Critical Issues in Science, Technology and Society Studies

Conference Proceedings of the 17th

STS Conference Graz 2018

7th – 8th May 2018

Imprint:

Critical Issues in Science, Technology and Society Studies
Conference Proceedings of the 17th STS Conference Graz 2018
7th-8th May 2018

Editor: Günter Getzinger
Layout: Stefanie Egger

STREAM: Gender – Technology – Environment

Rethinking the Body as a Network: Drawing Inspiration from Japanese Animated Cyborg Bodies
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Abstract

There is a prevalent tendency among Japanese to be skeptical towards medical transplantations of vital organs, especially when their donors should be so-called 'brain-dead' persons. This is because it does not necessarily have to be the brain which (alone) ensures a person's identity and also because the 'foreign' parts in the receiver's body can endanger his or her integrity (cf. Ohnuki- Tierney 1994). This may indicate an understanding of the body as a compact and bounded entity, however a lot of Japanese anime movies and series offer a rather different picture. First, the differences between animal, human, vegetal or mechanical bodies are fluid and unsteady, so they change both their form and substance, and second, the bodies seem to flow between material, virtual, and dream realities without any apprehensible anchoring. This paper aims to propose an integrated understanding of these two techno-socio-cultural phenomena by using some of the philosophical approaches that draw on both Japanese and Western traditions. The philosopher Ichikawa Hiroshi describes various types of the body: some of them are not limited by the skin but rather represent a structure or a network intimately connected to their environment, other bodies included. The philosopher Yuasa Yasuo treats the well-known problems of subjectivity and body-mind unity but instead of taking this unity as the point of departure and then explaining it, he sees it as a possible goal of bodily techniques inspired by Buddhist meditation practice.

Thus it seems that not only is the subject fundamentally embodied (as for example in the phenomenology of Maurice Merleau-Ponty) but most importantly, it appears to be able to absorb and integrate into itself anything (both biological and mechanical) from its environment, and change with it. I will argue that this way of thinking can offer some alternatives to the highly individualistic Western milieu and could even be a better departure for responding to environmental issues while more justly treating all possible relations and connections between different people, biological species, and other entities.

1. Transplantations in Japan

In Japan, there has until recently been a very strict law dating from 1997 concerning the donation of organs. Not only was it an opt-out[1] instead of an opt-in systemi but there was also a restriction with regard to age (15 years old), and family consent was necessary. This changed with the law of 2010: there is now an opt-out system but there continues to be a considerable shortage of organ donors. (Egawa et al. 2012)

Scholars usually agree on four main causes for the fact that organ transplantations are not particularly popular among the Japanese: The first possible reason is the first Japanese heart transplantation, which was performed on Hokkaido in 1968 (only one year after the first semi-successful human heart transplantation in the world). It is known as the 'Wada case' and it provoked a scandal because the patient died not long after the operation and the surgeon was later accused of murdering both the donor (it was later revealed that the declaration of the donor's death before removing the heart might have not been entirely justifiable) and the patient (whose own heart may not have been in such a bad state). Thus the public has often perceived organ transplantations as a mere means of career advancement for doctors instead of the regular treatment for the patient's sake. (Lock 1999)

The second problem is that of gift exchange. The infinite gratitude saved people feel towards the dead donors is always psychologically problematic (Varela 2001) but the sophisticated system of gift exchange in Japan and the impossibility of the enormous gift of a vital organ to fit into it makes this problem almost unsolvable. (Ohnuki-Tierney 1994)

The two last usually discussed factors are differing approaches to bodily integrity and brain death. These are interconnected and I will focus on them more. In Japan, the identity of a person is usually understood as a complete body (**五体** – *gotai* – five body parts) compared to the Western concept where identity is situated in the head, that is in rationality. So for some people, the organ transplant is an unnatural rationalization which comes from the West. The emphasis on bodily integrity can be also supported by anthropological evidence like the lack of interest in ear-piercing, never adopting foot binding from China, etc. Even though the fact of having someone else's organ in one's own body is surely an unusual experience for most people regardless of the culture he or she feels to be part of (Nancy 2008), the Japanese seem to see it as especially problematic. (Lock 1999; Ohnuki-Tierney 1994)

The notion of brain death is related to this. If personhood is distributed in the whole body, why should a person be dead if it is 'only' his or her brain that does not work? Brain-dead people still have a lot of traits which are associated with life: a brain-dead person usually has a normal skin color, is warm, their heart is beating, their digestion works, they can even deliver a child (e.g. Kinoshita et al. 2015). Personhood is not necessarily located in the brain exclusively, so the fact that the brain itself is dead does not have to indicate the death of the person. All this is again set to be connected to Western rationalization: when it comes to stating brain death, relatives have to rely on proclamations of experts educated in Western science. To continue with life support thus does not have to mean only the unnecessary expenses spent on already dead people. Instead, it is the prolongation of life or the natural way of dying slowly rather than one moment of

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1   This means that people are not considered to be potential organ donors automatically and they have to explicitly state their consent. A similar situation can for example be found in the United States or Germany. In the Czech Republic and in Austria (among others), there is by contrast the opt-out system.

declaration of (brain) death and then turning off the machine. To pay for the life support is also seen as the family members' manifestation of gratitude towards their (older) relatives and future ancestors.

2. Anime

We have seen that although the situation has been changing lately, a general distrust towards the notion of brain death and transplantations in general is still prevalent. However, probably everybody who has ever seen some anime, i.e. Japanese animated movies or series that are extremely popular both inside and outside of the country, knows that deformations and reformations of space and human or humanoid bodies in particular are very common themes. These can be connected to some Western scholars as well. Donna Haraway in her famous 'Cyborg Manifesto' from 1985 describes three dichotomies typical for our Western type of thinking which, according to her, it is now high time to abandon: human/animal, organism/machine, physical/nonphysical. (Haraway 2016) Many anime cross all of these three boundaries. The human/animal can be seen in the internationally renowned work of the director Miyazaki Hayao, but for me, the other two boundaries are more interesting. The famous anime *Ghost in the Shell* (Oshii 1995) is about a state employee, the cyborg Major Kusanagi whose only organic part is a small piece of a brain and she therefore longs for exploring a mysterious identity with which she feels to have a lot in common. The entity is not only entirely artificial (i.e. without any organic part), but most importantly, it originated in virtual space (so it does not have a fixed material identity) and came into existence solely on its own. In one of the scenes, the major, inspired by the questions the cyberspace entity provoked, talks about her own personality and the problem of identity in general:

> "We can quit but we'd have to give back our cyborg parts and augmented brains to the government. All components that make me up as an individual. There are countless ingredients that make up the human body and mind. A face and voice to distinguish oneself from others, the hand you see when you wake up, your childhood memories and feelings about your future. And that's not all. There's also the ability to access vast amounts of information from an infinite network ... All of that blends to create a mixture that forms me, and gives rise to my conscience."
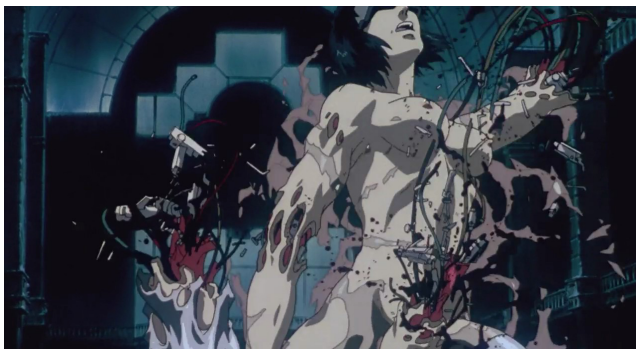
In the screenshot (Figure 1), there is Kusanagi trying to get access to the cyber entity. Her body is falling apart, which she does not care about and probably also does not feel. After that, she managed to merge with the cyber entity and with cyberspace.

Figure 1

Major Kusanagi is an elevated organic form – part human, part machine, as all of us are to some, even if to a lesser extent.[1] Another type of machine–person mergings are mechas – big robots in human shapes controlled from inside by a person, usually used for fighting or sometimes for work. In *Neon Genesis Evangelion* (Anno et al., 1995–1996), there is an extraterrestrial invasion of battling angels coming successively and the only way to fight against them are mechas with teenagers controlling them from the inside. In order to be able to do this, the chosen children have to synchronize with them: they enter the machine and after a while, their movements are directly reflected in the movements of the mechas. Many problems arise precisely from these connections: connections are either too strong – so the mechas are impossible to disconnect – or too weak – so they start to act on their own, etc.

In Figure 2, there are two mechas: one of them is going berserk because it is infected by the angels, the other one was deliberately disconnected from a boy's body, after the boy refused to fight the first one because of a child being inside of it. Then this mecha in a 'dummy mode', that is controlled by auto-pilot, tore the infected mecha into pieces. You can see that the 'dying' mecha actually resembles a living body with all the blood and flesh flying around.

Figure 2

My last example of anime with uncanny connections is *Paprika* (Kon, 2006) in which dream time-space and conventional reality merge through a technical device called DC Mini. It is a device developed for medical uses, which enables to share dreams with other persons. Its prototype has been stolen and misused and consequently a horror-like dream of one of the characters starts leaking into the city. Nevertheless, it is exactly thanks to these semipermeable boundaries and vaguely defined relations between the main character Dr. Chiba and her dream alter ego called Paprika, that it was possible to bring the city back to normal.

In Figure 3, Dr. Chiba is seen as split between herself and Paprika, and on the contrary, the two main antagonists are seen as combined in one body and fighting each other.

Figure 3

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1   This is Donna Haraway's claim in The Cyborg Manifesto and we can easily perceive it around us or feel it in ourselves: all human (and other) bodies are shaped by technology, starting with techniques of food preparation, wearing clothes most of the time, or repairs of body parts, such as teeth, joints etc.

3. Conclusions

We see that when it comes to transplantations, the Japanese are against breaking bodily boundaries, whereas in anime, it happens very often – and not always in an utterly negative way. It needn't be such a contradiction after all: it is almost a cliché by now that if an anthropologist finds out about a strict rule, it often means that there is something dangerous to be taken care of. Ohnuki-Tierney (1994) for example writes that the boundary between monkeys and humans in Japan is not so strict which may be one of the reasons why the Japanese are careful about animal transplants. By contrast, in the West there is an insurmountable difference between humans and animals, wherefore an animal implant cannot endanger our (mostly psychological) identity. The anime thus show the possibilities and risks related to permeable bodies, that is: with bodily changes come also substantial changes in personal identity. Whereas in the West, consciousness is mostly seen as independent of the body and more or less constant.

One of the approaches that can help, is the philosophy of the French phenomenologist Maurice Merleau-Ponty. He sees the subject and the Self as fundamentally emerging from the body: the Self is the embodied subject. However, the felt body does not have to always be identical to the actual biological body – for example the white cane used by the visually impaired can work as a full replacement of a bodily part; on the other hand, people often experience the phenomenon of a phantom limb.[1] (Merleau-Ponty 1945) But Merleau-Ponty still considered the body and the subject to be a compact entity.

Yuasa Yasuo, a Japanese philosopher of the second half of the 20th century, took a very different approach. While making use of Western phenomenology and connecting it to the Japanese philosophical but also practical tradition, he inverted the argument: Westerners are quite used to taking the unity of body and soul and the compactness of the self in general for granted but rather than the point of departure, it can be the goal to achieve – by meditation, or other holistic exercises. (Yuasa 1987)

Another approach is that proposed by Ichikawa Hiroshi: in his book *The Body as Spirit* (1975), he ultimately seeks to elevate the body to become spirit but rather than two entities that are or are not closely connected, he sees them as the two extremes of the same phenomenon. We should strive for harmony, but this does not mean that our bodily personhood has been one and indivisible since ever and will be so forever. He introduces many types of the body divided into two classes: The body as phenomenon – the body as itself, as object, subject, or as seen by me through the eyes of the other – and the body as structure – oriented towards the environment. Some types of the body (especially from the second class) reach beyond the skin. Through the integration of all (the) bodily versions, one can achieve unity – but not of the body and mind as separate entities but of the body *as* spirit. (Nagatomo 1986; Ozawa-De Silva 2002)

Among Western scholars, among the closest one to these ways of thinking may be Annemarie Mol, who writes about the body multiple, that is – a body that is more than one but less than many (Mol 2002). Our usual problem is that we commonly think in the framework of *either* and *or* but some contemporary Western scholars – for example in the tradition of ANT – and Japanese scholars who try to integrate Japanese and Western philosophy show us that everything can change and that there could be lots of layers or versions of reality and also our bodies.

The Japanese public may be more aware of it than the Western one and may need more time to

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1   A phantom limb is the sensation that a missing limb is still attached.

come to terms with the newest medical technology coming from the West. But we also experience a lot of dissonance, both in relation to medical practice and outside of it. A more holistic approach towards ourselves and our milieu without sharp differentiations could also help us to behave more responsibly in relation to environmental issues. I propose to let this 'Japanese-inspired' multiple style of thinking into our lives – for academical, personal, and social reasons.

References:
Egawa, Hiroto, Hiroshi Date, Norihida Fukushima, Hironori Haga, Atsushi Sugitani and Kazunari Tanabe (2012), 'Current Status of Organ Transplantation in Japan', *American Journal of Transplantation* 12: 523–530.

Haraway, Donna J. (2016), *Manifestly Haraway*, London – Minneapolis: University of Minnesota Press.

Kinoshita, Yoshihiro, Hidenobu Kamohara, Atsushi Koter, Daisuke Niimori, Katsuyuki Sagishima and Takahiro Tashiro (2015), 'Healthy baby delivered vaginally from a brain-dead mother', *Acute Medicine & Surgery* 2 (3): 211–213, https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5667260/ [14 June 2018].

Lock, Margaret (1999), 'The Problem of Brain Death: Japanese Disputes about Bodies and Modernity', in Youngner, Stuart J., Robert M. Arnold and Renie Schapiro (Eds.), *The Definition of Death: Contemporary Controversies*, Baltimore: John Hopkins University Press, 239–256.
Merleau-Ponty, Maurice (1945). *Phénoménologie de la perception*. Paris: Gallimard.
Mol, Annemarie (2002), *The Body Multiple: Ontology in Medical Practice*, Durham – London: Duke University Press.

Nagatomo, Shigenori (1986), 'Ichikawa's View of the Body', *Philosophy East and West* 36 (4): 375–391.

Nancy, Jean-Luc (2008), 'The Intruder', in Nancy, Jean-Luc, *Corpus*, Rand, Richard A. (Trans.), Fordham University Press, New York, 161–170.

Ohnuki-Tierney, Emiko (1994), 'Brain death and organ transplantation: cultural bases of medical technology' *Current Anthropology* 35 (3): 233–254.

Ozawa-De Silva, Chikako (2002), 'Beyond Body/Mind? Japanese Contemporary Thinkers on Alternative Sociologies of the Body', *Body & Society* 8 (2): 21–38.

Varela, Francisco J. (2001), 'Intimate Distances: Fragments for a Phenomenology of Organ Transplantation', *Journal of Consciousness Studies* 8 (5–7): 259–271.

Yuasa, Yasuo (1987), *The Body: Toward an Eastern Mind-Body Theory*, Nagatamo, Shigenori and Thomas P. Kasulis (Trans.), Albany: SUNY Press.

Filmography:
Anno, Hideaki et al. (1995–6), *Neon Genesis Evangelion*, Musashino, Tokyo: Tatsunoko Production and Gainax (Figure 2).

Kon, Satoshi (2006), *Paprika*, Nakano, Tokyo: Madhouse (Figure 3).

Oshii, Mamoru (1995), *Ghost in the Shell*, Musashino, Tokyo: Production I.G. (Figure 1).

