et al., 2012). In this case, the objectification process of energy efficiency is analyzed according to how the word is delimited (in different ways) and used (differently) to form arguments within narratives.

Methodological Approach

We analyzed framings of industrial energy efficiency and savings by studying articles in Norwegian online newspapers from January 1, 2013 to January 1, 2018. Eight different Norwegian newspapers were selected to cover different segments of the public debate, including newspapers with different topical (political, technical, and daily newspapers) and geographical (local, regional, and national) foci: *Dagens Næringsliv, Klassekampen, Verdens Gang, Aftenposten, Adresseavisa, Rana Blad, Varden,* and *Teknisk Ukeblad.* Of the 326 articles gathered through the web database Retriever, 309 were analyzed and coded in-depth after removing non-relevant articles.

Initially, we explored several search criteria to capture the different framings of energy efficiency, savings, and reductions. The final search parameters were the word industry in combination with one of the following Norwegian equivalents: *energy efficiency, energy-efficiency, energy economization, energy efficient, energy reduction, energy saving*, and *save energy*. We coded the articles in Norwegian and translated the selected quotes for this paper to English after the analysis. By coding the meaning content of the words as used in the discourse, we sought to avoid translation issues between Norwegian and English. We coded whether the authors provided explicit definitions or expressed meaning content of the concept in terms of how they linked to technical efficiency ("less for more" relationships), behavioral change, and absolute energy reductions (output). We also coded if the concepts were framed in the articles as merely generic words or entities without expressed (or obviously implicit) meaning content. In this way, we sought to capture not only the academic definitions of the concept, but also investigate the larger cultural currents of meaning content in media discourse.

Further, we coded the articles according to 18 categories.[7] The most relevant here are "main narrative" and "media events." In our emergent coding, we identified four narratives in which energy efficiency and savings featured as a *solution*: narratives of *climate change, economic change, green growth*, and *reliable energy supply.* These broad narratives carry with them an array of diverse sub-narratives, positions, and arguments. The purpose of this study was to investigate how the concept of energy efficiency appears within them and legitimizes argumentations (and not explore all avenues of the narratives themselves).[8] We also found and registered media events, that is, cases where two or more articles revolved around a specific news story (e.g., wind park controversies, climate conventions). While rare in our material, we found a few media events where contention turned toward the concept of energy efficiency itself. What makes these anomalies interesting is not their frequency, but their rarity. We focus on one particular glitch in this paper, as it triggered a debate over the concept of energy efficiency spanning several news articles. Here, our analytical approach was inspired by Latour's (2005) advice to "feed controversies" and focus on issues that are controversial and subject to debate or disagreement (p. 21). This implied expanding our analysis and following a media event we characterized as a glitch as an opportunity to understand both the peculiarity of these situations and the discourse-as-usual.

Investigating "breakdowns" to understand "order" is a viable research strategy used in studies of societal norms in ethnomethodology (Garfinkel, 1967), as well as conflict studies in the Manchester School. The overall methodological principle can nevertheless be referred to as phenomenological-inspired hermeneutics (Geertz, 1973). We seek to understand the whole (the conceptualization of energy efficiency) through a focus on a specific part (an anomaly in the media discourse) to examine the world view (narratives on societal change) through which the concept emerges.[9] In the following sections, we investigate the objectification of energy efficiency in media discourse, how it produces consensus, and what the temporary dissolvent of consensus during a glitch can tell us about the discourse-as-usual.

7 Article identification number (v1), newspaper (v2), article name (v3), date (v4), genre (v5), size (v6), theme (v7), local/national/international level (v8), industry case (v9), actors mentioned (v10), text producer (v11), sources (primary, secondary, tertiary) (v12), media event (v13), main narrative (v14), associated sub-narratives (v15), and the author's position within narratives (positive, negative, neutral, conflict) (v16). Finally, we coded which concepts were used for energy efficiency/savings (v17) and included a comment variable coding these concepts' explicit/implicit framings (v18).

8 Note that these narratives are empirically derived from the research design and search words on energy efficiency and reductions.

9 As Douglas (1966) shows, anomalies are of particular interest both for anthropologists to explain and for societies to manage.

Discourse-as-Usual: Energy Efficiency in Norwegian News Media

Within the Norwegian news discourse, energy efficiency and savings entail different meanings and causal outcomes ready for application within different arguments. Tracing the concept's usage in newspaper articles, it is evident that it holds both different *referents* and *references* (e.g., Bye et al., 2016), sometimes within an article but especially between articles. However, the concepts are most commonly used generically without explicit references and explanations. Next, we briefly present the discourse-as-usual and how energy efficiency is subject to processes of objectification and attributed a multitude of possible characteristics.

The Objectification of Energy Efficiency and Savings

The term *energy efficiency* was increasingly used in Norwegian news media during the period studied. Most often, the concept is not explicitly explained, but there are two characteristics of what energy efficiency and savings "do" that are expressed, namely entailing relative or absolute reductions in energy consumption. Several articles express a "more for less" characteristic of energy efficiency through ratios, comparisons, energy results, or explanations. This reflects modern definitions of energy efficiency (Patterson, 1996), explained in articles as "energy efficiency – to do more with less energy – is one of the instruments"[10] or through explicit ratios expressing amounts of products divided by energy. There is a large variance on the specification of the parameters (the more and the less), ranging from purely generic to explicit energy efficiency indicators (e.g., energy divided by tons of aluminum).

Other articles attribute reductions in energy consumption to a characteristic of energy efficiency or as a direct effect of efficiency: for example, "the solution is to reduce the winter consumption of electricity through energy efficiency and heating methods requiring low or none electricity."[11] These effects of energy efficiency are also expressed in absolute numbers, as with, "Energy efficiency will reduce the electricity demand heavily, up to 15 TWh."[12] Here, the causal effect—what energy efficiency *does*—is reducing overall energy consumption. Reducing energy consumption (or energy saving) is usually framed within a climate narrative and expressed through popular sayings such as, "The most climate-friendly kilowatt there is, is the one that will never be used."[13] Such statements connect the climate aspect to reduced energy consumption. Only a few articles explicitly frame lower quantities of energy services through behavioral change—and in these cases, individuals must change their behavior (and not companies or larger systems). Thus, energy efficiency is given different meanings in different articles, diverging from the academic definitions of the concepts.

Most commonly, the concepts are used as generic words. When used without definitions or explanations, they tend to feature as a self-explanatory *entity* causally related to other entities, such as in the example below:

> Renewable energy and energy efficiency are important strategies to increase energy security in Europe, but also to decrease climate gas emissions and create new jobs. (Politician, Labor Party, *Aftenposten*, 08.13.2017)

It is in this causal relationship (as either a cause or an effect) that the entity's function is revealed. Connections are made between the concept and assumed effects and multiple benefits, such as energy security, emission reduction, and job creation. In such arguments, the uncharacterized entity can cause all these effects. Another example of generic framing formulates the concept of energy efficiency as an adjective or quality statement. The purpose of the quality statements within the arguments, as with the one below, is to underline the efficiency of something:

> The main competitive advantage of Norwegian industry is that it is very energy efficient and utilizes clean, renewable hydroelectric power as an energy source. (Journalist, *Varden*, 11.01.2016)

It is not only the meaning that varies in and between articles, but also the object that "is" energy efficient, from a product or organization in some articles to industry sectors or countries in others. The temporal and spatial system boundaries of the energy efficient object diverge (e.g., the world, previous practices), as does the object of comparison (e.g., industry in other countries). Thus, energy efficiency—as a media object—is attributed properties through the functions that it holds in different contexts. As such, meaning is inscribed to the entity by its attributed properties while also concealing the meaning of the word in the same objectification process.[14]

Consensus across Narratives, Controversies, Levels, and Positions

We find there is almost no controversy about energy efficiency itself in news discourse, but it is used—and has a function—in various arguments in other controversies in the Norwegian context. In the following section, we elaborate on the narratives and media events

10 Journalist, Klassekampen, 01.19.2013.
11 Statnett representative, Teknisk Ukeblad, 03.27.2014.
12 ZERO, Aftenposten, 12.18.2013.
13 Journalist, Dagens Næringsliv, 02.27.2016.
14 Resembling the way Latour (e.g., 1999) asserts that objects are defined.

in which energy efficiency and savings feature. We focus on the breadth (rather than depth) of discussion to show the "multiple benefits" associated with and legitimized by the concepts in news media discourse.

We identified three main narratives in which energy efficiency serves as a *solution*. Common to all three are different types of societal *change* and the need to address these changes.[15] The narratives are also prominent at different levels (global, national, and local). The first narrative, labeled "climate/environment narrative" (40%), includes articles placing arguments within a narrative of climate change. The second narrative, labeled "economic stability and growth" (16%), contains articles concerning economic growth and industrial stability. The third narrative, which we labeled "green growth" (16%), comments on the interlinking and decoupling between climate change and industrial growth.[16] Within the narratives, energy efficiency is framed as a *solution* and often referred to in arguments that mention several strategies, as in the example below:

> A new course in climate politics would require more full-scale CCS, renewable energy, energy efficiency, funding to adjust industries, and more electric cars on the road. (Journalist, *Klassekampen*, 09.28.2013)

While energy efficiency features in similar ways as a solution in the other narratives, it differs in terms of solving different things (as summarized in Table 1).

TRANSITION NARRATIVES AND FRAMINGS OF ENERGY EFFICIENCY

	Climate narrative	Economic narrative	Green growth narrative
Energy efficiency within the change narrative	Energy efficiency is one of the strategies to address climate change by reducing energy consumption, which can displace carbon-intensive practices elsewhere through the export of electricity or products.	Energy efficiency is vital to ensuring economic competitiveness and growth in Norwegian industry.	Energy efficiency is important to enabling economic growth and reaching climate targets (decoupling). Increased energy-efficient production in Norway can displace carbon-intensive practices elsewhere.

Table 1. Transition narratives and framings of energy efficiency.

Within the transition narratives, there are several ongoing controversies where energy efficiency also has a function on both sides of a given argument. The most prominent of these in our data material is that of the development of onshore wind parks, hydro parks, and transmission lines, which splits politicians and NGOs calling for nature preservation and local democracy on the one hand and climate change mitigation and energy security on the other ("Nature/Climate"). A second prominent controversy is the debate concerning the increase of transmission capacity to Europe ("Green battery for Europe/Green industry in Norway"). Here, the main topic of contention is the impact on energy prices for Norwegian industry. A third controversy is the future of the Norwegian oil and gas industry, where specific controversy concerns the possible expansion of Norwegian oil and gas fields in the Arctic region or whether this industry should be phased out ("Sustainable oil and gas/Phase out"). Arguments connect to the transitions narratives by establishing logical pathways including or excluding the object of contention. Here, the use of the energy efficiency concept functions as an alternative within the argument, as in the "Nature/Climate" controversy below:

> The proposed wind park build out is ruthless, massive in scale, and does not acknowledge the consequences and impact on nature in Trøndelag. We have to oppose it. As an alternative, we should pursue energy economization and reduced consumption and upgrade existing hydropower, transmission networks, and other renewable energy sources, such as solar, geothermal energy, and offshore wind. (Politician, *Adresseavisa*, 09.04.2013)

While this stance establishes a climate narrative, e*nergy economization* and *reduced consumption* form a more favorable pathway than establishing wind parks. Similarly, establishing electricity transmission lines triggered opposition in a local newspaper, where energy efficiency is the preferred alternative to constructing transmission lines:

> The best would of course be to not construct the [transmission] line. Instead, the billions could be used on families and industry in Trøndelag so they can upgrade buildings, install heat pumps, and pursue energy efficiency. (NGO, *Adresseavisa* 06.03.2013)

We find similar views in all controversies and media events in our data material. While the articles' authors front opposing positions between narratives or within a more specific controversy, the energy efficiency concept enters the argumentation as rhetorical ammunition on both sides. In these controversies, the actors employ

15 In scholarly debates, these changes tend to be addressed as transformations or transitions (e.g., Jørgensen, 2012).
16 We also find a narrative of reliable energy supply (16% of articles) in which energy efficiency features. We do not address this narrative further in this article.

energy efficiency to legitimize their positions and narratives. The concept seems to create a shared understanding of at least one of the elements that needs to be done (energy efficiency) to solve the problems at hand.