Doing and thinking (techno)science in feminist perspective. Learning with an Italian women's (hi)story about feminism, science and technology[1]

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Introduction

The diverse ways of thinking the relationship between science-technology and feminism

This paper would like to offer a very initial and partial insight into one main idea – the diverse ways of thinking the relationship between science-technology and feminism – that I would describe as follows: different genealogies the relationship between science and technology construct different and partial spheres of pertinence in which the notion of *technoscience* is relevant from a feminist perspective.

In the past thirty years, in different research fields, including STS, *technoscience* has emerged as a prominent notion, materially-and-discursively constructed and co-agented, and basically meant as "a world and a time in which scientific knowledge and the material production of technologies are inseparable from socio-political processes and imaginaries" (Puig de la Bellacasa 2017). In order to enhance the complexity and the multiversity[2] of this concept, it may be important to consider that diverse historical-theoretical genesis underpin it, in a way that it could be worthy of thinking about it as a differently conceptualized intersection among the relationship between science and technology, on one side, and the social, the economic and the political, on the other.

This way of thinking about *technoscience* is not aimed at a nostalgic and anachronistic, rapprochement of Western past, when early modern philosophies of science's separations among contexts of scientific knowledge production and its utilization were not only applied to a distinction among pure science and its technological uses (and abuses), but simultaneously included a broader division among internal and external – extra-scientific as well extra-technological – contexts (e.g. socio-political-economic). It is rather an attempt to question if the inextricable relationship between science and technology can differently signifies and impacts, whether it is thought as interrelated to the political, the economic, and the social, considering that these spheres are not so easily overlapping, and especially insomuch as early modern philosophies of science themselves assembled them as uniformed and unspecified contexts, external to scientific knowledge production (Latour 2005).

Nowadays, interchanges among these spheres appear to be a way, or maybe a strategy, contemporary neo-liberalist material-discursive order functions, in that it governs by following prevalent economic reasons which tend to surrogate any political agency, while holding it and moreover reducing it to an undifferentiated societal (Guazzicalupo 2014).

Accordingly, the operation of distinguishing among these spheres of pertinences is not motivated by a regressive separation's desire. It is instead committed to an effort at enhancing

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1   This paper actually tries to connect different learnings: besides the Italian women and science groups I have being learning with over the years, I would like to mention my present thinking with Diotima – Female Philosophical Community at University of Verona.

2   This concept is used in de-colonial literature on science and technology and ecology.

the complexity of the relationship among these spheres while incrementing their specific relevance. As far as techonoscience plays an essential part within contemporary neo-liberalist order, which functions as a form of governance which is primarily a-political, with important effects on the redefinition of the collective as predominantly societal, this intervention could therefore become relevant in that techonoscience itself can differently produce (and be produced by) materialities, discourses, significances, ways of thinking, agencies, practices and interventions with regard to these different pertinences. As a result, also the relationship to otherness (both human and non human), might importantly change when approached with reference to these different locations, in ways that, ultimately, but most significantly to me, can differently resonate in a feminist perspective.

This proposition should be properly explored with regard to the various feminist onto-epistemologies, that starting from the same period, around the early 1980s, have engaged a different characterization of the relationship between science and technology, ranging from earlier feminist epistemologies (Harding 1986; Alcoff 1993; Tanesini 1999) to feminist science studies (Mayberry, Subramaniam & Weasel 2001), and to more recent fields, including feminist technoscience studies (Asberg & Lykke 2010), feminist new materialism, post-human studies, and lately, animal studies and environmental humanities (Asberg & Braidotti 2018). Moreover, it would require in depth and accurate speculation, with specific insights into the study fields I have mentioned, therefore demanding an effort at thinking and discussing far more exceeding the one I am going to spend in this writing. The only excuse for not doing it in this paper, is that I have started to work on this idea in the past few months within my PhD research project. The first part of it explores different dimensions of this enunciation in relation to a reflection upon 'contemporaneity' and 'contemporary human condition', considered as a large horizon of reasoning but specifically interconnected to neo-liberalist order.

This paper neither goes into this wider inquiry, nor it delves into the mentioned feminist onto-epistemological research fields, while it focuses on a much more limited area, that is Italian feminist elaborations on science and technology, from mid-1980s to the end of the 1990s[1]. Although circumscribed in time and space, I believe these elaborations are, nevertheless, worthy of attention because they offer examples that cast some light upon my speculative proposal. More specifically, they help to reflect upon the relationship between science-technology and feminism, with regard to one of the above mentioned spheres of pertinence: the political one. Furthermore, they contribute to concurrently think about a problem addressed in the section "Gender, Technology, Environment" of the STS Annual Conference, namely the tendency in feminist theorizing on science and technology "to keep the subject/object of analysis at distance", therefore strengthening a gap between fascination with technoscience and *on-the-ground* engagement.

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1   In 2007 I begun to work at a research project promoted by the Italian Women and Science Association, aimed to explore, structure, analyse chronologies of events and elaborations about feminism and science in Italy. A large part of these events and elaborations partly originated in the late 1970s and later, between the mid-1980s and the end of the 1990s, flowed into the Coordinamento Nazionale "Donne di Scienza" (National Coordination of "Women of Science"). After having re-constructed events and elaborations in the years 1978-1986 (Allegrini 2013), since 2016 I am working on the period 1986-1998 (Allegrini 2018, forthcoming).

1986-1999. Italian feminist elaborations on science and technology as a body of thoughts *and* practices

Italian feminist elaborations on science and technology identify an articulated body of thoughts and practices typically intertwined with each other. Between the mid-1980s and the 1990s, a large part of these studies *and* practices flowed into one informal but nationally recognized organization, named Coordinamento Nazionale Donne di Scienza (National Coordination of "Women of Science"), which was located in Bologna at the Women's Research and Documentation Center. From 1986 to 1998 more than a hundred of women practicing scientists and science theoreticians used to meet, think together and discuss at the Coordinamento. Among them, several "women and science" groups coming from a number of Italian cities regularly took an active part in it, namely: Gruppo Donne e scienza (Torino); Gruppo donne e scienza (Bologna); Piccolo gruppo romano donne e scienza (Roma). Besides these groups, for a shorter period, until 1992, also members from Ipazia, Comunità scientifica femminile (Ipazia, Female scientific community) from Milano Women Bookstore Collective, were fully involved in the Coordinamento, continuing its path informed by sexual difference thought and practice afterwords (Allegrini 2013). Starting from 2003, a nucleus of these women researchers and science theoreticians established a new women and science group, this time formally organized and based in Roma – the Associazione Donne e Scienza (Women and Science Association), which gathered a significant part of these experiences and prolonged them till nowadays.

In order to consider some aspects of this story, which may shed light on my idea previously introduced, I would like to draw specific attention to Coordinamento Nazionale Donne di Scienza (Bologna, 1986-1998) and Ipazia, Comunità scientifica femminile (Milano, 1987-1999), not to emphasize the theoretical-political controversies which led to the already hinted autonomous pathways. These controversies are usually interpreted against the background of a different cultural politics and theoretical conceptualization underpinning Italian feminism of that period – especially, but not exclusively, connected to gender approaches and sexual difference thought/practice[1]. Despite the importance of keeping the memory of these disagreements which, I believe, are nevertheless more a sign of political plurality in Italian women's elaboration and practice on science and technology, than an unsolvable conflict among feminist positions, I would like to point to a common trait, easily recognizable in the relational practices that vivified these experiences.

Women's relational practices to bridge the gap between feminist thinking S-T from inside/outside S-T (or between "women expert and non expert")

The Coordinamento Nazionale Donne di Scienza was informed by a relational practice between women reflecting on science-technology from inside science-technology ("women who does science") and women reflecting on science-technology from outside ("women who thinks science"). Ipazia, Comunità scientifica femminile, especially until 1992, adopted the practice of relationship between "women expert and non-expert in science". These two practices differed under many aspects, not to mention to a partial disagreement on considering both of them as a political practice or a relational style[2]. However, in both cases, they reflected the already

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1   As often underlined by several participants I interviewed.
2   As sometimes suggested by participants I interviewed.

underlined essential concern among these women that feminist elaborations on science-technology was not to be separated from political relationships among women.

Alongside a significant lack of academic institutionalization which, for a long time and partly still today, has characterized women's/gender/feminist studies scholarships in Italy, between the 1970s and the 1990s, multiple articulations and ramifications outside academy, including women's centers, libraries, magazines, bookstores, can be considered the peculiar public-institutional contexts where the cultural, intellectual, political elaboration carried by feminists flourished, in most of cases not apart from political intervention on the territory. As frequently reminded in national and international literature on Italian women's and feminism's history (Marcuzzo & Rossi-Doria 1987; Bono & Kemp 1991; Bertilotti & Scattigno 2005; Guerra 2008), this can be considered a generic aspect describing Italian feminism between the end of the 1970s and the end of the 1990s, therefore exceeding both the specific cases of Coordinamento and Ipazia.

It could be furthermore observed that in several feminist (or women's) Italian contexts of these years, the word "practice" did not exclusively relate to activism, initiative, public intervention, while it was often meant as closer to the idea of "practical philosophy", or a practice of doing (among the English references: Scarparo 2004), whose sense might be partly resonant with some basic concepts of international feminist theories of the 1990s developed around, or with reference to, Adrian Rich's 'politics of locations' (Rich 1986). Among them: situated knowledge (Haraway 1988), positioning and situating (Alcoff 1996), women's transversal politics (Collins 2000; Yural-Davis 1997). However, the peculiarity of the Italian case is that feminist elaborations were (and still are) a living thought, carried on in the presence of other women – "pensiero in presenza", in the words of philosopher Chiara Zamboni (Zamboni 2009), and grounded on the terrain of a plurality of women's public spaces, where thinking together and discussing with other women, was more politically important than elaborating theories[1].

Coming back to Coordinamento and Ipazia from this perspective, it could be noticed that both their relational practices were not so much aimed to question how (and whether) to bridge the gap between feminist theorizing on S-T and doing S-T as a feminist. Notably, this issue was a central problematic question raised in early feminist epistemological debates, beyond the alternative between the *woman question in science* and the *science question in feminism* (Harding 1986), as much as feminist empiricism was not to be assimilated to doing scientific research as a feminist (Longino 1987). Much more frequently, but not less importantly, they ware more basically intended to build a bridge, a connection, between feminist thinking S-T from inside/outside S-T.

As biologists Rita Alicchio and Cristina Pezzoli wrote: "we were in search for common words, grounded in one's own experience, transversal to different disciplines, allowing a mutual understanding, possibly but not necessary aimed at identifying shared priorities/initiatives"

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1   It is for this reason that, although the quoted article describes "practical philosophy" with specific reference to Female Philosophical Community Diotima, it is concurrently possible to consider that such "pensiero in presenza", which qualifies an important aspect characterising this women's community (Zamboni 2009), resonates with a living thought practice that – thought not peculiarly philosophical – was (and still is) largely widespread in different women's/feminist places in Italy. I would like to precise that I am not distinguishing between the two terms "feminist" and "women's" to conform to the prevalent modes these places named (and still name) themselves.

(Alicchio & Pezzoli 1988).

However, not always this collaboration come to terms. On the contrary, it often ended up to divergent paths of thoughts (and initiatives), frequently due to a way of thinking the relationship between science-technology and feminism diversely implied in differently situated knowledge, mainly, though not exclusively, linked to the two positions inside/outside S-T (or expert/non expert in S-T). Was technology to be meant as an utilization/application of science or was technology part of science? Was technology a prosthetic extension (tool) or was it an instrument of scientific knowledge (applied science)? Other discussions leading to divergences were about different ways of thinking a feminist perspective – as for instance those informed by different conceptual frameworks, ranging from sexual difference thought/practice to gender difference and gender differences oriented approaches.

These uneasy exchanges often brought about discussions not only resulting in theoretical-political conflicts, but sometimes causing painful separations as well. Nevertheless, I would like to underline that these disputes have concurrently significantly constructed *a* complex *ground* enabling the exchange itself: a political terrain that made effectively possible to confront positions of women inside and outside science-technology.

From past to present. A strengthened gap between feminist thinking S-T from inside/ outside S-T?

Although this period of feminist Italian studies *and* practices can be considered concluded, at least form the point of view of the prevailing political practices (relational practices or styles), during the following decades new beginnings of debates have periodically emerged. I suggest that they overall have followed the two sides of the above mentioned relational practices. From past to present, yesterday as today, in fact, not always feminist elaborations of "women in science" have met feminist reflection carried out by "women outside science", especially, I would like to point, since the political terrain where confronting plural ways of thinking S-T and feminism from inside/outside S-T has dissolved or only impoverished.

In the following years, women thinking S-T from inside S-T (or those science theoreticians working close to practicing scientists) have kept on exploring which transformations have occurred *within* S-T, with reference to the shift from modern to contemporary science – e. g. the emergence of 'new in-becoming science-forms', ranging from cybernetics to ecology, the impact of virtual simulation (computing) on the relationship between sciences and applied sciences (to mention to a few issues) with one main concern: at what extent these new 'in-becoming science-forms' differ from modern science? (Donini 1987, 1987a, 1990; Gagliasso 1986, 1987, 1987a; Associazione Donne e Scienza 2004; Gagliasso & Zucco 2007; Gagliasso 2008). However, later in the years, some of the crucial questions which were previously challenging from a feminist perspective – as for instance, how to relate these transformations to the permanence or dissolution of androcentric nucleus in science/sciences? (Donini 1987, 1987a, 1990; Gagliasso 1986, 1987, 1987a) faded away, maybe proportionally to the loss of political terrain that help producing this questioning.

Women reflecting on S-T from outside S-T, especially since the half of the 1990s, have been more involved in Donna Haraway's argumentation (the *Cyborg Manifesto* was translated in Italian in 1995), acknowledged not much as a prominent approach aimed at specifically interrogating S-T transformations at present, but as a significant feminist theory interpreting subjectivity in

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technoscientific post-modernity.

During the last ten-fifteen years, the attention to Haraway's issues continues and renews in different areas of gender and post-human studies, lately focused on the "animal turn" (from *Companion Species Manifesto*, 2003 to *Staying with the trouble. Making Kin in the Chthulucene*, 2016), however, still largely regarded as elaboration upon political-expressive opportunities technoscience opens to otherness (Lenghissa et al. 2017). Technoscience meets feminism insofar it is meant as an essentially positive force de-centering the anthropocentric posture which historically defined what is human (natural vs cultural, human vs non human, organic vs inorganic...) within a framework in which *naturcultures* are predominantly considered good objects/subjects to reflect with. This reflection is to be understood at the light of the urgency to outline new complexity ethical-political forms and interventions, especially considering the problem of species survival in Anthropocene. Nevertheless, at the same time, might this reflection point to one way of thinking technoscience and feminism, while shadowing other possible significances? Might it tend to emphasize a fascination with technoscience while strengthening a gap with *on the ground* experiences of/reflection on it?

I am not going to answer to these questions, but I would like to go back to the Italian women's history to find some suggestions about these problems.

Conclusive notes. Doing and thinking (techno)science in feminist perspective. Learning with an Italian women's history about feminism, science and technology.

In both the Coordinamento and Ipazia, the vanishing points of feminist theorizations on S-T were bounded by a relational practice among women, and vice-versa a feminist relational practice opened to a theoretical reflection, thus generating a symbolic-political space in-between, where new words, thoughts and meanings could circulate freely, yet grounded in a material-relational context. In both these experiences, a relational practice was meant as a process of "thinking in the presence of others", therefore exceeding both the purely theoretical dimension of a thought, and its practice meant as a translation of theory (Stengers 2015; Stengers & Despret 2017).

The transformative value of this practice is therefore primarily methodological. It can be described as a resource of transformation of the object of reflection while transforming the subjects involved (Zamboni 2009), or as a form of women's transversal politics, that refers to a diverse range of not assimilated and non-assimilable positions, yet in search for common and shared goals (Associazione "Orlando" mid-1993, quoted in Yuval-Davis 1997).

More importantly, I would emphasize the political-poetical intention that informed these experiences. In other words, they did not predominately resulted in specific goals to gain, or initiative to undertake, but created a common creative-generative-political space, in between science-technology and non science-technology, science-technology and feminism, the latter meant as an overall *different* politically relevant situatedness, by which *difference* was open to a diverse range of possibilities (meanings, speculations, agencies, interventions...). This Italian (hi)story of women and science (some groups and interrelated individuals) did not, in fact, produce essential feminist theories on techno-scientific knowledge and practice, nevertheless it is an example to learn with in that it generated relationships and thoughts thorough discussions in the presence of other women and whereas techno-scientific and political words and practices were not separated one from the other.

These few final notes, which poorly conclude this paper, would like to underline a way of thinking

the concept of *on the ground* as the specific, peculiar, situated relational context connected to the experiences of women practicing scientists, and not apart from them. By highlighting this aspect, I am trying to emphasize that the importance of this story is not so much, or not exclusively, about the grounded or practiced notions (of science-technology and feminism) that have been thought, while *the ground* meant as the (political) terrain that made these women think together (Stengers 2015; Stengers & Despret 2017).

References

Alcoff, Linda Martin and Potter, Elizabeth (Eds.) (1983), *Feminist Epistemologies*, New York: Routledge

Alcoff, Linda Martin (1996), "The Problem of Speaking for Others" in Roof, Judith and Wiegman, Robyn (Eds.), *Who Can Speak: Authority and Critical Identity*, Chicago: University of Illinois Press, 97-119

Alicchio, Rita and Pezzoli, Cristina (Eds.) (1988), *Donne di scienza: esperienze e riflessioni*. Centro Documentazione Donne di Bologna. Torino: Rosenberg & Sellier

Allegrini, Alessandra (2013), *1978-1986, All'origine del Coordinamento Nazionale Donne di Scienza*, Roma: Fondazione Brodolini

Allegrini, Alessandra (2018, forthcoming), *Una storia di femminismo e scienza in Italia. 1986-1998, Il Coordinamento Nazionale Donne di Scienza*

Associazione Donne e scienza (2004), 'Ragionando della nuova scienza', Primo Convegno Annuale, Roma

Bertilotti, Teresa and Scattigno Anna (Eds.) (2005), Il femminismo degli anni Settanta, Roma: Viella

Bono, Paola and Kemp, Sandra (Eds.) (1991), *Italian Feminist Thought: A Reader*. Oxford and Cambridge Mass: Basil Blackwell

Collins Hill, Patricia (2000), *Black Feminist Thought: Knowledge, Consciousness, and the Politics of Empowerment*, New York & London: Routledge

Donini, Elisabetta (1987), 'La scienza al di qua del bene e del male', *Nuova Ecologia*, ottobre: 71-73

Donini, Elisabetta (1987a), "Commento alla relazione di Elena Gagliasso", in Marcuzzo Maria Chiara and Rossi-Doria, Anna (Eds.), *La ricerca delle donne: studi femministi in Italia*, Torino: Rosenberg & Sellier, 162-172

Donini, Elisabetta (1990), *La nube e il limite. Donne, scienza, percorsi nel tempo*, Torino: Rosenberg & Sellier

Gagliasso, Elena (1986), 'Pensieri sulle donne e sulla conoscenza', in Donini, Eliesabetta, Fox Keller, Evelyn, Frontali, Laura, Frontali, Marina, Gagliasso, Elena, Hack, Margherita, Manacorda, Paola, Melchiori, Paola, Muraro, Luisa, Vegetti Finzi, Silvia, "Donne e scienza", Dossier, *SE Scienza Esperienza*, Settembre, 29

Gagliasso, Elena (1987), 'I nomi di Galileo. Abitudini di pensiero e responsabilità scientifiche', *Reti. Pratiche e saperi di donne*, No. 1, settembre-ottobre: 7-12

Gagliasso, Elena (1987a), "Conoscenza scientifica e tecnologia: il rifiuto, il confronto, le scelte teoriche", in Marcuzzo Maria Cristina and Rossi-Doria, Anna (Eds.) (1987), *La ricerca delle donne: studi femministi in Italia*, Torino: Rosenberg & Sellier, 145-161

Gagliasso, Elena (2008), "Il loop della biopolitica: bioscienze-controllo-mercato", in Modonesi, Carlo and Tamino, Gianni, *Fast Science. La mercificazione della conoscenza scientifica e della comunicazione,* Milano: Jaca Book

Guazzicalupo, Laura (2014), "Neoliberalismo e soggettivazioni femminili", in Dini, Tristana and Tarantino, Stefania (Eds.), *Femminismo e Neoliberalismo*, Roma: Natan Ed., 35-48

Guerra, Elda (2008), *Storia e cultura politica delle donne*, Bologna: Archetipolibri

Yuval-Davis, Nira (1997), *Gender and Nation*, London: Sage Publication

Latour, Bruno (2005), *Reassembling the Social*, New York: Oxford University Press

Lenghissa, Giovani et al. (2017), "Limiti e confini del Postumano", *Lo Sguardo, rivista di filosofia,* No. 24, (II)

Haraway, Donna (1988), 'Situated knowledges: The Science Question in Feminism and the Priviledge of Partial Perspective', *Feminist Studies*, Vol. 14, No. 3: 575-600

Haraway, Donna (1995), *Manifesto Cyborg: scienza, tecnologia e femminismo socialista nel tardo ventesimo secolo*, Milano: Feltrinelli

Haraway, Donna (2003), *The Companion Species Manifesto*, Chicago: The University of Chicago Press

Haraway, Donna (2016), *Staying with the trouble, Making Kin in the Chthulucene*, Durham: Duke University Press

Harding, Sandra (1986) *The Science Question in Feminism*, Milton Keynes: Open University Press

Longino, Helen (1987), 'Can There Be A Feminist Science?', Hypatia, 2 (3): 51-64

Mayberry, Maralee & Subramaniam, Banu, Weasel, Lisa (Eds.) (2001), *Feminist Science Studies: A New Generation*, New York & London: Routlege

Puig de la Bellacasa, Maria (2017), *Matters of Care: Speculatives Ethics in More Than Human Worlds*, Minneapolis and London: University of Minnesota Press

Rich, Adrienne (1986), "Notes toward a Politics of Location", *Blood, Bread and Poetry: selected proses 1979-1985*, New York: Norton Paper Back

Scarparo, Susanna (2004), 'Feminist Intellectuals as Public Figures in Contemporary Italy', *Australian Feminist Studies, V*ol 19, No. 44, July: 4

Stengers, Isabelle (2015), *In Catastrophic Times. Resisting the Coming Barbarism*, London: Open Umanities Press/Meson Press

Stengers, Isabelle and Despret, Vinciane (2017), Women Who Make a Fuss. The Unfaithful Daughters of Virgina Woolf, Minneapolis and London: University of Minnesota Press

Tanesini, Alessandra (1999), *An Introduction to Feminist Epistemology*, Oxford: Blackwell Pub.

Zamboni, Chiara (2009), *Pensare in presenza*, Napoli: Linguori

Zucco, Flavia and Gagliasso, Elena (Eds.) (2007), *Il genere nel paesaggio scientifico,* Roma: Aracne

Åsberg, Cecilia and Braidotti, Rosi (Eds.) (2018), A Feminist Companion to the Posthumanities, London: Springer

Åsberg, Cecilia and Lykke, Nina (Eds.) (2010), Feminist Technoscience Studies, *European Journal of Women's Studies*, 17 (4), 2010

Problematizing the speculative ecologies of microplastics

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Introduction

The idea of organizing a panel with my colleague Franziska Klaas arose from discussions about the particularities of collaborative work within ethnographic research in fields of pollution, contamination and toxicity. In this paper, I will focus on the necessary conditions for potential collaborations in ambiguous fields where multiple representations of a phenomenon and rather unpredictable research findings complicate decisions. I will introduce the notion of speculation and ambivalence in my field of research: the problematisation of plastics in the ocean and other environments.[1] Therefore, my research contributes to an anthropology of quite speculative futures and ecologies, analysing our on-going experiment with plastics and its afterlives in emerging *naturecultures*. I am interested in how the notion of the speculative and the unpredictable do shape knowledge production and emerging politics in this field.

Following media representations, it seems that plastics in the ocean are rather easy to manage and technological solutions are heavily promoted. However, during my research it became evident that neither the problem is that simple nor its solutions. As I will show, via propagating big solutions, still a modern separation between nature and culture is at work – which is part of the problem, too.

Speculative ecologies of plastics in the ocean

Anthropogenic marine litter, such as plastics, has become a novel environmental challenge. In retrospect, the introduction of plastics and its unexpected trajectories can be understood as an experiment with a still unknown outcome. Synthetic polymers as a historically rather young material have become yet an anthropogenic marker with long-term effects for global environments. Plastic's short life span (for example as a packaging material or as a single-use product) stands in contrast to its long afterlife: In the water, plastics do not mineralize; they degrade into tiny fragments, so-called microplastics (particles below five millimetres).

The invention of the term microplastics has dramatically changed the perception of plastics in the ocean and even on land. In water, plastic loses its form, degrades and therefore, be it buoyant or not, flows with the water currents. It becomes an errant fluid form: a dispersion of tiny particles in the ocean that resembles and reassembles the marine snow in the water column. According to estimates there are 5,25 trillion (1012) plastic particles in the ocean, of which 92,4% can be considered as microplastics (Eriksen et al. 2014). Beyond that, particles from synthetic fibres recently monitored in an atmospheric study in the centre of Paris (Dris et al. 2017)

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1 Over the last two years, I have focused both on (scientific) knowledge production on plastic marine litter, as well as on the politics and policies that have emerged because of the existence of these new entities. I have followed these practices via multi-sited ethnography in different fields such as marine science, environmental activism, citizen science and new forms of management and governance, for example the German "Round Table on Marine Litter" that was initiated in 2016 or the development of one of the largest marine protection areas in the Pacific off the coast of Rapa Nui.

show that tiny plastic particles have become ubiquitous in different environments, such as the air, and also in fresh water and the soil. Although there is more and more data about concentrations of microplastics in different environments, the impact of micro- and nanoplastics on the ecosystem, species and even the human body is still very unpredictable. Science, politics and activism have to deal with "mutant ecologies" (Masco 2004), with rather unformed objects and unpredictable effects.

Plastics have become part of the environment. Degraded into microscopic fragments, these tiny particles float and become sediment in the ocean or drift in the atmosphere. They are involved in the reassembling of ecosystems by forming novel aggregates and interactions with other species, or serve as a surface for small pelagic animals, algae and microbial life. In 2013, a team of marine researchers from Woods Hole in Massachusetts came up with the term "plastisphere" (Zettler, Mincer, and Amaral-Zettler 2013) to describe these emergent microbial lifeforms on plastics in the ocean. In these competitive environments plastics serve as a novel and attractive habitat for the creation of bacterial biofilms. This development confronts the conventional separation between what is classified as the synthetic and as the natural. Therefore, the plastisphere challenges scientific knowledge production. Novel entities and lifeforms emerge that complicate caring for these evolving environments. Whereas plastic tends to be represented as an alien intruder in environments, this neglects the ambiguous roles it also plays. Plastic in aqueous environments is a disturbing factor but also is a new habitat, a surface on which new lifeforms are created. Although bacteria here do what they always have done, namely search for durable habitats in a competitive environment to create biofilms, the role an anthropogenic material might play in these processes is of considerable interest. It might have also a major impact on marine ecosystems as the encroachment of the Vibrio bacteria in the Baltic Sea demonstrates (Kesy et al. 2016).

Notwithstanding scientific knowledge production, media representation about marine plastics diverges significantly (De Wolff 2014). This affects the image production and its underlying politics of scale. Furthermore, while focusing on macroplastics (visual and coherent materialities), the problem of plastic and waste in general seems to be manageable. In contrast, the perspective on microplastics and nanoplastics shows an area of rather unformed objects with uncertain effects. Nonetheless, the ocean is still viewed from the land when it comes to solutions. On the one hand, land-based ideas for waste management neglect the ocean's fluid ontology, on the other hand they disregard the degradation of plastics into microscopic particles in the water. Regarding the presentation of the phenomenon, another obstacle is the translation of the term microplastics in ecological discussions: first, most effects of microplastics are rather unpredictable. We do not fully understand how microplastics might harm the environment. Second, the term is not related and translated to people's terrestrial experience: it seems that plastics in the ocean and our entanglement with rather coherent plastic objects in our daily lives represent two different spheres. That might change with recent monitoring of micro- and nanoplastics as dust emissions in the air or as part of the soil.

Multiplying the ghosts of speculation and ambivalence
The modern separation of nature and culture as theorized by Bruno Latour (2012) becomes contested regarding the accumulation of plastics in different environments. As STS researcher Banu Subramaniam (Subramaniam 2014) argues, the natural and the cultural cannot be easily

separated and we are still haunted by the ghosts of natureculture.[1] The aggregation of microplastics in the ocean and the emergence of new hybrid lifeforms on synthetic surfaces can serve as a reflection for human entanglements with plastic, the embeddedness of the synthetic polymers in human environments, infrastructures and even bodies. In the words of Timothy Morton: "we ourselves are implicated" (Morton 2007, 187). What concepts in feminist technoscience, political ecology, multispecies ethnography and queer ecologies help to tackle these kinds of socio-environmental phenomena? But also, what are the constraints and limits of a natureculture perspective that deals with entanglements and the ghosts of permanent ambivalence?

Because of its circumventing, evading and erratic character, plastic calls into question notions of pure nature, of authenticity or virginity, even of reproductivity, queering nature (Davis 2015). In recent years, the notion of *entanglement* in the works of Karen Barad (Barad 2007) and others (Myers 2012; Taffel and Holm 2016; Tosoni and Pinch 2016) were in vogue to describe hybrid encounters in *naturecultures* – but can it really capture all of the dynamics of this emerging phenomenon? Most entanglements can be disentangled: Think of Haraway's steady use of textile metaphors from quilts to string figures (Haraway 2016). A turtle that becomes entangled in a six-pack-ring might die. Though, there is the hypothetical option to help the animal escape its plastic trap. But what if the amalgamation of synthetic materials in the environment goes even further? When the aggregation of plastics and entities in seawater like plankton (Long et al. 2017) becomes much more "melded", using ideas of purification or separation is impossible.

Here the notion of "slime" (Helmreich 2009, 129–30; Schrader 2012) might be interesting to work with. Unlike entanglements, slime does much more to address the uneasiness and uncanniness of the phenomenon. The anticipation of the uncanny is informed by other ghosts of the 20th century, such as radioactive contamination that challenge thinking in relatively "straight" temporalities. In the marine *plastisphere* or in atmospheric emissions we are seeing the emergence of unformed objects whose long-term effects and risks are hard to evaluate. In an essay in Cultural Anthropology from 2013, Michelle Murphy contemplated about the new status of these unformed objects and about their undecidable effects, in her words:

"of becomings that are never fully finished, of conflicted materializations always in a state of uneasy entanglement, or queer objects that defy attempts to pin them down […] But where early technoscience studies was often always-more-of-the-same narratives, the stories of unformed objects tend to be heterogeneous, open-ended, and a challenge to convey in linear writing" (Murphy 2013).

The contemporary world appears increasingly threatened by its own waste, by what has been forgotten but not gone. Thus, the historiography of the material cultures of plastics can lead to new insights concerning their contingent economies and also its underlying promissory capital (Hawkins 2013; Westermann 2007). On the other hand, emerging alternatives to prevent waste or the Zero Waste movement bring to mind ghosts of an often unreal and idealized past, and a version of purified nature.[2] In addition, environmentalism in the North has adopted often a quite

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1   Subramaniam shows for example how ecological discourses about invasive species often follow the same argumentative patterns like the discourse about human migration.