Breaking Consensus with Limits: More for Less, but Increased Absolute Energy Consumption

While energy efficiency is not an object of controversy in the discourse-as-usual, we found a few examples where consensus surrounding energy efficiency temporarily dissipates. Here, the inherent conflict between actors, narratives and positions becomes visible as a conflict regarding the meaning of energy efficiency itself. In the following section, we explore one such controversy in depth, involving a media event that caused a temporary breakdown in consensus surrounding the prospects of energy efficiency as a solution in both a climate and economic growth narrative.

Following a national conference for energy efficiency and the environment arranged by Enova in January 2013, the former Norwegian Oil and Energy Minister Ola Borten Moe stated that the government's objective was to increase energy efficiency and increase energy consumption, as reported in the business newspaper *Dagens Næringsliv* (01.30.2013):

> The Norwegian government will not put a cap on energy use and is not against increased energy use. We are at the same time engaged with energy efficiency and wish to produce more for less, said Borten Moe.

Over the next three days, this statement led to several articles debating the concept of energy efficiency and the connection between energy efficiency and national carbon reduction objectives.[17] Journalists argued the paradox of fronting energy efficiency as a climate policy if the objective was not an absolute reduction in energy consumption. For instance, the regional newspaper, *Adresseavisa* published a critical short-article called "Unclear about Climate Objectives":

> Yesterday, the responsible cabinet minister for Enova contributed to confusion regarding the government's ambition for climate change mitigation. Several of the 700 listeners at the Enova conference were puzzled when Ola Borten Moe emphasized that the government would not set a cap on energy use and emissions. "From my point of view, it is good if we can both increase energy efficiency and at the same time increase the total energy consumption. That means we have succeeded, that we increase the value creation and employment in Norway," he said. It is nice that the cabinet member thinks outside the red-green box. What is challenging is that this statement about increasing energy consumption makes it even more unclear what the government will achieve with climate efforts and Enova as an instrument. "Oil Ola" must beware so that he doesn't become "Waste Ola." (Newspaper Leader, *Adresseavisa*, 01.30.2013)

This argument centers on how energy efficiency policies can contribute to climate targets if the objective is to *increase* energy consumption. Further, the newspaper challenged Enova on whether their financial support of energy efficiency projects are actually industry policy incentives rather than climate efforts. Enova's director agreed that absolute energy consumption might in fact increase despite efficiency efforts:

> We are concerned with efficient energy use, and that means that energy consumption as such may increase. But the increase in the industry sector will hopefully come at the cost of, for example, aluminum production produced with non-renewable energy outside Norway. (Enova director, *Adresseavisa* 01.30.2013)

When challenged on using the word "hopefully," the director had to agree that there was no way to measure or know for sure that the increased production of goods in Norway would lead to reduced production and related carbon emissions elsewhere. Other articles lent support to the stance that improved energy efficiency and increased energy consumption were in fact positive outcomes. An advisor from the same political party supported and explained what the minister said in a short article entitled "To Get More Out of Less":

> If we increase energy efficiency, we strengthen both value creation and employment rates in Norway. This means that we produce more for less. Resource efficiency and reduced CO2 emissions are central. (Political advisor, *Adresseavisa* 02.01.2013)

In this statement, the main narrative is one of value creation and economic growth, where energy efficiency entails producing more for less and strengthening competitiveness. Other actors also took sides in criticizing the newspaper for confusing their audience, stating that increased energy consumption was a wanted outcome as long as it was more energy efficient. In this media event, the apparent agreement (on a number of levels) dissolved, and the confronting views on what energy efficiency *is* and what it can and should do surfaced when confronted with absolute limits. Two days later, the media event was over. In fact, ten days later an article in the same newspaper proclaimed that energy efficiency was a vital climate strategy. Thus, the controversy became a mere *glitch* in the discourse-as-usual.

17 In our dataset, we found six articles debating the ministers' politics and definition of energy efficiency following this conference.

Producing Consensus in a Discourse-as-Usual

It is apparent that several of the actors do not address the same phenomena nor their effects when drawing on the familiar concepts of energy efficiency, savings, and reduction. The multitude of associations, combined with the overwhelming tendency to utilize energy efficiency as a generic word (either as a description, quality statement, or entity), contributes to black-boxing what energy efficiency is and what it can do. Thus, energy efficiency as an object encompasses a repertoire of associative meanings and effects. Indeed, in most articles, the links between the concept and the repertoire of possible associations and effects are black-boxed (as illustrated in Figure 1). As such, energy efficiency relates to different academic definitions and actors' interpretations of energy efficiency and savings through associations only. Yet, the entity appears *scientific* and conveys scientific legitimacy.

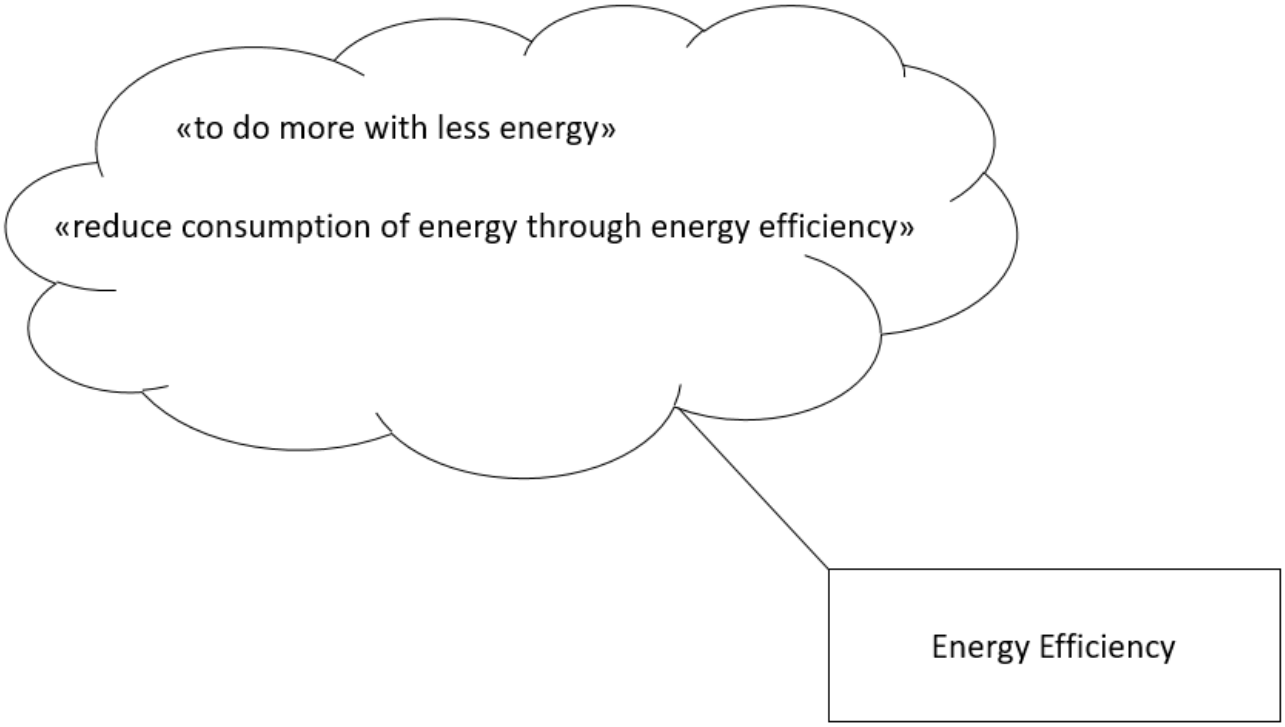

Figure 1: Illustration of how energy efficiency as a black box draws attributes from a repertoire of associations

A main finding in our data is that the energy efficiency concept is seldom the focus of contention or the main article topic. This can be partially attributed to the invisibility of energy (Kempton & Montgomery, 1982) and energy efficiency in particular (Lutzenhiser, 2014). However, the concept is visible in debates, featuring within argumentations of opposing positions in media narratives and specific controversies and thereby producing consensus without revealing the mutual exclusiveness of the positions. Actors who stand on different sides of media controversies all agree on the need for energy efficiency and employ the concept in their claims. Even within controversies such as local wind parks, transmission lines to Europe, the future of the Norwegian oil and gas industry, and electricity prices, actors employ the concept and effects of energy efficiency to legitimize their "for" or "against" statements. In this way, energy efficiency is a flexible media object that can legitimize opposing arguments, as well as converge narratives (as illustrated in Figure 2).