2   For example, some bulk food stores [Unverpackt-Läden] rely heavily on a romantic view of a "better" past without plastic packaging, on the ideas of homeland (*Heimat*), hominess and the desire for an idealized version of nature.

(neo)liberal stance, that is directed towards the proactive citizen and consumer. Therefore, it regularly implements a moral and normative regime regarding notions of pollution, (im)purity and toxicity that are too individualized to bear any attraction for queer-feminist and antiracist politics. Feminist technoscience and feminist anthropology have shown how the question of the environment and the ecological is intoxicated in several ways. On the one hand, it is hard to relate to older ecofeminist standpoints that work within a clear nature/culture divide (MacCormack and Strathern 1980). On the other hand, some queer and cultural studies approaches that celebrate that environments and species might become contaminated with endocrine disruptors like Bisphenol A (a common monomer additive) find themselves squarely in the comfort zone of discourse theory and do not engage with issues like environmental injustice.

The problem of modern solutions
Microplastics are dispersed, become part or aggregate with natural environments. Plastics in the ocean do not stay "outside of nature", but become new hybrid components. In contrast, ideas of cleaning the ocean from plastic seem to ignore the diffusion and the amalgamation of microplastics. They are guided by an idea of purification and they adhere to large scales. Nevertheless, projects like the "Ocean Cleanup" have become media hypes although nearly all marine scientists I met during my research were sceptical of the project. Moreover, they emphasized the potential harmful effects of such large-scale projects for marine ecosystems. Max Liboiron (2015) criticises this kind of "technological fix" that "refuses to recognize the inherent wickedness of the problem". Technological fixes often are end-of-pipe solutions that "attempt at combating the symptoms but not the cause of the social, political and ecological crises of the times", as Arturo Escobar (2004, 209) writes. And he further argues that

> "modernity's ability to provide solutions to modern problems has been increasingly compromised.
> In fact, it can be argued that there are no modern solutions to many of today's problems. that there
> are no modern solutions to many of today's problems" (ibid.).

However, this modern logic of solutions and technological fixes is still omnipresent and also environmental activists are often pervaded by such ideas. As already stated, some kind of solutions can be more problematic than the actual problem. Reliance on technological fixes shifts the focus away from questions of responsibility for the contamination with microplastics.[1] In light of the dispersal of microplastics in even remote regions of the world, questions of environmental justice and care should be put on the political agenda. Inspired by ongoing debates in STS about the politics of care, Sebastian Ureta employs the concept "caring for waste" in his research about the handling of tailings in Chilean copper mines. He underlines that „caring for waste necessarily recognizes that waste is not going to go away, no matter how much we wanted it or planned it" (Ureta 2016, 5). From this vantage point, it might be interesting to display the ambivalent qualities of plastic litter and to recognize the specific scalability of

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[1] Some kind of environmental campaigns, such as plastic bag bans, can even be misleading when they are not seen as a mere starting point. As a result, the focus might shift away from other significant input sources, such as fibres from synthetic fabric or the wear and tear of car tires (Wagner et al. 2018). In these examples plastics already enters the environment in form of microscopic particles (microfibers or fine dust particles).

microplastics as a novel and serious "matter of care" (Puig de la Bellacasa 2011). In other words, there is a need to search for new tools to address ecological issues as *matters of care* that shows our entanglement with the problem and thus, the resulting consequences for further collaborations in the field.[1]

References

Barad, Karen. 2007. *Meeting the Universe Halfway: Quantum Physics and the Entanglement of Matter and Meaning*. Durham/London: Duke University Press.

Davis, Heather. 2015. 'Toxic Progeny: The Plastisphere and Other Queer Futures'. *PhiloSOPHIA* 5 (2): 231–50.

De Wolff, Kim. 2014. 'Gyre Plastic: Science, Circulation and the Matter of the Great Pacific Garbage Patch.' San Diego: University of California (Diss.). http://escholarship.org/uc/item/21w9h64q [28 June 2018].

Dris, Rachid, Johnny Gasperi, Cécile Mirande, Corinne Mandin, Mohamed Guerrouache, Valérie Langlois, and Bruno Tassin. 2017. 'A First Overview of Textile Fibers, Including Microplastics, in Indoor and Outdoor Environments'. *Environmental Pollution* 221: 453–58.

Eriksen, Marcus, Laurent CM Lebreton, Henry S. Carson, Martin Thiel, Charles J. Moore, Jose C. Borerro, Francois Galgani, Peter G. Ryan, and Julia Reisser. 2014. 'Plastic Pollution in the World's Oceans: More than 5 Trillion Plastic Pieces Weighing over 250,000 Tons Afloat at Sea'. *PloS One* 9 (12): e111913.

Escobar, Arturo. 2004. 'Beyond the Third World: Imperial Globality, Global Coloniality and Anti-Globalisation Social Movements'. *Third World Quarterly* 25 (1): 207–30.

Haraway, Donna J. 2016. *Staying with the Trouble: Making Kin in the Chthulucene*. Durham, NC: Duke University Press.

Hawkins, Gay. 2013. 'Made to Be Wasted: PET and Topologies of Disposibilaty'. In *Accumulation: The Material Politics of Plastic*, edited by Jennifer Gabrys, Gay Hawkins, and Mike Michael, 49–67. London: Routledge.

Helmreich, Stefan. 2009. *Alien Ocean: Anthropological Voyages in Microbial Seas*. Berkeley, CA: University of California Press.

Latour, Bruno. 2012. *We Have Never Been Modern*. Cambridge, MA: Harvard University Press.

Liboiron, Max. 2015. 'How the Ocean Cleanup Array Fundamentally Misunderstands Marine Plastics and Causes Harm'. 2015. http://discardstudies.com/2015/06/05/how-the-ocean-clean-up-array-fundamentally-misunderstands-marine-plastics-and-causes-harm/ [28 June 2018].

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1   Apart from the politics of technological fixes with their logics based in bigness, propagation via Ted Talks and well financed media campaigns, there are many interesting initiatives that have been working in the field of plastic litter for years. I like to highlight two projects I had the opportunity to visit in the last two years:
(1) The Chilean Citizen Science Project "Científicos de la Basura" (http://www.cientificosdelabasura.cl/) that collaborates with teachers and pupils in the whole country and that was able to produce interesting data for all Chilean coastal regions. In addition, the initiative emphasizes the relation between marine litter and the local waste management and engages in the improvement of recycling in Chile.
(2) The "Civic Laboratory for Environmental Action Research" (https://civiclaboratory.nl/) in Newfoundland (Canada) that works with a feminist and anti-colonial approach for monitoring plastic pollution in collaboration with local fishing communities. They have managed to reduce costs in monitoring equipment with the introduction of cheaper DIY-technologies.

Long, Marc, Ika Paul-Pont, Helene Hegaret, Brivaela Moriceau, Christophe Lambert, Arnaud Huvet, and Philippe Soudant. 2017. 'Interactions between Polystyrene Microplastics and Marine Phytoplankton Lead to Species-Specific Hetero-Aggregation'. *Environmental Pollution* 228: 454–63.

MacCormack, Carol, and Marilyn Strathern. 1980. *Nature, Culture and Gender*. Cambridge, UK: Cambridge University Press.

Masco, Joseph. 2004. 'Mutant Ecologies: Radioactive Life in Post–Cold War New Mexico'. *Cultural Anthropology* 19 (4): 517–550.

Morton, Timothy. 2007. *Ecology without Nature: Rethinking Environmental Aesthetics*. Cambridge, MA: Harvard University Press.

Murphy, Michelle. 2013. 'Studying Unformed Objects: Deviation'. *Cultural Anthropology* 15.

Myers, Natasha. 2012. 'Dance Your PhD: Embodied Animations, Body Experiments, and the Affective Entanglements of Life Science Research'. *Body & Society* 18 (1): 151–89.

Puig de la Bellacasa, Maria. 2011. 'Matters of Care in Technoscience: Assembling Neglected Things'. *Social Studies of Science* 41 (1): 85–106.

Schrader, Astrid. 2012. 'The Time of Slime'. *Environmental Philosophy* 9 (1): 71–93.

Subramaniam, Banu. 2014. *Ghost Stories for Darwin: The Science of Variation and the Politics of Diversity*. Champaign, IL: University of Illinois Press.

Taffel, Sy, and Nicholas Holm, eds. 2016. *Ecological Entanglements in the Anthropocene*. Lanham, MD: Lexington Books.

Tosoni, Simone, and Trevor Pinch. 2016. *Entanglements: Conversations on the Human Traces of Science, Technology, and Sound*. Cambridge, MA: MIT Press.

Ureta, Sebastian. 2016. 'Caring for Waste: Handling Tailings in a Chilean Copper Mine'. *Environment and Planning A* 48 (8): 1532–48.

Wagner, Stephan, Thorsten Hüffer, Philipp Klöckner, Maren Wehrhahn, Thilo Hofmann, and Thorsten Reemtsma. 2018. 'Tire Wear Particles in the Aquatic Environment-A Review on Generation, Analysis, Occurrence, Fate and Effects'. *Water Research* 139: 83–100.

Westermann, Andrea. 2007. *Plastik und politische Kultur in Westdeutschland*. Zürich: Chronos.

Zettler, Erik R., Tracy J. Mincer, and Linda A. Amaral-Zettler. 2013. 'Life in the "Plastisphere": Microbial Communities on Plastic Marine Debris'. *Environmental Science & Technology* 47 (13): 7137–7146.

Hidden discrimination in academia. Mentoring as an Empowerment Strategy for Female Researchers in Medicine.

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Abstract

This article examines the (equal) opportunities for female researchers in the Faculty of Medicine at a German university, the hidden obstacles in pursuing individual careers in academia, the factors preventing females from reaching leading positions as well mentoring as an instrument favoring the predictability, security and stability of the academic career. The authors performed several quantitative studies on the working conditions as well as a survey on mentoring effects for female researchers working at the Medical Faculty. The main target group includes female researchers at the postdoctoral phase of academic qualification.

1. Introduction: Are there signs of gender discrimination in academia?

Increasingly precarious working conditions are considered to be a common phenomenon among academics of both genders[1] at universities in Germany. Nevertheless Gender equality plans demonstrate the underrepresentation of women at higher stages of their academic careers. Especially, it refers to the field of medicine, where the proportion of women resembles a pyramid – the higher the academic qualification level is the fewer females are represented. While the majority of medicine students (64,5%) as well as doctorate researchers (66,7%) is female, only few female researchers manage to reach the top of the pyramid. The percentage of female professors is 21,2 % for the W2 positions and only 17,0 % for the highest W3 positions[2].

In order to prevent the structural discrimination of female researchers and increase the proportion of women at universities, the position of women representatives, renamed later on into the position of equal opportunities commissioners was introduced all over Germany at the beginning of the 1990s [2]. One of the tools to promote equal opportunities in academia is considered to be a formal mentoring program for female researchers.

The reasons of the underrepresentation of women in higher positions in academia can vary in every individual case, but we can suppose a certain latent discrimination of the female gender in the educational system of Germany. In this article we analyze the working conditions of female researchers at the Medical Faculty. Our special interest lies on the target group of employees between two qualification stages – after the PhD degree and before the habilitation. We investigate, which personal and professional key skill female researchers gain through mentoring and conclude, how helpful the female-oriented program are in order to if not to reach gender balance than at least to raise awareness of existing gender imbalance within the scientific community.

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1   In this article we analyse the variable "gender" by comparing the conditions for male and female researchers. Because of unavailability of data, the third gender is currently not the subject of our analysis.
2   Internal statistics of Heinrich-Heine-University Dusseldorf, 2016.

2. Methods

2.1. Quantitative study on the working conditions

We performed a quantitative study on the working conditions for academical employees at a medical faculty in Germany by analysing the employment contracts over a period of four years (2012 – 2015).

	Analysis of employment contracts	Reconciliation of family and career
	2012-2015 (PhD, MD only)	2013-2015
Type of contract (first vs. continued employment)	+	
Gender (m/f)	+	+
Academic title		+
Contract duration (Cod) in months	+	
Weekly working time (wwt) in %	+	+
Tariff classification	+	+
Age	+	+
Maternity protection y/n		+
Parental leave without working y/n		+

Table 1. Overview of the data collected

A multivariate analysis of variance (MANOVA) was performed with the test statistic Wilks' lambda and the factors gender and contract type. As dependent variables we indicated **duration of the working contract** (cod) and **weekly working time** (wwt). Due to the exploratory question Bonferroni correction of level of significance was omitted. All in all we analyzed 2774 working contracts of the employees of the medical faculty concluded in the years 2012 – 2015. We divided the contracts into two groups based on the variable **contract duration**. Postdoc employees with the duration of their working contract shorter than 70 months belonged to group A, respectively group B included all postdoc employees having a contract duration longer than 70 months.

MANOVA for fixed-term contracts

For group A a MANOVA was conducted with the test statistic Wilks' lambda and the factors gender and type of contract (initial contract vs. extension). Dependent variables were **contract duration** and **weekly working time**. The sample consisted of all fixed-term contracts between 2012 and 2015 (2650 persons, of whom 1530 were women and 1120 were men).

Type of contract	Female	Male	Total
Fixed term 95,5 %	1530	1120	2650
	58 %	42 %	
Permanent 4,5 %	47	77	124
	38 %	62 %	

Table 2. Database

MANOVA for permanent contracts

For group B a MANOVA was conducted with the test statistic Wilks' lambda and the factors gender and type of contract (initial contract vs. extension). Dependent variables were *age* and *weekly working time*. The sample comprises 124 employees (47 women and 77 men).

Analysis of the reconciliation of family and career

We performed a gender analysis for all academical employees of the medical faculty examining the weekly working time and the fact and duration of parental leave of those employees who became a new parent during the period of investigation.

The analysis of the duration of parental leave was performed with ALSTAN based on Excel. This tool gives an analysis of the demographic composition of an institution. There is no specific evaluation of individual datasets.

For the academic and clinical career we analyzed different groups. The groups are defined as follows: doctorate researchers, postdocs and researchers with a postdoctoral lecture qualification of the medical faculty (excluding physicians). For the medical career group we included only physicians. They are divided into assistant physicians, medical specialists and senior physicians. A look at the claim and duration of parental leave within these groups might reveal a possible correlation of the work-life-balance. In order to make an objective comparison between men and women, we considered only parental leave excluding the leave within mandatory maternal protection period. For the analysis of the reconciliation of family and career, we collected 265 datasets about parental leave regarding gender, age, duration of parental leave and academic status from 178 persons.

2.2. Quantitative and qualitative empirical data on mentoring

The findings on the mentoring part for this article are based on an online survey conducted 2016 among the former mentees of a female-oriented mentoring program SelmaMeyerMentoring at a German university who participated in the program from 2006 to 2016 (response rate 64%). As program is open for the female young career researchers of all faculties, we sorted out the data for the participants (mentees) from the Medical Faculty and the Faculty of Mathematics and Natural Sciences (n=121), who worked in the field of medicine.
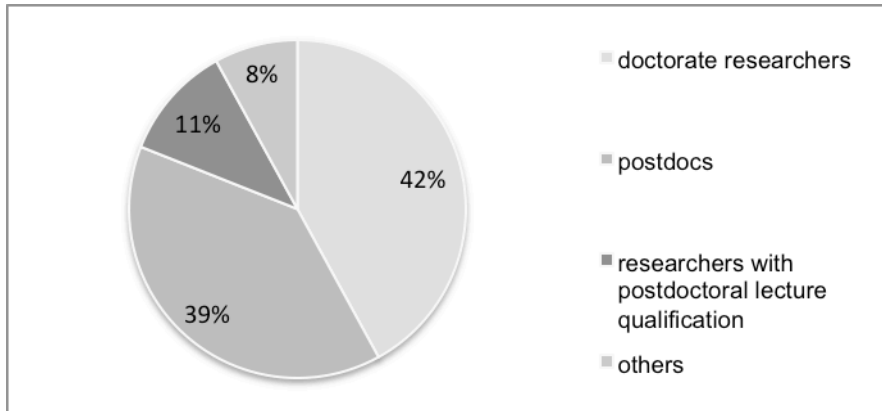
Fig. 1. Data set of mentees at Medical Fakulty and Faculty of Mathematics and Natural Sciences, (N=121).

At the same time, 31 semi-structured qualitative interviews with experts were carried out. The mentees and experts were asked to express their individual goals and personal as well as institutional benefits through the participation in the mentoring program.

3. Findings

3.1. Differences in the working conditions between male and female employees

There were main effect for the factors gender ($F(2/2645)=12.647$; $p<.001$, $\eta2=.009$) and contract type ($F(2/2645)=74.195$; $p<.001$, $\eta2=.053$) as well as an interaction ($F(2/2645)=3.184$; $p=.042$, $\eta2=.002$).

In the fixed-term employments gender doesn´t influence the contract duration significantly, but the weekly working time of an employee. In contrast to the previous findings [11] a main effect of contract type on the variable **weekly working time** was found ($F(1/2645)=25.207$, $p<.001$, $\eta2=.009$), whereas no effect was present on the variable **contract duration** ($F(1/2645)=1.627$, $p=.202$, $\eta2=.001$). We could observe the interdependence between these two variables. Men have longer weekly working times (M=.838, SD=.008) than women (M=.787, SD=.007).

The factor contract type affects the variable **contract duration** ($F(1/2646)=146.895$; $p<.001$, $\eta2=.053$) as well as the variable **weekly working time** ($F(1/2646)=6.811$, $p=.009$, $\eta2=.003$).

Generally, new employed staff has longer contract durations (M=25.438, SD=.531) and longer weekly working times (M=.826, SD=.008) than retained employees (contract duration: M=17.379, SD=.401; weekly working time: M=.799, SD=.006). An interaction between both variables was observed.

In contrast to men, the contract duration of women who were newly employed and those who were retained differed strongly from each other (women: arithmetic mean new hire=28.812; arithmetic mean retained=16.157; men: arithmetic mean new hire =25.065; arithmetic mean retained =18.601). The same circumstances were revealed with regard to the weekly working time: on average newly hired women work 80,8 % of a full-time job (retained female employees work 76,6 %). Newly employed men work 84,3 % of a full-time week (retained male employees 83,2 %).
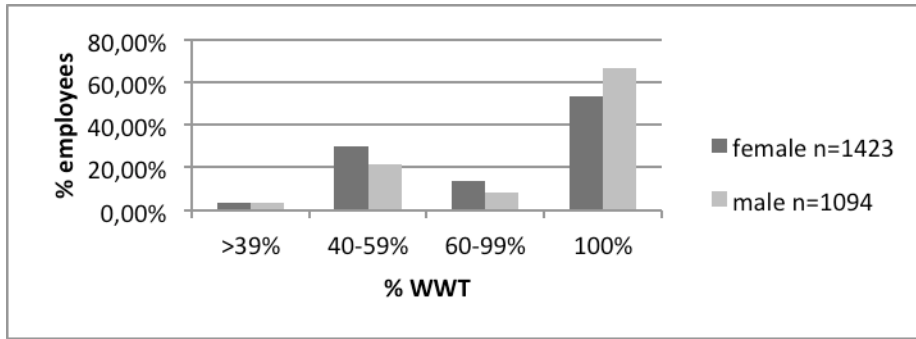
Fig. 2. Distribution of weekly working time by gender (1=100% WWT, i.e. full time)

During early academic and clinical career men and women are on equal terms when it comes to fixed-term contracts. But we found out, that men receive contracts with longer working hours more often (men: 84 %; women: 78 %). This fact leads to a gender pay gap and prospectively to a gender pension gap in the future.

Differences in the permanent working contracts

The analysis is based on contracts from 124 employees, of whom 47 were women and 77 were men. We found a main effect of the factor gender ($F_{(2/119)}=8.132$; $p<.001$, $\eta 2=.012$), but no main effect of the parameter contract type ($F_{(2/119)}=1.697$; $p=.188$).

There was a main effect of gender on the variable weekly working time as well as on the variable age. In general men had longer weekly working times (M=.973, SD=.021) than women (M=.888, SD=.026) and they were older at the beginning of their employment (men: M=42.565, SD=.651; women: M=39.708, SD=.789).

	Factors/parameters	Gender	Contract type	Interaction
Fixed-term	CoD	p=*.202*	P<.001	
	wwt	P<.001	P=.009	
	total	P<.001	P<.001	P=.042
Permanent	age	P=.006		
	wwt	P=.013		
	total	P<.001	*P=.188*	P=.006

Table 3. Results from MANOVA, p: α-error margin

Men were also twice as likely to perceive a permanent contract as women. This implicates the better opportnities for men to plan their career and family formation, rather than women.

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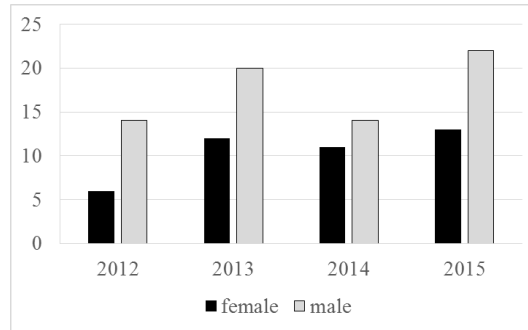
Fig. 3. Number of all permanent work contracts by gender

Parental leave in interdependence to the academic career stage

In the present work we analyzed the gender differences, the academic career stage and the age structure in interdependence to the claim of parental leave. From 2013 to 2015 women applied for parental leave 178 times and men 47 times. On average women claimed 170 days of parental leave and men only 47 days (the medium age for both genders 35,5 years). The parental leave is most commonly claimed between the ages of 31 and 35 (m/f).
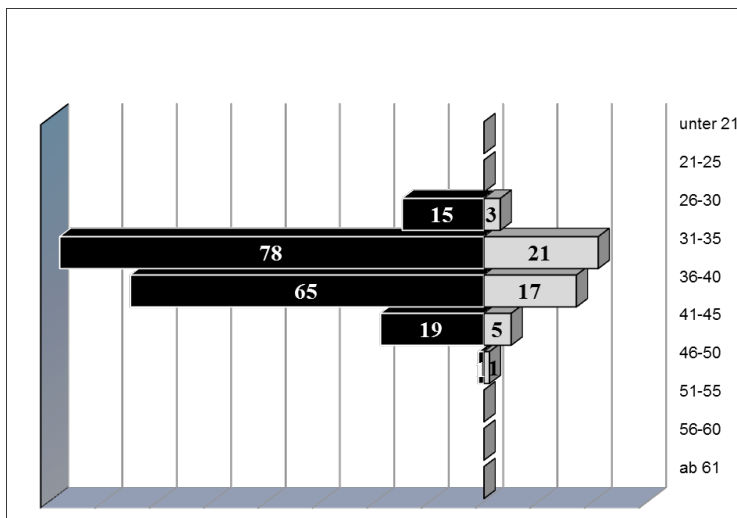
Fig. 4. Number of employees in parental leave in interdependence to the employee´s age and gender (black colour: female employees, grey: male employees)
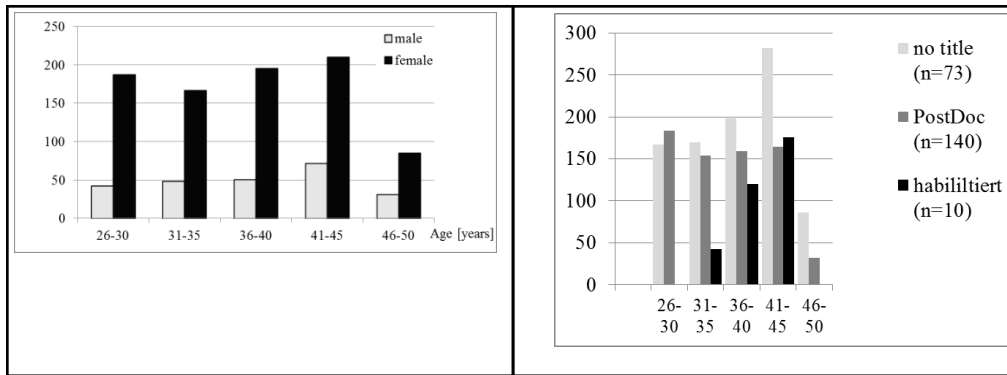
Fig. 5. An average duration of parental leave in days in interdependence to the employee´s gender and age (figure 5.A) and in interdependence to the employee´s qualification stage and age (both genders m/f) (figure 5.B)

The duration of parental leave increases with age (m/f) among employees, who have no doctorate and those who have received a postdoctoral lecture qualification. Whilst the researchers with a postdoctoral lecture qualification claim a significantly shorter parental leave between the age of 31 to 35 years (less than 50 days), this duration more than triples between the age of 41 to 50 years (on average 175 days). The number of employees having a doctorate remains almost the same in every age category. There is no difference between the fixed-term and the permanent employees or the stage of the clinical career with regards to the duration of parental leave.

These results lead to the conclusion that gender among of all analyzed factors has the greatest influence on the claim and the duration of parental leave. We came to the conclusion, that male academic staff claims parental leave infrequently and for shorter periods of time, comparing to female ones.

3.2. Findings on the benefits through mentoring

The academic sphere is governed by a strict game that functions according to a peculiar long-standing game manual, which remains invisible, intransparent and unclear especially for the early stage researchers who are newcomers in the field. Nowadays, researchers have to pass through certain qualification steps in their academic careers in a limited period of time, which lasts twelve years (case Germany). The famous rush hour of life for female researchers between 30-40 years is the peak of the intensive scientific career and simultaneously the time to plan their family and raise children. This strict system disadvantages the underrepresented group of female researchers in particular, for whom twelve years are often insufficient to reach a leading position in academia.

Mentoring as a measure against discrimination

The SelmaMeyerMentoring program was initiated and developed by the central equal opportunities officer and endorsed by the university management. The president of the university is traditionally a patron of the program and many professors are eager to ready to be mentors for the younger researchers.

Since 2006 the program has been supporting early stage female researches. The program consists of three modules (one-to-one mentoring, workshops and networking events) and lasts regularly 18 months. Already 385 mentees from all faculties took part in it.

We analyse the key skills that mentees can develop through participation in the female-oriented mentoring program and we assume that these skills can contribute to successful career of female researchers in medicine.
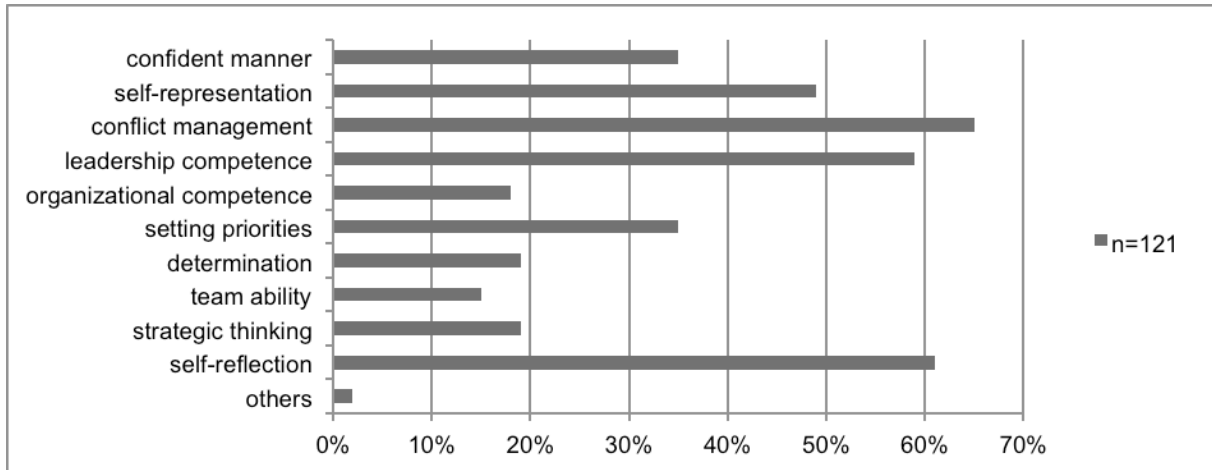
Fig. 6. Key skills developed through mentoring program

Such soft skills as conflict management, self-reflection, leadership, self-representation, confident manner and setting priorities were the most frequently mentioned skills which mentees gained and built through participation in the program.

Through the acquisition of external mentors, mentoring programs effectively gather their experiences making their inside information available to early stage researchers. Experienced mentors support the development of the early career scientists in one-to-one mentoring relationship by sharing their experiences and outlining the paths to their careers.
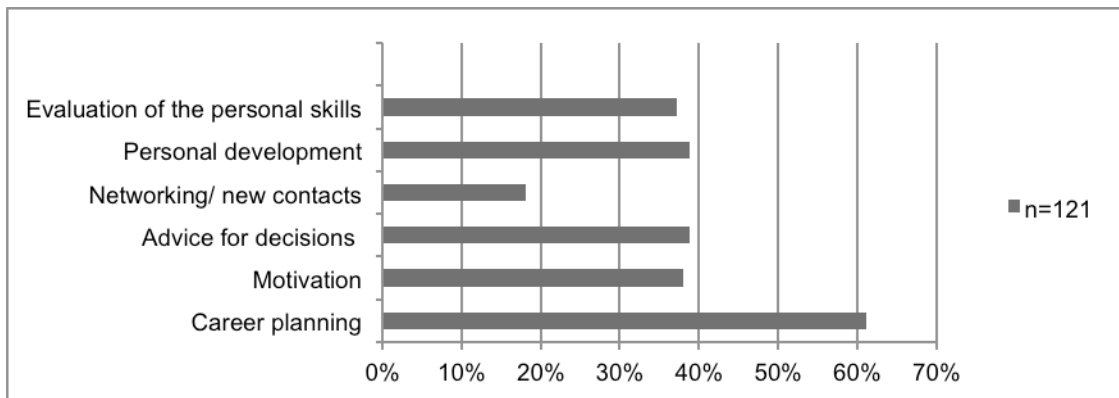
Fig. 7. The skills and competencies the mentees learned from their mentors, %.

According to the empirical data from surveys, mentees effectively questioned their mentors about their career choices, motivation, advice, personal development and estimation of their own skills and found the experience especially supportive. The board of experienced

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researchers is seen as a valuable resource for the younger researchers to develop their careers in academia. Experienced mentors support the younger academics by sharing their experiences and describing their career paths.
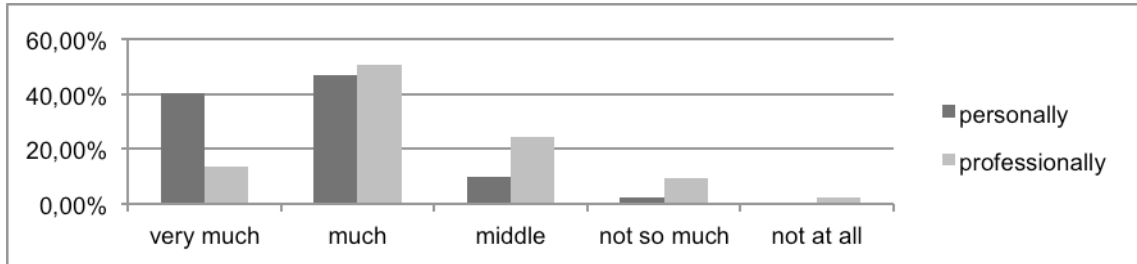
Fig. 8. Personal and professional benefits of mentees through mentoring program, n=121

The survey results demonstrate the high satisfaction of mentees. 87,6% of them mentioned that they could benefit personally and 63,8% benefited professionally though participation in the program.