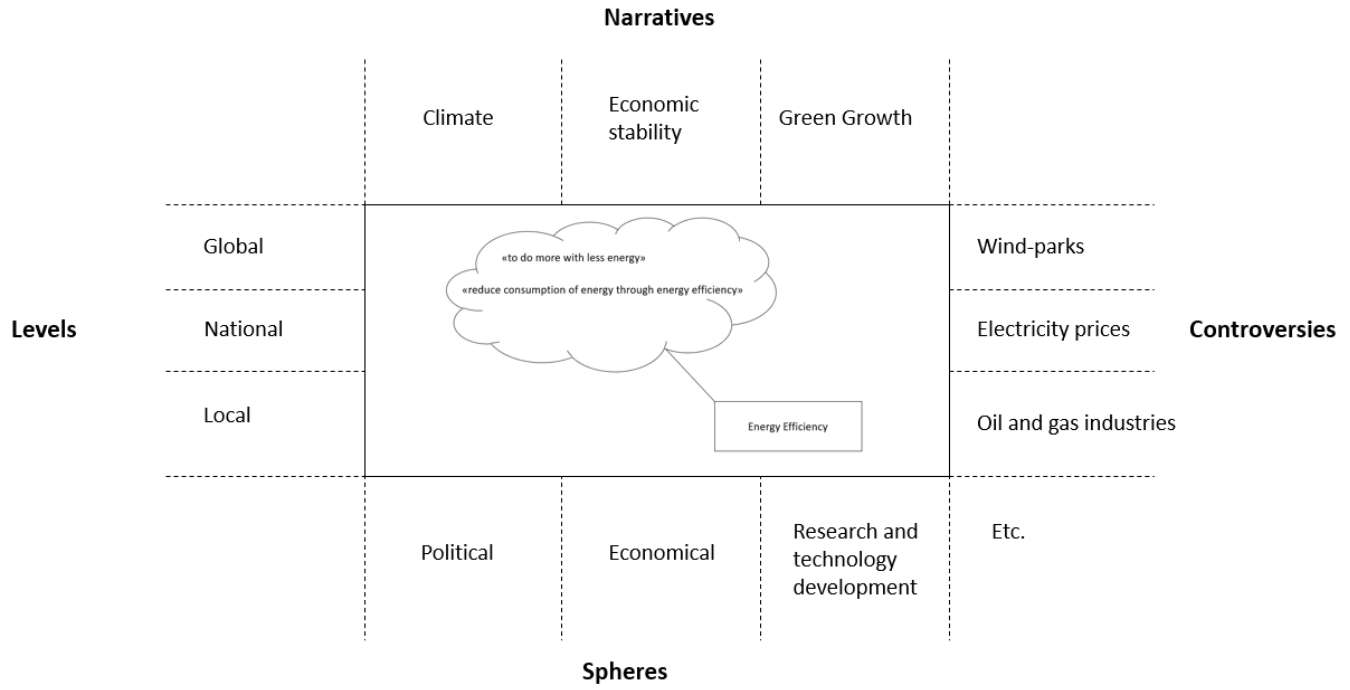

Figure 2: Illustration of how energy efficiency translates across narratives, controversies, levels, and spheres

Energy efficiency is a concept that bridges opposing positions and narratives, thus sharing characteristics with *boundary objects*. According to Star and Griesemer (1989), boundary objects function as *translation tools* between different social worlds and can be products, people, discourses, or processes (p. 387). A boundary object is adaptive to different views, but also robust enough to maintain its identity across these views. While there is contention surrounding what is and is not a boundary object (Star, 2010), energy efficiency shares characteristics with boundary objects in the way it *functions* in Norwegian media discourse: it seemingly translates between narratives, opposing positions, and levels, producing consensus in the discourse-as-usual.

Breakdown of the Boundary Object

Similar to other boundary objects (e.g., Brand & Jax, 2007), the descriptive and generic use of energy efficiency makes it malleable to accommodate different narratives and positions. The interchangeable use of concepts and meaning content partly reflects what Wilhite and Nørgård (2004) argue is a self-deception in climate policy, namely, the equation between *efficiency* and *reductions*. However, rather than *equating* these concepts, we argue their relationship as *black-boxed* in media discourse. This is not only a semantical difference, though. While associating *efficiency* with *reductions* can be legitimized in a climate narrative, it is not the same in narratives of economic growth that promote increased overall energy use. The investigation of how energy efficiency features in the discourse as a black-boxed entity, concealing actors' views and wants on absolute energy reductions, provides one explanation of how it is able to unite adversaries across otherwise conflicting narratives of climate change and economic growth.

The characteristics of energy efficiency as attributed by association in media discourse are not mutually exclusive, but in the media event we labeled a glitch, they suddenly are. This moment of controversy and temporary breakdown of consensus opens a window to study the concept's taken-for-granted nature. When the Minister of Oil and Energy explicitly stated that increased energy efficiency *and* increased energy consumption was the wanted outcome, the link to other possible meanings and effects was disrupted, and efficiency and reductions were clearly not equated. By explicitly taking positions on the wanted effects of energy efficiency, the media event forced a discussion of what Jackson (2017) refers to as "absolute limits." Suddenly, there was disagreement about the meaning of energy efficiency as well as its desired effects. It no longer united adversaries or opposing views, and the boundary object seemed to collapse. This temporary fall of consensus indicates that the object never actually *translated* between oppositions. On the contrary, it illustrates the *apparent translation* that the concept holds in Norwegian news discourse.

In this event, we can peak inside the black box and observe the fundamental disagreements about what energy efficiency is, can, and should do. The concept's robustness in the discourse-as-usual lies in the way it can be interpreted and aligned with different narratives on societal change. The repertoire of associations lends the characteristics of a boundary object that mediates and translates between different social worlds. However, energy efficiency's interpretive flexibility shares characteristics with Schrödinger's cat: as long as we do not open the black box, energy efficiency (as a concept in media discourse) can imply both absolute reductions and absolute increases in energy consumption. When Schrödinger's cat is observed to be either alive or dead—that is, the boundary object appears to have collapsed—energy efficiency no longer translates across actors' different views on societal change. In this case, the link to the repertoire of meanings dissolves, and it is no longer possible for actors to interpret the effects of energy efficiency as only absolute energy reductions. The object loses its interpretive flexibility, at least temporarily.

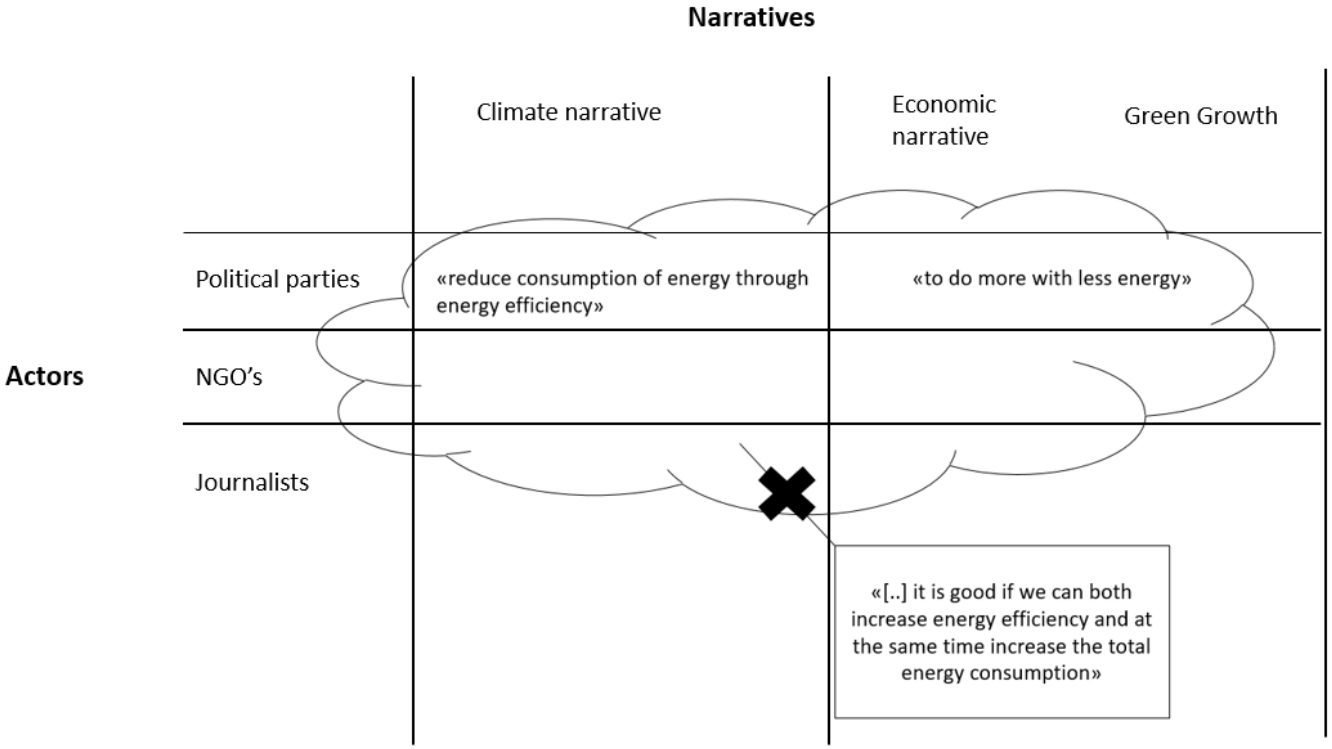

Figure 3: The glitch actualizes differences between actors fronting different narratives

By making the meaning and wanted effects of energy efficiency explicit (as illustrated by disrupting the link to alternative associations in Figure 3), differences between opposing positions are revealed. The breakdown of energy efficiency as a boundary object allows us to clearly see the oppositions in the discourse-as-usual.

Glitches, not Permanent Breakdowns in the Discourse-as-Usual

It seems that energy efficiency is able to unite adversaries because all have an interest in the concept. Researchers obtain funding by researching energy efficiency, industry can increase production by becoming more energy efficient, politicians show that they take the climate crisis seriously by arguing for energy efficiency, and NGOs fulfill their purpose by promoting energy efficiency. Researchers, industries, politicians, and NGOs depend on the various rhetorical outcomes of energy efficiency, which is also illustrated by Lutzenhiser's (2014) discussion of the dominant position of the energy efficiency industry. In Bateson's (2000) terms, we can view this as a systemic dependency on energy efficiency as a black-boxed explanatory principle. Through logics of addiction, the explanatory principle is imperative for this social system to work. It explains without a common understanding and works exactly due to this lack of shared understanding or translation across conflict lines. As such, despite differences in interest, various actors may find it better not to open this black box and rather allow the concept to work as an explanatory principle. The concept thereby achieves a gravity of its own (Larsen, 2010) that works across conflict lines. The gravity of the explanatory principle is profound, and removing it is therefore not an option. Thus, while a glitch can illuminate the different interests at play, it does not manifest in permanent policy or discourse change. In a glitch, we are able to observe the conflicts of interests, goals, and perspectives surrounding the concept. Yet, the swift normalization and the fact that they seldom happen show what seems to be a common ground between all actors to produce consent about *not challenging* energy efficiency, allowing everyone's activities to go on. This is why, we argue, glitches are only temporary and not breakdowns of the concept.

Conclusion

Through the present analysis, we found that energy efficiency as a black box produces consensus across different interests and narratives. The term *energy efficiency* is a different tool in different hands for different purposes, though it appears to be the same.

While posing as a scientific concept, our analysis shows how it associates multiple and contradictory meanings and outcomes in media discourse, as evoked by association rather than rigorous academic definitions.

The analysis of energy efficiency's rhetorical use shows a peculiar aspect of the concept's interpretive flexibility. If interpretive flexibility flows from black-boxing fundamentally different opinions, these objects do not necessarily translate between social worlds but rather conceal differences between them. In our case, concealment in the public debate reflects what Wilhite and Nørgård (2004) call a self-deception in energy policy, the equation of more with less, and efficiency with savings and absolute reductions. However, our argument is not only a call for the correct use of these concepts. Rather, we show the conflict that arises when perspectives on the need—or refusal—to acknowledge absolute limits are made explicit. Essentially, this goes to the heart of the debate on the need for respecting absolute planetary limits (Jackson, 2017) and consequently address absolute limits to energy consumption and economic growth. Still, we found that narratives of behavioral changes, reducing energy services, and economic growth are largely missing from Norwegian media discourse. This is perhaps not surprising, as Jackson (2017) tells that the dilemma of rejecting growth is only marginally visible as a public debate (p. 211). However, a consequence of this is that discussions of energy efficiency are also mainly situated within media narratives concerning business as usual. This adds to the point made by several scholars addressing the legitimizing powers of energy efficiency, namely how it promotes a status quo discourse (Lutzenhiser, 2014; Ruzzenenti & Wagner, 2018; Shove, 2018).