With much consideration of special issues and requirements of early-stage female researchers, mentoring offers a hierarchy-free space for the casual exchange of the insider knowledge between experienced mentors and developing mentees. Through communication with more experienced mentors and with the peers from other disciplines, mentees managed to expand their existing networks and to get a chance to exchange knowledge between different disciplines and professional groups.
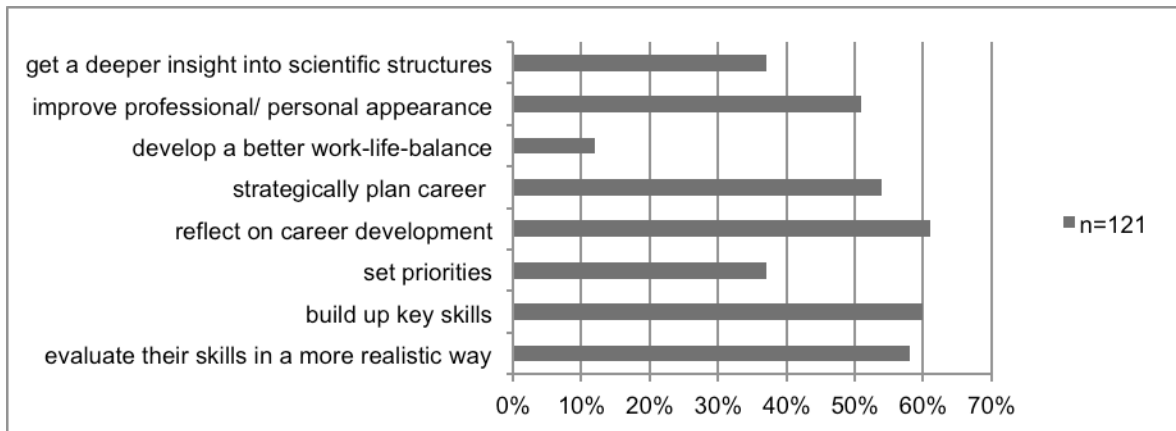
Fig. 9. Through mentoring mentees were able to...

Through mentoring the mentees were able to reflect on career development (61% of mentees mentioned it), build up key skills and competencies (60%) and evaluate their own skills in a more realistic and objective way (58%). Besides the mentees learned to plan their career strategically (54%) and to improve professional/ personal appearance (51%). 37% of mentees got a deeper insight into scientific structures. 12% of them learned to develop a better compatibility of family and career.

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3.3. Conclusion

In this article we analyzed the working conditions of female researchers at the Medical Faculty and showed certain signs of discrimination of female academic medical staff, which are not obvious at a first glance. Our main findings are: men are twice as likely to perceive a permanent contract as women; male academic staff receives contracts with longer working hours more often and claims parental leave infrequently and for shorter periods of time, comparing to female academic staff.

These findings implicate the better opportunities for male academic staff to plan their career and family formation, rather than for female; the results explain also the gender pay gap and a gender pension gap in the future.

We came to the conclusion that female researched need special female-oriented mentoring programs with the help of which they can improve their soft skills. We examined the results of the mentoring program that precisely sets the goal of more female management in academia and enables early career female researchers to identify, develop and systematically implement their personal skills and competences in strategical planning of their academic careers. In particular, we analysed the benefits and the key skills that mentees from medicine field gained through participation in the female-oriented mentoring program and came to the conclusion that the female researchers of all qualification stages can build skills essential for successful realisation of their career and social standing. That is why structured formal mentoring programs that encourage and empower female researchers to stay in academia can be viewed as one of the effective instruments of the equal opportunities policy at German universities.

References

Gedrose B., Wonneberger C., Jünger J., Robra B., Schmidt A., Stosch C. In: Deutsche Medizinische Wochenschrift 137, S. 1242–1247 (2012)

Kaczmarczyk G. (2001): „Erwartung – Realität – Ausblick", In Georgia, Heft 3, Frauen in der Hochschulmedizin, S. 2-6, Online unter:
http://www.med.uni-goettingen.de/de/media/beauft_frauen/georgia_03.pdf

Krais B., In: Dalhoff J. und Girlich J. (Hg.): *Frauen für die Stärkung von Wissenschaft und Forschung. Konferenz im Rahmen des Europäischen Jahres für Kreativität und Innovation.* Bonn (2009)

Larivière V., Vignola-Gagne E., Villeneuve C., Gelinas P.; Gingras Y., Scientometrics **87** 483–498 (2011)

Lind I., In: Wissenschaftsrat (Hg.): *Exzellenz in Wissenschaft und Forschung. Neue Wege der Gleichstellungspolitik* Köln (2007)

Mangematin V., Mandran N., Crozet A., (2000): "The Carreers of Social Science Doctoral Graduates in France: the Influence of How the Research was Carried Out," Grenoble Ecole de Management (Post-Print) hal-00424362

Masetkina E., Demming-Pälmer M. (2016): „Meilensteine und Entwicklungen aus 10 Jahren SelmaMeyerMentoring", In: Vervoorts A. (Hg.): Festschrift zum zehnjährigen Jubiläum des SelmaMeyerMentoring an der Heinrich-Heine-Universität Düsseldorf, S. 26-41.

Petersen R., Grümmer R., Jendrossek V., Sauerwein W. and Schara U. (2018) *'Mentoring in a medical faculty: a chance for organisational learning'*, Int. J. Learning and Change, Vol. 10, No. 3, pp.198–219.

Scheidegger N., In: Wissenschaftlerinnen-Rundbrief (**1**), S. 8–11. (2013)

Statistisches Bundesamt, (2012) https://www.destatis.de/DE/PresseService/Presse/
Pressekonferenzen/2013/Geburten_2012/Begleitheft_Geburten.pdf?__blob=publicationFile

.
Vervoorts Anja, Kalus Anna, Kreißl Ch., In: Klemisch M., Spitzley A., Wilke J., (Hg.): *Gender- und Diversity-Management in der Forschung*, Fraunhofer Verlag, IAO STAGES, Stuttgart, S. 92-103 (2015)

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STREAM: Digitalisation of Society

Trust in algorithms. An empirical study of users' willingness to change behaviour.
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Introduction

As mobile applications have become part of our everyday life, digital society has begun to use algorithmically generated recommendations as a foundation for decision-making. Whether it is choosing the most efficient route on the way to work, taking an umbrella, if the weather-app forecasts rain or adapting a daily workout routine according to a virtual trainer – algorithms influence our actions at an increasing frequency.

Our work aims to answer the question, how users' willingness to change their behaviour due to such recommendations is being constituted. We therefore look at the factors that influence their trust in app providers and privacy. Additionally, we want to identify how trust itself plays a role in this context and in turn influences the willingness to change behaviour.

We establish a research model to grasp the matter theoretically. In order to achieve this, we take a big data process model as a starting point and combine the technology acceptance model (TAM) with theories of trust. Subsequently an empirical study is conducted to validate the postulated coherences.

The mentioned recommendations are formed by a process of interaction between users and apps, which depends on large amounts of data. This user generated *big data* is important for the algorithms to compute a "big picture" of the current situation. On this basis, algorithms generate and then submit recommendations to a large number of individual users, who then have the choice to change their behaviour. Such recommendations can mostly be found in apps that use "Behaviour Change Techniques" (BCT) (Conroy et al. 2014). Both Conroy et al. as well as Middelweerd et al. (2014) provide a taxonomy of such techniques that is displayed in Fig. 1. and recurs to the taxonomy established by Abraham and Michie (2008).

Although the mentioned papers focus on the health and fitness sector, it becomes clear, that BCT are used throughout many types of apps. This especially applies for the very popular navigation and weather apps. Therefore, we focused our research on these app types as well as on health and fitness apps.

Conroy et al.	Middelweerd et al.
Provide instruction on how to perform behavior	Provide feedback on performance
Model/demonstrate the behavior	Prompt self-monitoring of behavior
Provide feedback on performance	Prompt specific goal setting
Goal setting—behavior	Plan social support or social change
Plan social support/change	Provide contingent rewards
Information about others' approval	Provide instruction
Goal setting—outcome	Prompt practice

Figure 1: Most frequently used behaviour changing techniques in apps (Conroy et al. 2014, p. 650; Middelweerd et al. 2014, p. 8)

Theoretical context and hypotheses

The process of big data related interaction has already been extensively studied in the course of the *ABIDA (Assessing Big Data)* project, which resulted in the big data process model shown in Fig. 2.
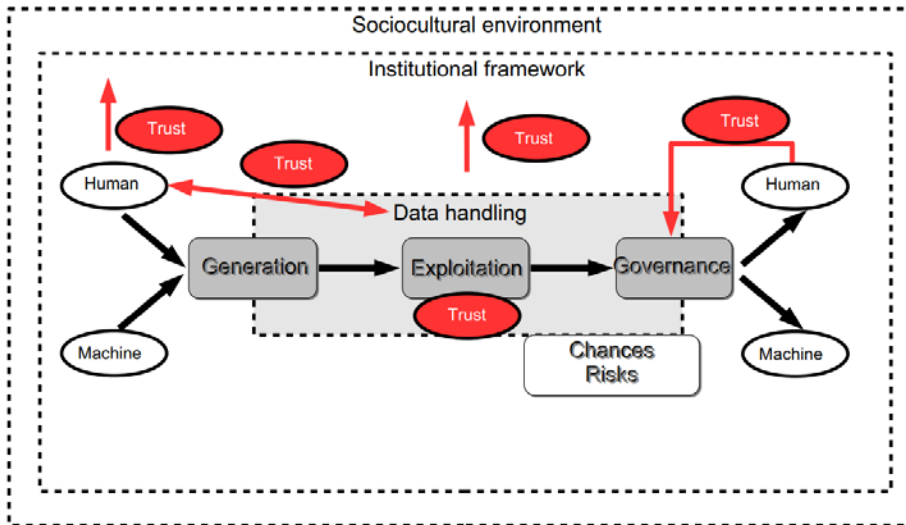
Figure 2: The big data process model (cf. Weyer et al. 2018, p. 74)

This model mainly consists of three phases: data generation, data analysis and data use, e.g. for controlling whole sociotechnical systems. In the first phase, data is being generated through the interaction of users and machines, the former of which creates information (e.g. through physical activity) that is then transformed into data by the latter. Subsequently, data is evaluated by

algorithms set up by handling institutions such as app providers or traffic management units. The resulting enriched data can then be used to generate interdependent recommendations and thus individually recommend actions.

We assume, that the whole big data process is heavily dependent on the trust that users place in their applications as well as the trust in data protection and privacy on part of the providers. Both providers of data gathering applications and users need mutual trust to ensure, that the data being put in has maximal quality. This affects the accuracy of the data and the willingness to comply with the suggested actions. Trust is therefore a key element for the algorithms that generate and use big data.

Core model

To grasp this subject theoretically, we take the *Technology Acceptance Model (TAM) (Davis et al. 1989)* as a starting point and establish an extended research model, including trust as a mediating variable and various external factors.
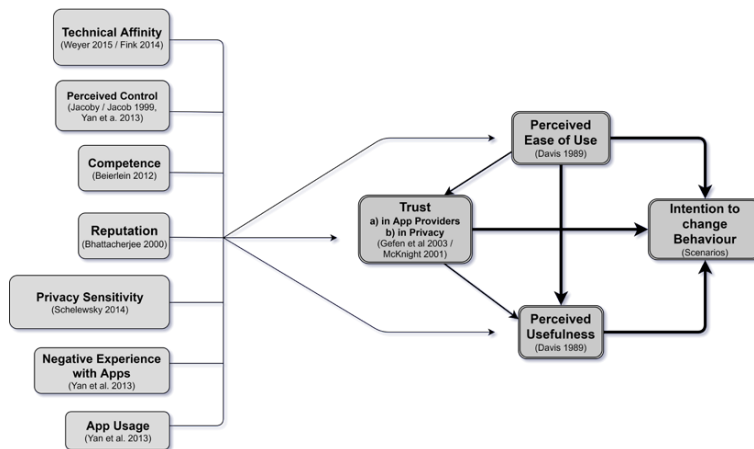
Figure 3: Research model of our study (own figure)

Figure 3 shows the full research model for our study. The integration of trust as a separate variable inside the core model as well as its positioning follow the work of David Gefen et al., who applied a similar core model to their research on trust in online shopping (cf. Gefen et al. 2003, p. 53). Due to the thematical similarity of both Gefen's and our subject, we decided to adapt the established core model and add specific external factors that match our research.

Concerning the term of trust itself, we work with the typology that was established by Harrison McKnight and Norman Chervany (2001). More precisely, we focus on institutional trust (McKnight and Chervany 2001, p. 33) in the shape of trust in national privacy regulations and interpersonal trust (ibid.) in the shape of the relationship between user apps and app providers (which can together be seen as the trustee).

External factors

The selection process of the external factors was also conducted following the maxim of thematical suitability. Following this pattern, the external factors can be divided into three groups: general personality traits that were found to be relevant such as *perceived control* and

competence, technology focussed traits such as *technical affinity* or *privacy sensitivity* and thirdly app related factors such as app's *reputation*, *negative experience* with apps or *app usage*.

The relevance of certain personality traits and the perceived quality of the experience for the trust relationship with apps has been examined by Yan et al. (2013), who explicitly focus on "trust of mobile applications" (Yan et al. 2013).

They find, that both usage time and quality, subsumed under the construct of "using behaviour" and "reflection behaviour" have an influence on "trust behaviour" (Yan et al. 2013, cf. p. 642, 654). Furthermore, they find that both the brand of mobile application (implicating that brands reputation) and user's personality also have an influence on trust behaviour (Yan et al. 2013, cf. p. 646, 653). Following these findings, we include the factors *perceived control, competence, reputation, negative experience* and *app usage* into our research model.

Regarding the factor of *technical affinity*, Weyer et al. (2015) confirm the earlier finding of Venkatesh and Meuter et al. that "system-independent factors, which can be examined which can be examined without observing the practical use of a specific system, may serve as predictors of attitudes such as acceptance." (Weyer et al. 2015, p. 207). In their survey they use the factor "general attitudes towards technology" (Weyer et al. 2015, p. 206) as a predictor for perceived control. Abstracting from this finding, we integrated these general attitudes under the term of *technical affinity* into our research model.

Schelewsky et al. (2014) also confirm the effect of *technical affinity* and refer to interaction effects between *technical affinity* and *privacy sensitivity* (cf. Schelewsky et al. 2014, p. 94f.). In this context they also find, that both factors affect the acceptance of technology (cf. ibid). Therefore, we also included the factor *privacy sensitivity* into our research model.

Summarizing the theoretical foundation of our study one has to point out, that we focussed on previous research concerning human-machine interaction as well as technology acceptance. We then established a research model following the "TAPAS"[1] (Windrum et al. 2007, p. 13) approach. For this reason, we also focussed on previous research including similar models and hence methodological comparability.

Hypotheses

Regarding our core model, we postulate that trust, measured by trust in privacy and trust in providers, has a significant and positive influence on the intention to change behaviour as well as the perceived usefulness. Likewise, we assume that the perceived ease of use has a significant and positive influence on trust. Thus the core hypotheses of the study are as follows:

H1: The more trusting a person is,...
    H1.1 ...the bigger is the willingness to change one's own behaviour.
    H1.2 ...the bigger is their perceived usefulness of apps.
H2: The bigger the perceived ease of use, the bigger is one's trust.

Regarding the external factors, we assume that *technical affinity, perceived control competence, reputation* and *app usage* have a significantly positive influence on all factors of the core model.

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1   „Take A Previous model and Add Something" Windrum et al. 2007, p. 13.

We also assume, that *privacy sensitivity* and *negative experience with apps* have a significantly negative influence on all factors of the core model.