Investigating the discourse-as-usual through an anomaly provides the opportunity to pinpoint the moral prerogative of energy efficiency as a concept. It essentially allows for a complete absence of consequences. As a black-boxed entity with the flexibility to associate both relative improvements with reduced absolute energy consumption *and* increased absolute energy consumption, it legitimizes ongoing activity for actors working toward limiting consumption, as well as actors promoting economic growth. Only in certain and few media events do fundamentally different views on the wanted outcomes of energy efficiency and savings and opinions on the need for profound societal change versus "a more efficient business as usual" become visible. Investigating the media objects' characteristics in this example is a valuable analytical approach to investigate the structures and functions of the concept within the macro discourse and the characteristics of this discourse. With the black box opened and different meanings revealed, the concept is no longer boundary-spanning. However, both climate and economic narratives depend on energy efficiency as a black box. Thus, the contention over what energy efficiency can and should do is only temporary and quickly normalized. It becomes but a glitch and does not cause permanent changes in how we talk about energy efficiency and reductions. As Wilhite and Nørgård (2004) note, energy policy is itself torn between more and less, and the only strategy that can be rationalized as serving both is one that promotes technical energy efficiency (p. 1006). Thus, the fact that the object only temporary breaks down is perhaps not surprising. It is as an explanatory principle, producing consensus, that the concept of energy efficiency work its magic.

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MEDIATING IMAGINARIES:

Educational robots and collective visions of the future

by Oliver Tafdrup

The aim of this article is to illustrate how visions of the future—sociotechnical imaginaries—mediate and thus shape sociotechnical practices involving educational robots in a Danish school context. In the analysis I show how imaginaries are manifested both in technological artefacts, teachers' discourse and in policy documents from political bodies such as the OECD and the Danish Agency for Digitisation (DIGST). To show this manifestation, I apply two concepts: The Science and Technology Studies (STS) concept of 'sociotechnical imaginaries' as formulated by Sheila Jasanoff (2015) and the concept of 'mediation' known from postphenomenological tradition. I develop an analytical framework based on these two concepts and coin a third — 'symbolic mediation' — to present and analyse a case study based on an ethnographic field study that included semi-structured interviews conducted in a Danish school setting. The case study shows how the use of the robot NAO—an educational technology—is driven by two related imaginaries that both serve as arguments for implementing and using the robot—the imaginary of the digital future and the imaginary of educational optimization.

Keywords: Sociotechnical Imaginaries, Postphenomenology, Mediation Theory, Educational Technology, STS, Human-robot interaction

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Introduction

In 1920 Karel Čapek introduced the Slavic term 'roboti' in his famous science-fiction play *R.U.R.* (2004) to designate artificial humanoid creations. Ever since, we humans have associated it with both our hopes and fears for the future of human existence and the society we live in. As an early precursor to *The Matrix* (Wachowski, L., & Wachowski, L., 1999), the play tells the now classic tale of how artificial humanoids rebel against their creators—a rebellion that leads to the extinction of humanity. It also illustrates how technologies are often closely associated with dystopic visions and imaginative representations of possible worlds. Such visions are present, however, in the world beyond sci-fi literature and films.

The history of educational technology offers another, less dramatic example of the entanglement between technologies and envisioned futures, as new technologies have historically been used experimentally in classrooms. Educational historian Larry Cuban points out that technologies like film media, the radio, and later the computer are all examples of technologies sold to institutions and implemented in educational practices under the promises of 'bringing the outside world into the classroom' and 'creating new revolutionizing ways of teaching and learning' (Cuban, 1986, p. 9). Like robots, educational technologies have thus been historically tied to technological fantasies and imagined futures about how technological developments will affect education, teaching and learning. This is no less true today, for educational technologies are being developed and used on the premise that digitalization will lead to profound changes in our society, especially in tomorrow's labour market (Tafdrup, 2019; Frey & Osbourne, 2017). However, one problem with this premise is that technologies often fail to realize the potentials such fantasies and visions often ascribe to them.

In this article I use a case study of the educational robot NAO to explore the entanglements of technological artefacts and constructed imaginaries about future society. Based on my fieldwork at a Danish school in 2017, the study illustrates how school principals and teachers associate NAO with certain kinds of imaginaries, and how these associations have led to NAO's implementation and use at the school. For this purpose, I develop a hybrid theory that enables one to conceptualize how NAO becomes associated and entangled with future visions.

More specifically, I argue that Sheila Jasanoff's concept of 'sociotechnical imaginaries' can be combined with the mediation theory found in postphenomenology (Ihde, 1990, p. 73, Verbeek, 2005, p. 123). By combining the two theoretical frameworks, one can show how technological artefacts are embedded into socially constructed imaginaries, and how these imaginaries in turn shape human–technology–world relations. In other words, I contend that one needs both postphenomenology and the concept of sociotechnical imaginaries to describe how the semantics of concrete artefacts like educational robots become associated with socially and politically constructed visions of the future. This article thus makes both a theoretical and an empirical contribution to ongoing debates in the related fields of science and technology studies (STS) and the philosophy of technology (e.g. Jasanoff, S., & Kim, S.-H., 2015; McNeil et al., 2017; REELER, 2019, p. 153; Blond & Schiølin, 2018, p. 151).

The question of why robots are implemented and utilized in an educational context links the theoretical discussion to a very timely topic—educational technology. As in many other OECD countries, in the past 20 years Denmark's public sector has developed a strong focus on digitization (Danish Agency for Digitisation, 2016, p. 13). Every five years, the Danish Agency for Digitisation (DIGST), a department under the Danish Ministry of Finance, publishes *The Digital Strategy*—a policy document outlining the Danish government's new digital initiatives as well as discussing the status of previous efforts. Since 2011, the political focus on educational technology has been intensified. In the 2011–2017 period, public funding of DKK 500 million, or about EUR 67 million, was utilized to equip Danish primary schools with digital technologies ranging from iPads to digital learning resources and robot technologies (Danish Agency for Digitisation, 2011, p. 22). Furthermore, in 2014 the National Agency of IT and Learning (STIL),[1] a department under the Danish Ministry of Children and Education, was established to manage new initiatives related to educational technology in schools and to ensure the success of the related public investments. As a result, digital artefacts have proliferated in Danish classrooms, and much attention has been given to whether and why digital technologies should be used to improve the ways that Danish pupils learn and how public schools prepare them for a labour market that demands a workforce that is able to use and create digital technologies (Tafdrup, 2019).

The arguments presented in DIGST and STIL policy documents emphasize how tomorrow's workforce will need digital competencies like coding, technical know-how, and networking through technology, and that pupils must familiarize themselves with a range of digital technologies to be ready for the future labour market. Critical education studies have described the connection between educational policy and economic rationalities at length. Educational sociologist Stephen Ball, for example, highlights how neoliberal policy agendas have integrated the logic of 'market', 'management' and 'competition' in education systems globally (Ball, 2016). Other scholars have emphasized how technological know-how and the ability to navigate a complex landscape

1 STIL is an abbreviation of the Danish name for the agency – 'Styrelsen for IT og Læring'.

of digital technologies are closely connected to a neoliberal discourse, where the use of data management and governance becomes related to ideas of accountability, quality, and efficiency (Williamson, 2017, p. 66).

I propose that the vision of an increasingly digitalized society can be understood as a sociotechnical imaginary that constructs the greater use of educational technologies as a rational trajectory towards equipping pupils with the competencies needed to succeed in tomorrow's labour market.

Fuelled, perhaps, by technological fantasies from science fiction, the public and political debate on the impacts of new technologies and automatization on human existence, society, and work life (e.g. Frey & Osbourne, 2017) have rendered the robot an artefact and a symbol strongly associated with popular and political visions of the future and the future labour market. As such, phrases like 'the robots are coming' can be found in newspapers as well as in official policy documents (e.g. STIL, 2016, p. 6). In this regard, the robot is a metaphor for autonomous technologies, but actual social and humanoid robots have found their way into primary school classrooms. As I argue in this article, this educational technology trend is driven by the same visions of the future––that is, sociotechnical imaginaries––manifested in Danish government policy documents.

I suggest that sociotechnical imaginaries of robots are not only present in general political discourses but are also part of the cultural lifeworlds and educational practices of the teachers and pupils that use them. The case study covered here emphasizes how sociotechnical imaginaries *mediate* the way teachers and school principals perceive and interact with the robot NAO. In other words, the study aims to illustrate how the use of educational robots is embedded into and entangled with specific imaginaries related to science and technology, and how these imaginaries mediate the relation between the educational robot NAO and its users. This aim can be summarized in the following research question: How can the combined use of mediation theory and the concept of sociotechnical imaginaries be used to analyse how future visions shape the phenomenological experience of the educational robot NAO?

Theoretical approach: Combining sociotechnical imaginaries and mediation theory

A first step to answering the research question is to explain the concepts I use to this end. In the following section I therefore present mediation theory and the concept of sociotechnical imaginaries and argue for why they can and should be combined.

Sociotechnical imaginaries

Within the STS field, the concept of imaginaries is used in ways often inspired by both philosophical and anthropological traditions. (McNeil et al., 2017, p. 425). In philosophy, the term 'imagination' has been used in epistemological discussions of the human ability to generate ideas or forms based on associations stemming from sense data (e.g. Aristotle, 350B.C./2001, p. 580; Hume, 2010, p. 97; Kant, 1980, p. 190ff), with Kantian philosophy being among the most important examples. In his *Kritik der Reinen Vernunft* [Critique of the Pure Reason], as well as in later works, Immanuel Kant dedicates several discussions to the concept 'Die Einbildungskraft' [Imagination] (1980, p. 147ff). One of the functions he arguably ascribes to the imagination is that of synthesizing experienced content so that it appears to the subject as a unity.[2] Without the imagination, for example, a cat would appear not as a cat, but as a flux of unrelated colours, shapes, and sounds. However, because the imagination is able to synthesize the cat, it appears as a single gestalt—a unity of sense data with an identity that persists over time (Ibid., p. 191). For example, I experience the cat I have fed today as the same cat I will feed tomorrow. Kant uses the term in this profoundly epistemological manner to describe a function related to human reasoning. When anthropologists and cultural theoreticians speak of imaginaries, however, their aim is often not epistemological in a narrow philosophical sense but is rather to understand how and why collective identities arise within cultures. Benedict Anderson (2006), for instance, has used the concept to analyse how people come to identify themselves as being part of a nation, and how the idea of a nation is constructed through the synthesis of different types of semantic content like symbols, narratives, and so on.

Although the philosophical and anthropological traditions have different focal points, they both ascribe a synthesizing function to the imagination. Sheila Jasanoff (2015) and her use of sociotechnical imaginaries to analyse future visions is more indebted to the latter. As I will show, though, she focuses on how these future visions are constructed—or synthesized—through sociotechnical practices associated with politics, science, and technology. In the introduction to the anthology *Dreamscapes of Modernity*, she defines the concept in the following way:

> [Sociotechnical imaginaries are] collectively held and performed visions of desirable futures (or of resistance against the undesirable), and they are also animated by shared understandings of forms of social life and social order attainable

2 The role of imagination in Kant's critical philosophy is a debated topic. See e.g. (Thompson, 2013).

> through, and supportive of, advances in science and technology. (Jasanoff, 2015a, p. 19)

This definition indicates that future visions are performed and materialized in sociotechnical practices. Imaginaries shape how policy agendas are formulated and funding is distributed, and they generate ideas about which technological artefacts people should develop and learn to use. In this sense, the concept of imaginaries addresses how shared visions of the future are important in the process of cultural world building—that is, how humans construct a shared understanding of their lifeworld. These shared visions do not come arbitrarily into existence but are co-constructed (Jasanoff, 2004) by various actors, including political organizations, academic disciplines and the local culture where sociotechnical practices are performed. Jasanoff also focuses on the relation between technology and visions of the future, an aspect that makes the concept of sociotechnical imaginaries interesting in relation to the use of educational robots in schools, as it enables one to address how visions of the future affect the way certain technologies are used in educational practices and why—'how the merely imagined is converted into the solidity of identities, and the durability of routines and things' (Jasanoff, 2015b, p. 323). Jasanoff argues that sociotechnical imaginaries are articulated in a variety of different sources, such as policy literature, spoken discourse and—as I will argue—in specific technological artefacts like educational robots.

To gain a more profound understanding of how sociotechnical imaginaries are 'converted into daily routines', one can fruitfully combine the concept with postphenomenological insights into how technological artefacts are always part of a cultural lifeworld in which they mediate human–world relations.

Postphenomenology and mediation theory

Founded by Don Ihde (E.g. Ihde, 1979, 1990, 2009), postphenomenology is a contemporary branch of philosophy dedicated to the phenomenological analysis of technological artefacts. Rooted in the empirical turn (Achterhuis, 2001) of American (pragmatist) philosophy of technology, postphenomenology rejects metaphysical and speculative approaches to the study of technology, such as the position Heidegger asserts in *Die Frage nach Der Technik* [The Question Concerning Technology] (1977). In postphenomenology, the metaphysical approach is replaced with a focus on the actual situated use of different technological artefacts—say, educational robots.

This is one reason postphenomenology insists on the prefix 'post',[3] although it is still a branch of phenomenology that shares some key insights with the classical phenomenological tradition of Husserl, the early Heidegger and Merleau-Ponty. Two such insights are the ontological claims that 1) the subject is always enmeshed and situated in the world as a living body, and 2) that consciousness is intentional; it is always directed towards an object—real or imaginary (Aagaard et al., 2018). The commitment to these ontological claims shapes the way materiality and technological artefacts are understood as mediating objects within the postphenomenological framework. The concept of *mediation* designates that artefacts actively shape human–world relations and thus also the various ways subjects are intentionally related to the world via objects (Ihde, 1990, p. 72, Verbeek, 2005, p. 122.). This is apparent when one looks not only at how devices like smartphones are used to connect with contacts or browse the internet for information, but also at how different types of affordances makes these types of artefacts attention magnets (Aagaard, 2018). They mediate human–world relations at both an existential and a hermeneutic level. Existentially, they shape the way we humans interact with and relate to other people by means of social media and text messages, for example. Hermeneutically, they mediate the way we interpret the world, providing us with tools like maps and GPS services that make it easier to navigate an unknown city, as well as with access to information on the internet that enables people to qualify (or confuse) their decision making.

As such, the idea that technological artefacts are neither neutral tools nor simple means to an end is central to postphenomenology. Technological artefacts are non-neutral precisely because they mediate—that is, actively shape—the human–world relation. In the seminal work *Technology and the Lifeworld,* Don Ihde develops four modalities of human–technology–world relations (Ihde, 1990, p. 72ff): 1) embodiment relations where technologies become entangled with the body in a way that shapes a subject's perception and embodied being-in-the-world, for example, when she uses a pair of glasses to improve her eyesight; 2) hermeneutical relations where a subject interprets the world through a technological artefact, such as when she uses a watch to interpret the time; 3) alterity relations where a subject relates to a technological artefact as if it were 'quasi-other', such as when a subject experiences robots as entities that appear to be animated; and 4) background relations where technological artefacts, such as internet cables, refrigerators, and electricity, recede into the background of a subject's surroundings. In 1990 Ihde saw these four relations as four types of mediation, but since then postphenomenologists have elaborated this framework of human–technology–world relations and thus expanded the postphenomenological vocabulary for analysing different kinds of mediation (e.g. Verbeek 2008, Lindsø Andersen 2018, Tafdrup, 2019).

Multistable artefacts, imaginaries and symbolic mediation

A commitment to an ontological anti-essentialism is another key postphenomenological feature that distinguishes the theory from the classical phenomenology of Husserl. Husserl famously developed the methods of 'eiditic reduction' and 'variational

3 For a discussion on the differences between between postphenomenology and 'classical' phenomenology, see (Aagaard, et al. 2018) and (Ihde, 2009).

analysis' as means of perceiving the essence of an object (Husserl, 2002). Contrary to Husserl, Ihde argues that there are no essences, only stabilities—stating that technological artefacts are thus 'multistable' (Ihde, 1990, p. 144). A knife, for example, can be used as both a kitchen utensil and a weapon. The use—and stability—of a technological artefact depends on the practice in which it is integrated, and every practice involving technological artefacts takes place in a culturally shaped lifeworld. For Ihde the term 'lifeworld' designates that technological artefacts are always used in an everyday context shaped by cultural references, semantics, discourses, and historicity. Thus, how a person interprets and uses technological artefacts depends on the cultural lifeworld in which that person as a body is situated (Ihde, 1990, p. 29).

I argue that the concept of sociotechnical imaginaries reveals an important aspect of how humans interpret and make sense of technological artefacts in their lifeworlds. As I show in the analysis sections, some artefacts—such as educational robots—are interpreted through a culturally shaped hermeneutic framework through which they come to be associated with certain shared visions of the future. I also argue that this insight can be utilized to give the postphenomenological toolbox a new perspective on mediation: 'symbolic mediation'. In this type of mediation, the focus lies not only on the concrete materiality of the artefact, but also on how the artefact is embedded in a hermeneutic and semantic framework that associates it with shared—and in the case of educational robots politically shaped—visions of the future. One can thus use the concept of symbolic mediation to analyse how future visions are converted into daily routines via technological artefacts, a use achieved by addressing the different ways artefacts come to be associated with imagined futures, for example, through the cultural hermeneutic frameworks of the users interacting with the given artefact.

Related ongoing debates in postphenomenology

Before commencing the analysis, I would like to highlight some relevant perspectives from contemporary debates in post-phenomenology. Imagination, robots, and politics are all topics that have come up in older as well as more recent postphenomenological debates.

As regards imagination, Gallit Wellner has contributed a philosophical discussion on how different technologies have historically shaped the way humans use their imagination to produce ideas and images (Wellner, 2018). With reference to Don Ihde and Kathryne Hayles, Wellner argues that what she calls 'the posthuman imagination' is distributed across humans and nonhumans. For example, augmented reality can technologically layer imaginative content onto reality. Wellner's conception of imagination thus corresponds with my point that technological artefacts materialize sociotechnical imaginaries. Her idea of posthuman imagination is also close to what I call symbolic mediation—that the symbolic value of an artefact affects how it is used. Wellner's concept of imagination differs from Jasanoff's conception of imaginaries in that Jasanoff focuses on the political implications of imaginaries. In my own use of sociotechnical imaginaries to analyse the educational robot NAO, I too focus on the relation between imaginaries as distributed future visions and as political discourse.

Postphenomenologists also debate the topic of human–robot relations. As shown above, Ihde was aware of how humans tend to relate to certain kinds of technologies as quasi-others, of which robots are, of course, an obvious example (Jørgensen & Tafdrup, 2017). Postphenomenological studies of human–robot relations have tended to elaborate on Ihde's concept of alterity relations by investigating the various problems and aspects of relating to robots in this way (e.g. Irwin, 2006; Liberati, 2017; Funk, 2018). The topic of otherness and the types of sentimental relations that humans can have with robots is a key topic in the field of human–robot interaction (HRI). In this article, however, I do not focus on how the teachers studied attribute a certain otherness to the robot NAO—although they tend to use sentimental concepts like 'cute', 'friendly', and 'baby-like' when describing it. As such, the topic of otherness is not irrelevant to the theme of this article, but I wish instead to explore the political dimension of educational technology, here exemplified by robots and future visions, and how this dimension drives the use of such artefacts in the classroom.

This focus inevitably introduces politics into the core of post-phenomenology. Researchers within the postphenomenological tradition have typically focused on the bodily and hermeneutical aspects of mediation, thus leaving the political dimension of the cultural lifeworld relatively untouched. As Ihde writes:

> My choice inevitably leaves other dimensions of the technological lifeworld underdeveloped. There are gaps, the largest and most important of which is the social-political dimension. … The sociology and politics of technological science itself are underplayed. (Ihde, 1990, p. xii)

Postphenomenology has, as stated, undergone some theoretical development since 1990. For instance, Robert Rosenberger (2018) discusses the potential of using concepts from Actor-Network Theory (ANT), Social Construction of Technology (SCOT), and postphenomenology in an article on the political dimensions of urban planning. In this connection, he applies a theoretical hybrid construct to analyse how architecture is used to keep skateboarders and homeless people away from Love Park in Philadelphia. Still, the theoretical potential for analysing the political dimensions of the technological lifeworld has arguably yet to be realized. Ihde's notion of the lifeworld has been criticized for not taking politics and power relations into account. Philosopher David Kaplan argues that one must address the lifeworld's political dimensions, such as authority and power, to

reach a more profound understanding of how materiality shapes our relations to the world (Kaplan, 2009, p. 237). Likewise, Rao et al. (2014) have argued that the concept of mediation can and should be understood through the lens of Marxism and the critical theories of Foucault, Hardt, and Negri. Rao et al. argue that such an approach can show how mediation processes are often tied to capitalist relations of production. Interpreting the concept of mediation through a Marxist lens enables a better understanding of how different types of mediation can function as a resistance to capitalist modes of commercial and profit-oriented production types. The use of open source software is an example of such resistance.

I agree with Rao et al. that the power relations and political dimensions of mediation are an important theme to elaborate on, and I suggest that the concept of sociotechnical imaginaries can be utilized to venture into this area. An enquiry into how sociotechnical imaginaries mediate the implementation and use of robots in schools can elucidate an aspect of the sociopolitical dimension of mediation. Sociotechnical imaginaries, understood as politically shaped visions of the future, mediate the relation between user and robot in at least two ways. First, on an institutional level they serve as a catalyst for organizational change. For example, school principals and teachers tap into sociotechnical imaginaries when they argue that robot technologies should be implemented and utilized in the classroom, thus providing teachers with a narrative that emphasizes why students should engage with robot technology. Second, the narratives related to sociotechnical imaginaries shape local practices with robots and characterize which practices are to be considered successes or failures.