Study design

For the empirical testing of our research model, we conducted a standardised survey among users of navigation, fitness and weather apps. The exact flow of the survey can be seen in Figure 4.
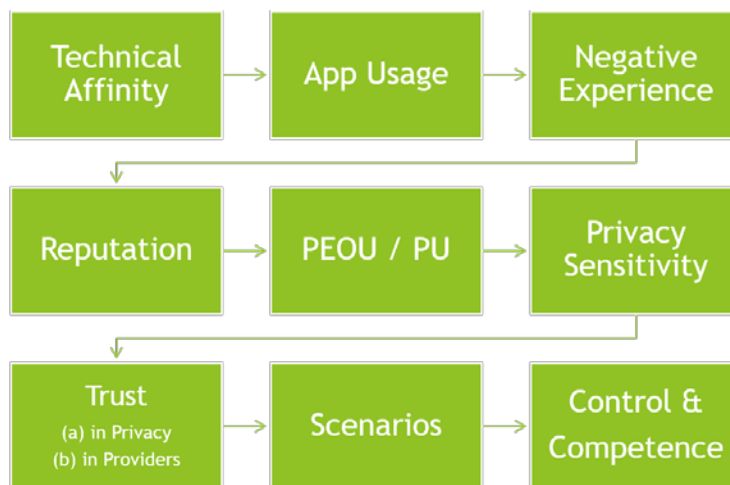
Figure 4: Survey flow in the used questionnaire

The mentioned factors were operationalised using already established scales where it was possible and choosing the thematically closest possible scales as a template where it was not. The origin or template of every used scale can be seen in Figure 5.

Scale	Origin
Technical Affinity	(Weyer et al. 2015)
App Usage	Own design
Negative Experience	Own design (after conduction of focus groups)
Reputation	Own design (cf. Bhattacherjee 2000)
PU / PEOU	Own design (cf. Davis 1989)
Privacy sensitivity	(cf. Schelewsky et al. 2014, p. 96)
Trust in app providers	Own design (cf. Amelang and Bartussek 1997)
Trust in privacy	Own design (cf. Anand and Kutty 2015)
Intention to change behaviour	Elicitation through scenarios
Perceived control	(Jakoby and Jacob 1999)
Competence	(Beierlein et al. 2012)

Figure 5: Overview of used scales

An exception was made by the way we elicited the *intention to change behaviour*: For this purpose, we created scenarios which were then assessed by the respondents. For example, we showed screenshots of a navigation app that offered a faster route than the one actually chosen. We then asked for users' willingness to choose the faster route based on given information.
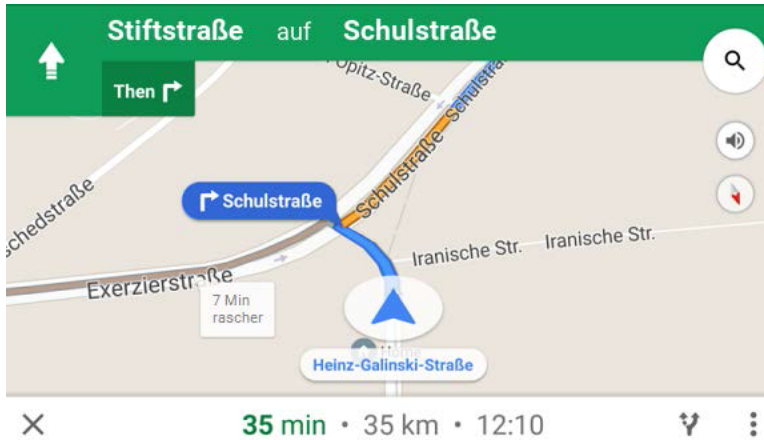
Figure 6: Scenario used to elicit the intention to change behaviour

Sample

In total, we analysed 212 datasets, 178 of which were complete and fully usable.

Attribute	Manifestation
Gender	55,6% female; 44,4% male; 0% other
Age	Median: 26 years; Range: 16 to 77 years
Education	Graduation: 64%; A-Level: 26,4%; O-Level: 2,2%; Other / no degree: 7,4%
Income (personal)	5000€+: 1,7%; 3601-5000€: 2,8%; 2601-3600€: 8,4%; 1301-2600€: 25,8%; 0-1300€: 53,9%

Figure 7: Basic attributes of the sample

Figure 7 shows basic attributes of the sample. Regarding the manifestations of these attributes, it becomes clear, that the sample is not representative for the whole population of Germany due to the studential (but not exclusively universitary) character of the respondents. Hence, a second representative survey has to be conducted using the results of this study as a starting point for eventual improvements of the questionnaire.

Evaluation of data

The evaluation of the collected data was realised in two steps: First, the quality of the used scales was analysed through factor and reliability analyses. Then, a structural equation model was established to examine the postulated coherences.

Scale quality

The analysis of tau-equivalent reliability shows that all relevant (and expressive) values for Cronbach's alpha are situated between 0,709 and 0,864, which was considered to be a sufficient internal consistency for those items, where an examination of internal consistency is methodologically sensible.

Some scales though, such as *negative experience*, while measuring one construct, by design have no need for internal consistency. For instance, *negative experience* is a formative construct, which means, it is formed by several individual negative experiences which are substantially different but still form one construct. Since both, factor analysis and measurements of internal consistency, aim at correlated items, these tests are not applicable for this type of constructs (cf. Eberl 2004, p. 7).

App usage on the other hand is a manifest construct directly measured by items that simply retrieve the usage frequency of different app types. Hence, it is self- explanatory why this scale does not feature any internal consistency.

The scale for *Reputation* qua factor analysis turned out to contain two separate factors, one was neglected. Due to this fact, the scale was reduced to three items which is a possible explanation for the low alpha value and shows a need for scale improvement before the representative survey.

Scale	Cronbach's alpha / Items
Technical Affinity	0,718 with 7 items
App Usage	Alpha not useful due to manifest character of scale
Negative Experience	Alpha not useful due to formative character of scale
Reputation	0,664 with 3 items (Alpha limitedly informative due to split character of scale)
PU / PEOU	0,861 with 8 items (PU); 0,856 with 4 items (PEOU)
Privacy sensitivity	0,843 with 7 items
Trust in app providers	0,758 with 8 items
Trust in privacy	0,819 with 5 items
Perceived control	0,709 with 3 items
Competence	0,864 with 3 items

Figure 8: Analysis results of the internal consistency

SEM

After the inspection of scale quality, the examined constructs were operationalised due to the results of this very inspection. The so formed indices were inserted into a structural equation model (SEM), which was then reduced within multiple iterations. The SEM is needed to model

relationships between variables that are assumed to be interrelated. These interrelations cannot be incorporated in standard regression models.

A prerequisite for using such a model is a clear and theoretically founded idea about the interrelations of a certain matter (cf. Weiber and Mühlhaus 2014, p. 3). As described in the core model section, this clear idea was developed by using the established TAM and extending it based on previous works on trust.

After modelling all possible interrelations, the model was gradually reduced by removing relations that displayed no significant effect. Figure 9 shows the remaining relations, color-coded according to significance levels.

In the overall model we achieved good fit values. The model was tested by means of the Goodness-of-Fit-Index (GFI) and the Adjusted-Goodness-of-Fit- Index (AGFI). These indices are normalised to a [0;1] interval. Both values exceed the presumed benchmark of 0.9 for a good model fit (cf. Weiber and Mühlhaus 2014, 210ff). The GFI value for the model is 0.977. If we adjust for model complexity the AGFI value is 0.939. To further test the model fit we used the Comparative Fit Index (CFI), which has the same benchmark value of 0.9 (cf. ibid, p. 214f). The tested model achieves the perfect value of 1.0.
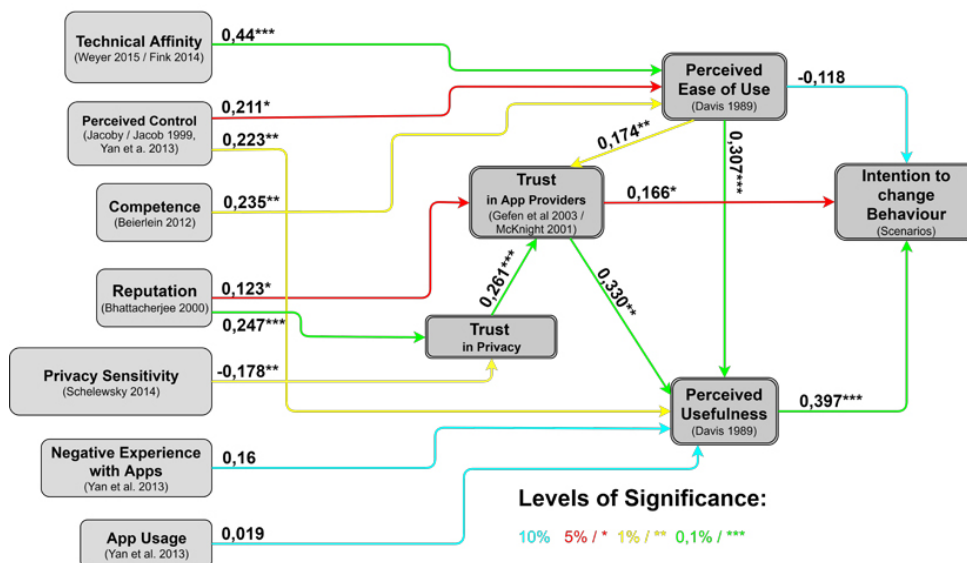
Figure 9: Results of the SEM calculation

Conclusion

Summarizing the results of our study, we conclude that trust in app providers has the assumed significantly positive influence both on the TAM as well as on user's users' intention to change their behaviour. Therefore, it is an essential component of users' decision making towards the acceptance of algorithmically generated recommendations.

Concerning the constitution of mentioned trust, it turns out that two factors show a significant influence trust: Reputation shows a significantly positive influence on both forms of trust which

shows that the perception of app's and providers' reputations influences both interpersonal and institutional trust. Privacy sensitivity, as expected, shows a significantly negative influence on trust in privacy ergo the institutional trust. Hence, these two factors appear to be the main direct determinants of trust itself.

Regarding the remaining external factors, technical affinity and competence show a significantly positive influence on the perceived ease of use, a result that is intuitive. Perceived control has the same kind of influence both on the PEOU as well as the perceived usefulness.

Besides these intuitive results, there are also weakly significant influences that lack contental explanation: Negative experience with apps for example shows a counterintuitively positive effect on PU while PEOU shows a negative effect on the intention to change behaviour. Although only being significant on a 10% level, we mention these results as an indicator for possible needs of further qualitative research following our study that could explain these phenomena.

Regarding all results, we see various opportunities for future research based on our findings. Currently, these results are being used by us for a follow up study. The aim of that study is to identify tangible modes of governance for complex traffic systems. To govern these systems, it is key to know how recommendations to change behaviour lead to users' factual action.

References

Abraham, Charles; Michie, Susan (2008): A taxonomy of behavior change techniques used in interventions. In *Health psychology : official journal of the Division of Health Psychology, American Psychological Association* 27 (3), pp. 379–387. DOI: 10.1037/0278- 6133.27.3.379.

Amelang, M.; Bartussek, D. (1997): Zwischenmenschliches Vertrauen.

Anand, T. N.; Kutty, V. Raman (2015): Development and testing of a scale to measure trust in the public healthcare system. In *Indian journal of medical ethics* 12 (3), pp. 125– 133. DOI: 10.20529/IJME.2015.044.

Beierlein, Constanze; Kemper, Christoph; Kovaleva, Anastassyia; Rammstedt, Beatrice (2012): Ein Messinstrument zur Erfassung politischer Kompetenz-und Einflusserwartungen. Political Efficacy Kurzskala (PEKS). GESIS.

Bhattacherjee, A. (2000): Acceptance of e-commerce services. The case of electronic brokerages. In *IEEE Trans. Syst., Man, Cybern. A* 30 (4), pp. 411–420. DOI: 10.1109/3468.852435.

Conroy, David E.; Yang, Chih-Hsiang; Maher, Jaclyn P. (2014): Behavior change techniques in top-ranked mobile apps for physical activity. In *American journal of preventive medicine* 46 (6), pp. 649–652. DOI: 10.1016/j.amepre.2014.01.010.

Davis, Fred D. (1989): Perceived Usefulness, Perceived Ease of Use, and User Acceptance of Information Technology. In *MIS Quarterly* 13 (3), p. 319. DOI: 10.2307/249008.

Davis, Fred D.; Bagozzi, Richard P.; Warshaw, Paul R. (1989): User acceptance of computer technology. A comparison of two theoretical models. In *Management science : journal of the Institute for Operations Research and the Management Sciences*.

Eberl, Markus (2004): Formative und reflektive Indikatoren im Forschungsprozess: Entscheidungsregeln und die Dominanz des reflektiven Modells. In. Ludwigs- Maximilians-Univ., Inst. für Organisation, Seminar für Empirische Forschung und Quantitative Unternehmensplanung.

Gefen, David; Karahanna, Elena; Straub, Detmar W. (2003): Trust and TAM in online shopping. An integrated model. In *MIS Quarterly* 27 (1), pp. 51–90.

Jakoby, Nina; Jacob, Rüdiger (1999): Messung von internen und externen Kontrollüberzeugungen in allgemeinen Bevölkerungsumfragen. In *Zuma Nachrichten* 23 (45), pp. 61–71.

McKnight, Harrison D.; Chervany, Norman L. (2001): Trust and Distrust Definitions: One Bite at a Time. In Rino Falcone, Munindar Singh, Yao-Hua Tan (Eds.): Trust in Cyber- societies. Integrating the Human and Artificial Perspectives, vol. 2246. Berlin, Heidelberg: Springer (Lecture Notes in Computer Science, 2246), pp. 27–54.

Middelweerd, Anouk; Mollee, Julia S.; van der Wal, C. Natalie; Brug, Johannes; Te Velde, Saskia J. (2014): Apps to promote physical activity among adults: a review and content analysis. In *The international journal of behavioral nutrition and physical activity* 11. DOI: 10.1186/s12966-014-0097-9.

Schelewsky, Marc; Jonuschat, Helga; Bock, Benno; Stephan, Korinna (Eds.) (2014): Smartphones unterstützen die Mobilitätsforschung. Neue Einblicke in das Mobilitätsverhalten durch Wege-Tracking. Wiesbaden: Springer Vieweg.

Weiber, Rolf; Mühlhaus, Daniel (2014): Strukturgleichungsmodellierung. Eine anwendungsorientierte Einführung in die Kausalanalyse mit Hilfe von AMOS, SmartPLS und SPSS. 2., erw. und korr. Aufl. Berlin: Springer Gabler (Springer-Lehrbuch). Available online at http://dx.doi.org/10.1007/978-3-642-35012-2.

Weyer, Johannes; Delisle, Marc; Kappler, Karolin; Kiehl, Marcel; Merz, Christina; Schrape, Jan-Felix (2018): Big Data in soziologischer Perspektive. In Barbara Kolany- Raiser, Reinhard Heil, Carsten Orwat, Thomas Hoeren (Eds.): Big Data und Gesellschaft. Wiesbaden: Springer Fachmedien Wiesbaden (Technikzukünfte, Wissenschaft und Gesellschaft / Futures of Technology, Science and Society), pp. 69–149.

Weyer, Johannes; Fink, Robin D.; Adelt, Fabian (2015): Human–machine cooperation in smart cars. An empirical investigation of the loss-of-control thesis. In *Safety Science* 72, pp. 199–208. DOI: 10.1016/j.ssci.2014.09.004.

Windrum, Paul; Fagiolo, Giorgio; Moneta, Alessio (2007): Empirical Validation of Agent- Based Models: Alternatives and Prospects. In *Journal of Artificial Societies and Social Simulation* 10 (2). Available online at http://jasss.soc.surrey.ac.uk/10/2/8.html.