Methods, data, and context

In the introduction I asked how one might combine mediation theory and sociotechnical imaginaries to analyse how future visions shape the phenomenological experience of educational robots. In the following, I discuss the methods I have used to answer this question. I also describe the case, the school where I conducted fieldwork and the educational robot NAO in greater detail.

To explore how sociotechnical imaginaries mediate the use of educational robots, I have utilized a case study research design based on interviews with five informants. I have also read policy papers for the purpose of doing desktop research into political agendas. This approach is firmly rooted in the traditions of both postphenomenology and STS. As Rosenberger and Verbeek emphasize, case study methodology has been essential to postphenomenological research because the tradition is committed to the empirical analysis of human–technology relations. The case study enables one to develop philosophical concepts closely related to everyday practices (Rosenberger & Verbeek, 2015, p. 32). A case study of robots in education is therefore an obvious springboard for a study intended to make a theoretical contribution to STS and philosophy of technology by theorizing sociotechnical imaginaries as a form of mediation. The case concept utilized in the study is inspired by what Bent Flyvbjerg refers to as a 'paradigmatic case' (Flyvbjerg, 2006, p. 232.), a concept implying that a case should be designed to reflect some general problems and phenomena related to a given field, in this case educational technology. To make the case reflect a paradigmatic attitude to educational technology, I selected a school that emphasized the use of technological artefacts—especially educational robots—as the site of my fieldwork. Since technology was a big part of the school's organizational identity, I saw an opportunity to study how sociotechnical imaginaries are converted into local practices and identities, to paraphrase Jasanoff's words above.

The case thus reflects a paradigm in contemporary education and politics—a human capital paradigm stressing the link between the use of educational technology, the competencies to use various digital technologies and the future labour market. As such, using the lifeworld of practitioners, I was able through this case to study the complex relations between these sociotechnical imaginaries and the everyday practices with robots at the school (Ibid. p. 223). The following table provides an overview of the informants[4] that participated in the case study.

TABLE 1.

Informant name	Occupation	Gender
Jim	Teacher	Male
Michael	Teacher	Male
Rikke	Teacher	Female
Jacob	School principal	Male
Lisa	Teacher	Female

The case study consists of interviews with four teachers and one school principal. The use of semi-structured interviews was a vital means for determining how sociotechnical imaginaries among the informants mediate their relation to the robot NAO. The five interviews gave me valuable insight into how the informants link their everyday sociotechnical practices to a (more or less) specific vision of a future digital society and labour market—an

4 In order to anonymize the interviews, the names of the informants have been changed.

insight I achieved by analysing their discourse and comparing their statements with those found in the policy literature.

Jasanoff emphasizes the methodologies of interpretive research in her methodological considerations, stating that examining how the past and present are linked to a possible future world is one way of looking into sociotechnical imaginaries (Jasanoff, 2015a, p. 24). This was my perspective throughout the data production and analysis process.

The interviews were based on an interview guide with questions grouped into three main categories: 1) associative questions, 2) questions related to interpretations of the future, and 3) questions related to the actual use of robots. In the first category, which consisted of *introductory questions* (Kvale, 2007, p. 60), informants were shown a picture of a robot the school had implemented and then asked to describe their associations. The second category consisted of *follow-up* and *probing questions*, with informants being asked to reflect on the future impact of robot technologies on society in general and education specifically. The third category consisted of direct questions about the informants' concrete experience with educational robots.

This range of categories and questions provided insight into how informants' future visions affected their attitudes to robot technology and use practices. After the interviews were conducted, the data was transcribed and analysed with the use of NVivo software. Here, theme codes based on the three aforementioned categories were applied to identify relevant topics, patterns and similar arguments across the interviews. Next, desktop research was carried out so that the interview data could be compared to the policy discourse on the contemporary political agenda of educational technology.

Policy documents from the OECD, The Danish Agency for Digitisation (DIGST), and the National Agency of IT and Learning (STIL) served as the basis for the document analysis. STIL's policy agenda (STIL, 2016) offered an up-to-date presentation of politically formulated arguments for why educational technologies, including robots, should be implemented as tools in Danish primary schools. In its policy agenda, STIL also refers to transnational policy literature, which provided an opportunity to follow the arguments through references to documents like the OECD policy agenda. This analytical strategy enabled an insight into how distributed sociotechnical imaginaries mediate local practices. The following table provides an overview of the policy literature.

TABLE 2.

Organization	Title	Year
The Danish Agency for Digitisation	Den Digitale Vej til Fremtidens Velfærd––Den Fællesoffentlige Digitaliseringsstrategi 2011-2015 [Digital Strategy 2011 – 2015]	2010
The Danish Agency for Digitisation	A Stronger and More Secure Denmark––Digital Strategy 2016-2020.	2016
STIL	STIL på vej mod 2020: Undervisningsministeriet [STIL––On the Way to 2020]	2016
OECD	OECD Digital Economy Outlook	2017

The document analysis was intended to provide an insight into how future visions were articulated and emphasized in the literature. The documents were therefore coded in NVivo, with a focus on how the future was conceptualized across the documents and on how the political and educational sector should respond to the challenges posed by society's ongoing digital transformation.

Context and case: The educational robot NAO

In this section I explain why I selected the robot NAO as an analytical object and the school as the site of my fieldwork.

NAO is a humanoid robot designed for classroom use. It is approximately 60 cm tall and can be programmed to perform various simple tasks. The figure below illustrates its visual appearance.

Fig. 1 - NAO

At the school, NAO is a tool primarily used to teach 7th–9th graders to code. The teacher would bring two to three NAOs to the classroom and divide the pupils into work groups. The pupils would then connect a computer to a NAO and use Choreograph software to code small sequences that the NAO could then execute. The actual programming consisted of combining pre-coded blocks of code into sequences. No actual programming language was used, although advanced users could program the NAO by using Python codes. The teacher would often give pupils some exercises that allowed them to explore NAO's various functions. For example, they could make NAO do Tai Chi, perform simple interactions with the surroundings, such as avoiding gaps, and recognize faces as well as greet people.

NAO was also used in 3rd- to 6th-grade language education, in which the teacher used pre-coded 'apps' that enabled pupils to have rudimentary conversations with NAO. For instance, NAO could ask pupils simple questions like 'What is your name?' and 'How old are you?' in English. When the pupils answered, NAO would respond 'Nice to meet you!' These were the most common uses of NAO that I encountered during my fieldwork.

I chose to conduct fieldwork at this particular school because the school has made technological innovation and the integration of educational technology in the classroom a major part of its brand, strategy and pedagogy. It was also among the first Danish schools to use robots in class. The school encourages pupils to engage with different technologies—during and after school—and has facilitated various workshops in the area of science, technology, engineering, and mathematics (STEM). The workshops have included how to build robots in Lego, to use 3D printers or to become better at programming NAO. In an interview I conducted with the school principal, he stressed that the school wanted to be frontrunners in this area, for which reason they have partnered with institutions such as the Technical University of Denmark (DTU) on developing educational technologies and STEM-related didactics.

The school purchased NAOs both because of its focus on using educational technology and because of the political focus on developing the STEM competencies of the future workforce. The school principal emphasized how he annually visited the BETT[5] show in London to gain inspiration, and how he often browsed the web for new interesting educational technologies. This was also how he became aware of NAO. In an interview he explained how a colleague and a YouTube video inspired him to implement NAO at the school:

> I made the decision to invest in NAO. A colleague from the school's IT-support team came by my office and showed me a video of NAO on YouTube. The video showed how NAO was used to teach children English. I was completely sold, and I knew we had to get one, because I knew that a couple of our pupils were struggling with traditional English classes. (Jacob, school principal)

This quote indicates how sociotechnical imaginaries are distributed and shared across various platforms ranging from the BETT Show in London to YouTube and local primary schools in rural Denmark. Danish media has also shown great interest in the use of NAO in schools. NAO was featured on Danish prime time television several times (e.g., TV2, 2015; Politiken.dk, 2010). In the media NAO has often been portrayed as a harbinger of schools' and society's impending digital transformation. As such, I can make the empirical observation that NAO—as an example of robotic technology—was closely related to distributed sociotechnical imaginaries at the time I conducted my fieldwork in 2017. As Ben Williamson argues: 'The imagining of a digital future projects a kind of mythology (a set of ideas and ideals) that animates, motivates and drives forward technical development' (Williamson, 2017, p. 17).

In my data set, NAO emerged as the Zeus of this mythology, which made the robot an obvious entry into a discussion on how sociotechnical imaginaries mediate the use of technological artefacts. In my interviews I also asked the teachers about various other kinds of educational technology, but they kept returning to NAO as an example of technological development and the robot itself as a somewhat mythological figure at the heart of shared future visions.

Analysis

In the following sections, I highlight two related imaginaries encountered in my fieldwork and my exploration of policy documents: the imaginary of the digital future and the imaginary of educational optimization.

The imaginary of the digital future

The following quote stems from an interview I conducted with a science teacher who had experience with using the NAO robotic technology.

> It's the direction in which society seems to be developing—more and more digitalized and more oriented to ICT. If you're not able to utilize these technologies, you're excluded from society. So, for us it's all about preparing them [the pupils] to be part of the labour market and making sure that they've got the competencies that are needed—and maybe we can achieve that through the technology we've acquired. Maybe we can make them frontrunners. (Jim, teacher)

5 BETT is an annual show and networking event for the educational technology industry.

Drawing on my theoretical framework, I would argue that the informant's response to my question indicates how the imaginary of the digital future mediates the use of technologies like NAO in the educational setting. The teacher emphasized how using technological artefacts served to prepare pupils for a future labour market. He adopted the arguments from the contemporary political discourse that stresses the importance of acquiring technological competencies and a familiarity with artefacts like robots. The informant also emphasized how the future in this imaginary is ambiguous. On the one hand, it is determined in the sense that the technological development producing technological artefacts like robots will lead to a society where digital solutions and the use of technological artefacts are at the core of the labour market and integrated into the everyday practices of more and more professions. On the other hand, the future is also seen as open-ended because the actual consequences of the digital transformation are fundamentally uncertain. A strategy for coping with this uncertainty is for the school to expose pupils to as many technologies as possible to prepare them for a wide range of future contexts that might confront them with problems requiring technologically mediated solutions. As one of the school's science teachers put it:

> We must give them [the pupils] skills and competencies, but we also need to familiarize them with tools. The more technologies we can expose them to, the more ready to engage with new technologies they become, I think. Because the chance that the new technologies remind them of something they have tried before is bigger. If our pupils can be ahead of the others when they reach high school in relation to knowledge and familiarity with technology, then I think this is good. Because then they quickly reach a state where they can start to use the technologies. (Michael, teacher)

This argument points to how the imaginary of the digital future contains an explicit emphasis on competition. The pupils' technological competencies and experience need to surpass those of pupils at other schools, a competition premised on a general technologically driven transformation of society and the labour market. Another teacher emphasized that, as she saw it, the school where she works and the education system at large mirror a greater transition in society. Thus, when robots like NAO find their way into more functions in the labour market, they will ultimately also become part of the teaching that takes place in the classrooms:

> I think that [the use of robots and other digital technologies] reflects the development of society. When the kids are done with school, robots will be everywhere. There are already lots of robots at factories, and they [the pupils] also see robots out there in society. So, in that way [the use of robots in the classroom] reflects the society. (Rikke, teacher)

All the above-quoted teachers stressed how digital technologies like robots serve as classroom tools to prepare pupils for the future labour market by familiarizing them with technological innovations and teaching them skills like coding. The school justifies the presence of technologies in the classroom by the fact that they mirror a general digital transition of the society that the school is a part of. In this respect, the imaginary of the digital future is congruent with other analyses of the present-day neoliberal education system and its relation to the labour market. Educational sociologist Stephen Ball highlights how neoliberal policy agendas have integrated the logic of 'market', 'management', and 'competition' in education systems worldwide (Ball 2016). I argue that the imaginary of the digital future and the idea of a transition to a digital society are among the ideological ways of legitimizing the integration of neoliberal and human-capital-related ideas into educational practices. The imaginary expressed by the teachers above resonates with the type of discourse found in both transnational and national policy literature. In OECD literature, a common interpretation of the future states that:

> The development of the digital economy and society fundamentally depends on the use of digital technologies by individuals, firms and governments … Such use can only be ensured if all actors improve the skills required for effective use of digital technologies. (OECD, 2017, p. 160)

This type of argument and future vision is also found in the Danish agenda for implementing educational technology. As mentioned above, The Danish Agency of IT and Learning (STIL) is a prominent actor in relation to the Danish policy agenda of educational technology. The following two citations from STIL show the discursive similarity between the above OECD argument and STIL's political agenda.

> In an increasingly digital world, STIL is given an important function in relation to improving the learning of children, young people, and adults and to qualifying the workforce for the future labour market. (STIL, 2016, p. 5)

Like the OECD, STIL emphasizes how an ongoing societal transformation into a digital future means that new skillsets will have to be taught at all levels of education, as acquiring these skillsets will be vital to the future workforce. Below, STIL elaborates on the consequences of transition for the education system.

> The rapid digital development of society affects the educational systems in two ways: First, the education system is responsible for providing students with the best methods and tools in the classroom … Second, the accelerating technological development poses new demands to which competencies are needed in order for us in Denmark to benefit from the possibilities of creating growth and welfare in society that stem from digitalization. (STIL, 2016, p. 9)

As both these citations manifestly show, a strong association exists between a certain interpretation of the future labour market, the

technological development and the learning that takes place in the education system. The imaginary of the digital future is arguably tied to a set of sociotechnical imaginaries that stress the ongoing technological and digital transformation of the economy and the impact this transformation will have on future society. Often cited examples of this argument are found in Brynjolfsson and McAfee's book *The Second Machine Age* (2014) and Frey and Osbourne's analysis titled *The Future of Employment: How Susceptible are Jobs to Computerization?* (2013). Despite the differences between these works' positions, a common theme is the economic and societal transition driven by continual technological development.

The above analysis indicates a close connection between capitalism, technology, and education—and, of course, learning. According to Foucault, this connection can be interpreted as an example of human capital thinking. In his lectures on the birth of biopolitics, he analyses the emergence of neoliberalism, pointing out that human capital theory contains a perspective of the individual 'as an active economic subject' (Foucault, 2009, p. 256). This implies that the labouring individual is regarded as possessing her own means of production in the form of health, intellectual, physical, social and other factors related to the personality and body of the worker, and which further affect the individual's opportunities to trade and generate value in a market. This understanding of human capital is closely tied to the politics of educational technology (Selwyn, 2017, p. 27). One consequence of this imaginary is a push for a transition to a type of learning environment that emphasizes the importance of using digital artefacts to give pupils the competencies needed in an increasingly digital society. As Alexander Means points out, the OECD's reaction to the above-mentioned technological developments is to argue for an emphasis on 21st-century learning—that is, on how to use digital technologies to collaborate and create knowledge, among other things (Means, 2018, p. 327-328). The use of robots in education can thus be seen as an example of teaching pupils 21st-century skills so they can develop their human capital and be prepared for a future where digital technologies are ever more present. Comparing the policy statements with those of the teacher reveals a distributed imaginary that is part of everyday school practice as well as present in the development of political strategies.

From an STS perspective the imaginary of the digital future is interesting because it explicitly associates sociocultural and economic change with technological change. I would argue that these associations between materiality, conceptions of the future and education are present in the local practices illustrated above. As Jasanoff emphasizes, sociotechnical imaginaries are embedded into practices, artefacts, and the discourse of everyday life as visions of the future. From a postphenomenological perspective, this embeddedness can be understood theoretically as a type of mediation. The imaginary of the digital future shapes the relation between the teachers and the (robot) technologies by installing a *technological intentionality* (Ihde, 1990, p. 141; Verbeek, 2010, p. 114) and by assigning a specific symbolic value to the materiality of digital artefacts. In this instance, technological intentionality refers to how sociotechnical imaginaries shape the way the teachers relate to the world through technological artefacts like robots. Robots are primarily used in classes to prepare pupils for the future labour market, a purpose manifested in the way the robots are used and the arguments for doing so. Thus, a specific interpretation of the future shapes how users perceive and interact with the robots as material artefacts. As I have illustrated through the interviews, robots become a sociocultural artefact tied to the idea of a transition to a digital future. Phrased in a classical phenomenological vocabulary, a specific *being-towards-the future* often characterizes the relations between the users and the robot. Moreover, both teachers and politicians seem to interpret this future along the lines of a transition to a digital society and a labour market that demands digital competencies. The imaginary of the digital future thus mediates the use of robots.

The imaginary of educational optimization

During the analysis of my empirical data, a second perspective emerged, namely the idea that educational practices in classrooms are undergoing a transition driven by the technological development of educational technologies. Thus, as I will show below, the use of digital technologies like robots is also tied to a sociotechnical imaginary that emphasizes how education is moving towards a future where technological artefacts will gradually optimize classroom practices and thus learning outcomes and release teachers from time-consuming basic tasks. I refer to this idea as the imaginary of educational optimization—an imaginary the school principal strongly emphasized in his interview, as he expressed a fascination with new technologies and their apparent potential. As he saw it, the robot NAO served as a tool for improving classroom practices by engaging pupils in an interactive learning process involving programming the robot to do specific tasks, and as a tool for motivating pupils to engage in learning processes.

> They [the robots] become more and more interesting and sophisticated. And I say interesting because I can use them in a teaching context. They have a positive impact on the pupils' learning processes and their self-esteem. (Jacob, school principal)

To elaborate on how digital technologies impact pupils' self-esteem, he related an anecdote about a pupil who had experienced failure and therefore lacked the motivation to engage in English class. When the pupil interacted with NAO, he gained the motivation to participate in the class and ultimately received high marks. This point is tied to a more general conception among some informants that digital technologies serve as change agents that fascinate and engage students in learning processes, thus optimizing the learning environment by affording the pupils an opportunity to engage in interactions with a learning outcome. As he also stated in the interview:

> They [the robots] are fascinating in a toy-like way. But at the same time there is much learning associated with them. You can immediately see if the shit works. How much learning do you think is associated with blabbering in German? You seldom get to speak German. With the robot you see the results right away. I think that is a point. (Jacob, school principal)

The school principal was making the point that the pupils are more quickly rewarded in learning processes where NAO is integrated, such as in coding classes, because, unlike in German classes, they can immediately see whether NAO reacts according to their intentions, which serves to speed up the learning process. However, contrasting experiences among the teacher group also counter the notion that NAO improves learning processes. As a Danish language teacher put it:

> I get tired. I have an ambiguous relationship with NAO, I must say. It's a technology that cost DKK 100,000 when we bought it. But it doesn't reach enough pupils. I haven't found any meaningful ways of using NAO. When I see NAO, I think of 100,000 kroner we could have used on something more relevant. (Lisa, teacher)

Several of the informants have had negative experiences with NAO and other digital technologies that failed to function properly or even broke down during class. Interestingly, such experiences did not seem to challenge the imaginary of educational optimization to any great degree. Although several teachers related their negative experiences with digital technologies, they also seemed to believe that the continued development and perfection of educational technology would eventually solve the problems and thus optimize teaching and learning practices in school. The below quote illustrates this point. A teacher who has had trouble with NAO in his classes asserts that the problems might have been averted if a newer version of NAO had been available.

> We had a first-generation NAO. There were some difficulties with the software, so we often experienced that it did not work, and we had to move on to something else. The blue one is a second-generation NAO, and the orange one is a first generation. Maybe we wouldn't have had all these problems if we had had the second-generation NAO from the start. (Michael, teacher)

The quote illustrates how (many) negative experiences with technologies seldom lead to a pessimistic view on the potential of educational technologies to improve education. This rationality lies at the core of what I understand as the imaginary of educational optimization—a fundamental belief that the technological development in the long run will optimize teaching and learning processes. I see the imaginary of educational optimization as sociotechnical because the line of thinking resonates with a certain philosophy of history tradition. An Enlightenment conception of history emphasizes how history—qua technology—progresses towards ever higher and better states (Misa, 2003). This imaginary is associated with, but not identical to, what Neil Selwyn critically analyses as 'the discourse of disruption'. This discourse also stresses that new technology paves the way for rethinking teaching and learning throughout the world's education systems, and is often manifested in slogans involving phrases like 'Education 3.0' or '21st-century skills' (Selwyn, 2013). As such, the discourse of disruption is arguably also linked to a metaphysical conception of history as continually progressing and developing towards higher states. For some of the teachers, however, the imaginary of educational optimization was not just a discourse but also a strategy for coping with negative experiences with NAO and digital technologies in general. This strategy is based on the premise that they as teachers must accept initial problems and occasional useless technologies in order to be technological frontrunners and to harvest the benefits of technology-driven educational practices in the future. Another variation of this argument is found in the interview with the school principal:

> If they [the robots] were better. If we had Pepper—the big brother of NAO, which is designed not to look dangerous—the teachers (if they had enough preparation time) could program the robot to do basic tasks. If NAO were better at speaking you could use it to carry out Danish dictation in the class, and then the teacher could do something else meanwhile, if the pupils were used to it. I could actually see a potential for cost reduction in this, to put it polemically. (Jacob, school principal)

The school principal expressed the imaginary of educational optimization through the argument that if they only had had a newer and better technology, Pepper, the problems related to using NAO might not have occurred. Further, he reflected on an improved version of NAO's ability as releasing teachers from such basic tasks as class dictation, and associated such a possibility with savings. This idea is also closely linked to the Enlightenment discourse, which highlights the continuous optimization of practices through a continual development of new technologies and improvement of already established technologies. Using the concept of symbolic mediation developed in this article, one can understand this line of thinking as an example of how sociotechnical imaginaries mediate human–technology relations. The imaginary of technological optimization shapes the human–technology relation by shaping how the technological artefact—in this case NAO—is interpreted and used. In this case, NAO has been interpreted through a specific hermeneutical framework that associates the technology with an ongoing technological development that will gradually improve teaching and learning processes.

Concluding discussion

The aim of this article has been twofold. First, I have argued the benefits of understanding the STS concept of sociotechnical imaginaries as a form of mediation that shapes the user–technology relation, thus bringing together the theoretical work of Sheila Jasanoff and the tradition of postphenomenological philosophy of technology. I have also put this theoretical construction to use by empirically analysing how sociotechnical imaginaries mediate the use of educational robots in a Danish school context. In this analysis, I have identified two related imaginaries that mediate the local practices involving robots (and other digital artefacts) at the school where the fieldwork was conducted: *the imaginary of the digital future and the imaginary of educational optimization.* The first imaginary associated the use of robots and digital technologies with an ongoing economic and societal transition to a future where the ability to use digital technologies is a key competency and a condition for success in the labour market. The other imaginary associated technological development with an ongoing improvement of teaching and learning activities in schools and functioned as a coping strategy when a technological breakdown or limited usability was encountered. At the core of both the identified imaginaries lies a technological determinism that stresses a type of causal relation between the development of technological artefacts and social change—both on a large scale (the society and economy in general) and on a small scale (teaching and learning processes in the classroom). However, this technological determinism was sometimes challenged when the informants encountered a breakdown of NAO or its failure to appeal to the pupils in class.

By tapping into the complex relation between education, technology and politics, I have shown how sociotechnical imaginaries mediate local practices through material artefacts. I have called this 'symbolic mediation' to emphasize how the robot NAO is associated with and materializes visions and images of the future that shape why and how NAO is used. Much more can be done to integrate the concept of sociotechnical imaginaries in the phenomenological and postphenomenological vocabularies. The phenomenological tradition contains several perspectives on the concept of imagination that have not been addressed in this article. Far more can also be done to analyse how future visions are established in education and how interpretations of the future shape pedagogical arguments.

A critique one could level against this article's findings is that arguments formulated in a political context seem to travel relatively undisturbed to the domain of education. However, as the empirical dataset of this study is not large enough to generalize any conclusions, the thesis of the article remains a potential basis for new research. Still, I would like to highlight that the informants quoted above use arguments close or similar to those of the policy actors. As such, one must consider the value of such arguments in relation to profound pedagogical reflections. In the interviews, the techno-political arguments seem to render the pedagogical arguments secondary, and I believe school principals and teachers need to be aware and critical of this pitfall when considering their strategies for implementing and using digital technologies spanning from tablets to robots. The successful use of digital technologies in education takes time and careful professional considerations. If such considerations are not carried through, educational technologies end up being expensive investments with limited use potential.

Declaration of interest statement

No potential conflict of interest to declare

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BOOK REVIEW

The Software Arts

Warren Sack, 2019.

Reviewed by Ragnhild Solberg

The words "computing" and "software" are sure to create some images in your mind. These images might be of machines or data chips, circuit boards or Boolean algebra, perhaps even sentient machines of the science fiction type. In *The Software Arts* (2019), Warren Sack argues that they should also be of grammar, logic, and rhetoric; in short, the trivium of the liberal arts.

As a contextual frame, the book is part of the ongoing series "Software studies", edited by Matthew Fuller, Lev Manovich, and Noah Wardrip-Fruin. Readers of this review might recognize titles such as *10 Print* (with the catchy full title of *10 PRINT CHR$(205.5+RND(1));: GOTO 10,* Montfort et al, 2012) which takes a Commodore 64 code as the basis for discussing code as a cultural object, or *Programmed Visions* (Chun, 2011) that presents how software is intertwined with governmentality. *The Software Arts* very much speaks to these other entries in the series. A central question driving the book is: What if the history of computing is not what we think? To explore this, the author envisions himself as the narrator of a story where historical and present computers are language machines instead of numerical machines, or, more precisely, "machines of rhetoric, grammar, logic, and dialectic" (118). This story must be told because, argues Sack, software in contemporary cultural and scholarly discourse is framed as a technical entity, far removed from the liberal arts. Thus, the book's mission is to show how computing grew from the arts, and that the arts are at the center of computing. In Sack's words, we "need to overcome entrenched divisions in knowledge itself, dividing 'humanistic' from 'technical' or 'scientific' culture" (xiv), and *The Software Arts* is part of that bridging.

A fundamental assumption is that software is essentially a rewriting or a *translation.* The humanities understanding that Sack builds on is translation as enabling the exchange of ideas with loss, change, or gain of meaning. Translation thus becomes both the object of study (the software texts of codes and the historic essays written about computers) and the method of analysis (using translation as a way of thinking about software). In order to accomplish this, Sack draws on actor-network theory (ANT), amended with more emphasis on semiotics. His justification is that ANT ethnographies for software and computer history are knowledgeable on programmers but light on semiotics and the texts of software. By looking for contradictions and instabilities in the texts themselves and placing these in their historical context, the author seeks to find what is lost in the act of translation.

The book is composed of eight chapters. Beyond the introduction and conclusion, the chapters are *Translation, Language, Algorithm* as well as the trivium of *Logic, Rhetoric,* and *Grammar.* I would note that the totality would benefit from being read in a physical format. My old Kindle, albeit perfect for reading fantasy literature, has some issues jumping back and forth between the text and the table of contents. As a result, I spent the majority of the introductory chapter wondering where it all was going, because the text itself wants to do everything at once. It does, however, eventually do *almost* everything. The author writes that "simply put, this book is a close reading of key texts of computer science and its history" (25), but there is little simple about it. Sack's generosity in explaining mechanical and liberal arts terms, presenting a comprehensive history of computer texts and their academic environment, and discussing numerous theorists of epistemology interspersed with lines of code and syntactic maps should show how this is a project that reaches beyond its 400 paged binder. Phrased otherwise, it becomes hard to follow at times, which is somewhat strange for a book with *rhetoric* and *language* as chapter headings and an intended demography including non-academics. As such, it is certainly a book for those who want a comprehensive dive into pre-digital software history, software as liberal arts, or the relationship between syntax and semiotics. For a broader audience, it is the general ideas presented that are of interest.

The core of the book's contribution is its rich history. The historical approach to the texts of software through the lens of logic, rhetoric, and grammar is an interesting read that allows the author as a narrator of stories to shine. One such story is how Alan Turing's "universal machine" is popularized beyond its original meaning (chapter 2). Misreading and popularization is also a form of translation, writes Sack. Going back to the original texts and their historical context, Sack shows that Turing and his contemporary Alonzo Church's claims are not that all machines can do anything, but about their specific machines working within specific limits. In contrast to many scholarly and popular conceptualizations of Turing machines, writes Sack, Turing's article shows that there are things these machines *cannot do.* Lost in translation from this text is the historic understanding of computers as something human, i.e. including the human worker operating and interacting with the machine and other people. Subheadings in *The Software Arts* such as "when computers were human" followed by "when computers became machines" emphasize this translation shift.

An important source for Sack is the eighteenth century French *Encyclopédie,* where he finds "the root for programming languages" (60) in its pairing of mechanical and liberal arts. One story follows the line from the *Encyclopédie* to how logic was displaced from the trivium due to, among others, the translation of logic into arithmetic (chapter 5). This "arithmetization", which Sack argues is an urge to make everything into math (that must be resisted), supposes a universal logic. However, according to Sack, logic is a language that has undergone several translations. Thus, there are several logics, one of which is software.

Ultimately, what Sack emphasizes is that all of these stories have present-day ramifications. He explains that

> epistemological divisions led to divisions in the educational system, where the liberal arts were taught separately from the mechanical arts. To this day, the Aristotelian barrier separates language that belongs to the liberal arts (specifically the language arts of the trivium) from machines that belong to the mechanical arts. (60)

In this lies not-so-modest implications for education redesign. First, accepting the book's premise requires bridging the mechanical and liberal arts, with the structural and institutional as well as philosophical changes that will bring. Sack himself suggests, "software studies should be actively finding ways to go beyond computer science, to fix computer science's omissions and mistakes, and to construct its own research agenda. Interaction, assignment, equivalence, and identity could be at or near the top of that agenda." (258). Second, all texts are and should be read as translations. The author's history of software is also a translation, one in which he is explicit about its role as such. Despite not acknowledging the rabbit hole of epistemology when software and logic and basically everything else is translation, in Sack's use translation seems to denote the interference and influence of other agents in what presents as real, of which we all can use an occasional reminder. For instance, he points interferences in algorithms constructed with the power to determine equivalences. While discussing how these algorithms can persuade us (chapter 6), *The Software Arts* nods to (but does not pursue) research that also bridges liberal and mechanical arts to uncover biases and black boxes in computational media, such as the work of Virginia Eubanks (2018) and others. The book's historical approach will result in older sources, but making the nod to emerging research in the digital humanities into a handshake would surely strengthen its argument.

According to Sack, gaps between the narrative of the computer and its rhetoric equations should force us, like the London tube, to "mind the gap" (31, 35). Through the gaps, Sack finds several historical connections between computer science and the liberal arts. In a sense, *The Software Arts* read like a defense of why we need software studies. It does so rather convincingly, through its insistence on debunking popularized conceptualizations of computation by reading the source material as translations. It would be interesting to hear what someone from mathematics or computer science have to say about this translation and whether it is as convincing to them (even if this proposition might reinforce the trenches of knowledge that Sack wants to remove). Overall, what the book does is show that there is value in strengthening the artistic bonds of how-to-knowledge with software. It reminds us that words have value; they matter, and they matter in a context. Through its focus on computers as machines of language and meaning, *The Software Arts* is an insightful narrative of software's integration in society, of the status quo of computational science, and of what the story could look like if we try to think of and with software as translation.

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ABOUT THE COVER ARTIST

Daniel Slåttnes

By Martin Anfinsen and Lina Ingeborgrud

The front cover of this issue displays a picture taken from Daniel Slåttnes' "Anthro-botanical investigations from the studio". In an excerpt describing this exhibition, Slåttnes primarily highlights the human-botanical collaboration between himself and a common houseplant (Peperomia obtusifolia) which initially inspired him: "When I first started working with the plant, we were just spending time together. I tried to imagine how the plant was breathing ..." From these humble beginnings, the relationship gradually grew. Using EEG (electroencephalogram), Slåttnes started exposing the plant to his brainwaves, while using an amplifier to listen in to the frequencies emitted from the houseplant. Taking the relationship further, the next natural step was to equip the plant with robotic legs, extending its movement in a shared physical space, and bridging the gap between botanical and human timescales. After the initial assemblage was made, the plant has banded together with five others of the same species and joined Slåttnes on exhibitions in Norway, Denmark and Sweden.

In addition to being aesthetically pleasing, we find this work intellectually intriguing, drawing up a world of interspecies communication, and machines and AI processes enabling human/non-human communication, collaboration, and artistry. Also, it serves as a perfect encapsulation of art bridging the constructed dichotomy of the natural and man-made – an endeavor well suited for this STS journal.

Daniel Slåttnes is a Norwegian artist living and working in Oslo and Västra Ämtervik in Sweden. He holds a Master from the Academy of Fine Art, Oslo National Academy of the Arts. The Anthro-botanical Investigations project (2015-2020) was lately displayed at the Digital Wild in March 2020, Trondheim.

To learn more about Daniel Slåttnes and his work, visit his website: https://slaattnes.com/