Yan, Zheng; Dong, Yan; Niemi, Valtteri; Yu, Guoliang (2013): Exploring trust of mobile applications based on user behaviors. An empirical study. In *J Appl Soc Psychol* 43 (3), pp. 638–659. DOI: 10.1111/j.1559-1816.2013.01044.x.

Algorithmic social ordering. Towards a conceptual framework

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Introduction

As the possibilities of digital technology continue to expand, its advance into more and more parts of everyday life and societal organization seems to assume a new quality. Increasingly, automatic information and decision-making systems are used to structure social processes, replace human judgement and generate order, as captured in the concepts of "algorithmic management" (Lee et al. 2015), "algorithmic regulation" (Yeung 2017a), "algocracy" (Aneesh 2009) and "governance by algorithms" (Just & Latzer 2017). It seems that governance and management is becoming more granular, subtle, responsive, encompassing and networked. Given the enormous possible consequences, we aim to contribute to a systematic understanding of these developments by analysing them from a particular conceptual perspective: the intersection of regulation and quantification.

Our general approach is shaped by the question of social order and the mechanisms of its establishment and perpetuation. In the social sciences this foundational problem usually refers to societies in general, as in Hobbes's political thought and its sociological interpretation by Talcott Parsons (1966), but it is also central for processes at the micro- and meso-level. Following Berger and Luckmann, we stress that social order is "an ongoing human production" (Berger & Luckmann 1991, 69), and propose to analyse the current societal transformations from the perspective of regulation as a specific form of such social ordering.

With Julia Black, we understand regulation as "the sustained and focused attempt to alter the behaviour of others according to defined standards or purposes with the intention of producing a broadly identified outcome [...]." (Black 2002, 26) It is set apart from other forms of social ordering in four main dimensions. Unlike tradition or the habitus, it is intentional. Unlike spontaneous acts of violence, its perspective is one of permanence. Unlike government, it includes a variety of actors beyond the state. And unlike Weber's domination, it is analytically independent of legitimacy. We believe that by developing a clear conceptual understanding of regulation and its technological components, we will be able to track the implications of the digital transformation for regulation and social ordering more generally. Informed by cybernetics, Christopher Hood, Henry Rothstein and Robert Baldwin (2001) have developed such an analytical framework for regulation, dissecting it into three components: information gathering, standard setting, and behaviour modification.

In order to address the problems at hand, we draw on and aim to contribute to three main strands of literature.

The sociology of quantification, valuation and classification has recently gained importance due to a an expansion of rankings, ratings and scores. It discusses the causes and consequences of the growing reliance on numbers in all parts of society. By transforming a continuous reality into a discrete representation, quantification promises to render human affairs increasingly commensurable and calculable, thereby increasing possibilities for control (Mau 2017). But while some authors have emphasized the role of digital technology in this process, until now we lack an understanding both of the concrete technological logic and the broader social implications of these processes. Supported by the spread of ever more powerful computer

technology, quantification increasingly assumes the form of an immense datafication. "Big data" and the "data deluge" are looming over an increasing number of segments of modern society. We believe that a conceptual understanding of algorithmic regulation could make a contribution here.

Another crucial point of reference is the literature on regulation. While a large part of regulatory studies has pursued a "command and control" (Black 2002) view of regulation with a strong focus on the state and its legal tools, more recently a part of the literature has turned towards a wider and more decentred understanding of regulation. Furthermore, notions such as "code is law" (Lessig 2006) or "regulation by design" (Yeung 2008) have disclosed the role of technology in regulation. These analyses provide a valuable starting point, but especially regarding the technological dimension of regulation a lot of work still remains to be done.

Finally, science, technology and society studies provide our primary access point to understanding the interaction between technological artefacts and social processes. Bruno Latour and others have proposed a shift towards a "sociology of associations" (Latour 2005) that cultivates an interest in the complex entanglements and assemblings of human and non-human actants. It is in such a way that we are enabled to study the myriad of small changes that add up to the rise of new digital forms of regulation and regulatory regimes.

Bridging the three literatures promises a fruitful and original perspective from which digitalization becomes visible as a non-linear, socially constructed and inherently political process. In the following we will sketch a conceptual framework that can guide such research.

A framework for studying algorithmic regulation

Our starting point for the analysis of regulation is a classic framework from regulatory studies, first spelled out by Hood, Rothstein and Baldwin (2001). This perspective adopts a cybernetic angle by analyzing regulation along the three components of information gathering, standard setting and behaviour modification. Karen Yeung (2017a) has drawn on this approach in her recent analysis of what she, adopting the term from O'Reilly (2013), refers to as algorithmic regulation. Her systematization is a valuable step towards a conceptual framework that we would like to build on by extending it with a number of further analytical distinctions.

The first component is that of *information gathering*, which is any form of collecting knowledge about some segment of reality that is to be regulated. It involves an epistemic process of construction based on information as well as their interpretation and modelling (Mahr 2003). The increasing datafication of both processes has led to the current duality of big data and machine learning. Karen Yeung has distinguished between reactive and preemptive information gathering, where the former uses given data to detect violations and the latter uses it to predict future behaviour (Yeung 2017a). For a further analysis, Bruno Latour's notion of "immutable mobiles" provides a fruitful starting point. Immutable mobiles for him are inscriptions that are "mobile but also immutable, presentable, readable and combinable with one another" (Latour 1990a) and thereby allow control at a distance. In an iconic way, this is illustrated by the map that makes it possible to control the territory.

With Latour we can analyze modern digital information systems as an environment for new and more effective forms of immutable mobiles, which crucially rely on what Adrian MacKenzie, in his ethnography of machine learning, has called "vectorization": the "drawing together" of a variety of heterogeneous aspects of reality into a mathematically well described feature space in which

every concrete object can be represented as a vector (MacKenzie 2015). But every such vector is characterized by a complexity gap towards the reality it describes, which is why Susan Star concludes that no mobiles are completely immutable (Star 1995, 91). The local specificities undermine the modular and standardized descriptions of immutable mobiles. James Scott has developed the concept of "legibilization" (Scott 1998) to describe such simplifications aimed at control for the pre-digital world and we think it is highly relevant for the digital one as well.

In order to analyze the strategic implications of such immutable mobiles as tools of legibilization, we propose to look at different kinds of algorithmic tools that can be employed in epistemic models for regulation. Examples would be simple deductive models along an IF-THEN logic, statistical models gained from training sets through supervised learning or mathematical optimization procedures that recommend analytically optimal behaviour. These tools, along with Slota's and Bowker's recent remark (2016) that knowledge is temporalized in new ways through algorithms, suggest that regulation might become more and more adaptive.

The second, primarily normative component is that of *standard setting*. It refers to the goals that are to be obtained by regulation. Karen Yeung distinguishes between fixed and adaptive standards, i.e., those that are determined once and for all and those that can change over time (Yeung 2017a, 3).

In order to become social realities, goals and standards of regulation undergo a process of definition, translation and calculation. No goal or standard 'speaks for itself', it needs indicators to be accessible and assessable. Goals and standards can take various forms: they can be shaped by a social domain or by a discipline, as in the case of the conflict between technical and legal standards; they can be area-specific, as in public health or commercial services; they can be abstract, like democratic values or customer satisfaction, or specific, like a 5% increase in users who are over 40 or a 1 pound weight loss within a month. The measurement can be quantitative or qualitative, direct or indirect, objective or subjective and absolute or relational. Whereas rules are always subject to interpretation due to the indeterminacy of language, code is binary and, even if not accurate, inherently determined. In order to be processed by algorithms, developers need to define their goals and standards in a way that can be applied to the data available. This requires the operationalization of broader goals that breaks them down into a variety of measurable entities. A specificity of algorithmic regulation is then the easy combination of more stable general goals and adaptive sub-standards.

Behaviour modification, finally, encompasses the effective dimension of regulation: the actions through which a decision is enforced. It is the attempt to move the regulated entity closer towards a desirable state by deploying appropriate means. Yeung distinguishes between such systems that automatically administer specific sanctions or decisions and those that keep a human "on the loop" (ibid., 4), but while being useful, this distinction reveals little about how behaviour is actually modified.

From the perspective of behaviour modification, regulation is successful to the extent that undesired forms of behaviour are rendered improbable. It is therefore dependent on a relation of strength and resistance or, in Latour's words, on a relation between "programs" and "anti-programs" (Latour 1990b, 105ff.). "Programs" are those factors that contribute to steering the behaviour of a particular entity — be it human or not — in a direction deemed desirable. Modifying behaviour thus means mobilizing all available programs from which desired effects can be expected. "Anti-programs", in contrast, refer to all the factors moving a particular entity in

a direction other than the one desired (Latour 1992; 1990b, 105). This category encompasses everything that increases the likelihood a regulatory attempt fails (from the viewpoint of the regulator). If a program is to be successful, it thus has to neutralize all anti-programs, i.e., all counteracting factors, so that the entity in question behaves in the desired way.

In his famous vignette about a hotel manager trying to ensure that guests leave their room keys at the counter before going for a walk, Latour points out two strategies for developing successful programs: acting on the customers and their interpretation of the world or acting on the key itself by attaching a weight to it that makes it uncomfortable to carry around (Latour 1990b). For Latour, this is the distinction between incorporation and excorporation. Elaborating on these two notions is a useful way of discerning types of behaviour modification.

Incorporation operates through the modification of the inner working of the regulated entity. In Foucauldian terms, we could speak of processes of subjectivation (Foucault 1990) and discipline (Foucault 1995, 135ff.): of internalizing subjective norms and values and creating bodily or mental routines and conditioning. An example of the former can be found in "lifelogging" and related practices of data-based self-monitoring that affect individuals' subjectivities and, thus, their individual behaviour, e.g., by increasing sporting activity (Schaupp 2016). The latter form of incorporation is employed, for instance, in what Fogg calls "conditioning technology", i.e., "[c]omputing technology [using] positive reinforcement to shape complex behaviour or transform existing behaviors into habits" (Fogg 2003, 53; see also Berlin Script Collective 2017, 24).

Excorporation, in contrast, focusses on environments and situations rather than on individuals themselves. Madeleine Akrich's (1992) analysis of how innovators inscribe normative assumptions into technology is instructive here. Building on a recent paper by the Berlin Script Collective (2017), we can distinguish three types of such behaviour modification through technological environments: *coercion*, *inducement* and the *initiation of re-interpretations* through the provision of knowledge. In each of these three cases, behaviour modification operates by (re)arranging the environment — e.g., through laws, taxes, or information campaigns — in such a way that the desired behaviour is rendered the most (instrumentally or normatively) rational option. To these three types of excorporate behaviour modification that make use of the rational capacities of individuals we add a fourth one which we term *influence through non-rational properties*: This type of influence makes use of the non-rational aspects of human behaviour and has been popularized by the debate about "nudges" and their mechanisms that exploit "heuristics and biases" (Thaler & Sunstein 2008; for digital environments, this kind of influence has also been explored by Yeung 2017b). The "status quo bias" for instance can be utilized through purposeful setting of technological defaults. As the fields of Persuasive Computing and Human-Computer Interaction show, digital technologies can be applied in all four of these types. Concluding this brief sketch of the framework, it is important to note that the three components should not be understood as successive phases. In reality, they are always intertwined, as the following case illustrates.

The example of Uber

As an illustration, the framework is now applied to the well-researched case of the personal transportation platform Uber and its regulation of drivers. Uber drivers usually register with the app and then indicate that they are currently available for work. While they are, they will be

matched with a nearby waiting customer, which they can accept or decline. If they accept, they are expected to pick up the customer and take them to their destination along a route suggested by the app. After the ride, the driver receives a rating from the customer. For the following discussion we apply our framework to the empirical descriptions by Lee et al. (2015), Rosenblat and Stark (2016) and Scheiber (2017).

Information gathering: Firstly, our framework focuses on the ways in which the regulatees and the environment are modelled by Uber, i.e., which aspects are digitally represented, which information is gathered and how that information is then used to shape the whole work process. Uber records and processes various kinds of information through its app and the sensors integrated in smartphones. This includes the locations of drivers and customers, but also aspects of the drivers' driving behaviour, for instance, their braking and accelerating. Furthermore, map data, traffic information and the location of other drivers are taken into account.

However, other aspects such as the altruistic and non-economic motivations of drivers, the condition of the car or the road, the emotional state of the customer, the traffic policy of the city or the current weather are, to our knowledge, not taken into account. It has to be stressed at this point that it is Uber alone who defines what kinds of information are gathered — not the drivers, nor the customers.

Standard setting: Uber's general goal of maximizing revenue is broken down into a number of secondary standards which Uber deems fitting to achieve that goal: Optimally matching drivers with passengers for short pickup times, suggesting to take Uber-chosen routes, reaching a smooth driving behaviour, realizing a maximum price for the ride and improving the customers' experience are among them.

Through a universal rating system, standard setting procedures are partly delegated from the company to customers. After each ride, passengers evaluate their drivers through a five-star rating system, without being restrained in their choice of criteria. This feature renders the regulatory process decentral and dynamic because behaviour that got a driver five stars last month may not get them five stars today. Here, too, it is insightful to look at those standards that were seemingly *not* deemed relevant by Uber, such as the drivers' health and happiness or ecological aspects.

Behaviour modification: For the sake of brevity this analysis is limited to the excorporate behaviour modification of drivers. Interestingly, all of the four types described above can be found in the case of Uber.

1) Fear of coercion is used in the mechanism that drivers whose ratings fall below a certain level, or who repeatedly decline ride requests or cancel rides, lose access to their accounts and are excluded from the Uber market. Before this happens, the drivers receive warnings, which are — of course — directly intended to change their behaviour.

2) Uber uses monetary inducement in a highly fine-grained and dynamic manner in order to facilitate a favourable allocation between supply and demand. This is achieved through so called "surge pricing", a temporary and local rise in fares after the system has identified a high demand in a certain area. This area will, for a limited time, be highlighted in red on the interactive map of the app.

3) The driving assistance by the Uber system corresponds to the initiation of re-interpretations. The most obvious means for this is the navigation function of the Uber driver app that ensures

drivers go in the right direction, which is essential for an enterprise specialized in transportation. Hence, local knowledge of streets and routes is not required for drivers. Preferably, drivers go along an Uber-chosen route. However, the criteria for suggesting a given route are not disclosed to the driver. It could be the shortest route or the route with maximum (or minimum) public visibility of the Uber car itself.

4) Fourth and last, sophisticated influence is exerted by exploiting the non-rational characteristics of drivers. For instance, Uber exploits people's "loss aversion", a phenomenon well-documented in behavioural economics, in a specific way: When drivers are about to log off, they receive a message reminding them of the money they would 'lose' by stopping now. For instance, one message reads "Are you sure you want to go offline? Demand is very high in your area. Make more money, don't stop now!" (Rosenblat & Stark 2016, 3768).

Further applications

The framework presented here is not limited to investigating the case of Uber. It can also shed light on other cases in which technological artefacts are used for regulation.

On the micro-level, we can analyse forms of technologically mediated self-regulation. Fitbits and other kinds of wearable fitness trackers which are supposed to improve their users' health are striking examples. Sleep trackers like WakeMate or energy use trackers like Wattvision enable similar kinds of self-regulation. A conceptual framework of regulation can add a fruitful perspective to the ongoing debate about the "quantified self" (Lupton 2016).

On the meso-level, we can analyse organizational regulation that is supported by artefacts or software. For instance, Raffetseder, Schaupp and Staab (2017) have investigated the software Salesforce that is able to automatically assign incoming tasks to employees, according to parameters such as current workload or experience. And recently, Amazon developed a wristband that vibrates when employees in warehouses place goods in the wrong shelves (Yeginsu 2018) – a form of excorporate behaviour modification that affords itself to quick incorporation.

Our framework also allows us to analyse how whole populations or sub-populations are regulated with the help of technology. Examples are computer-assisted forms of organizing the criminal justice system (such as the ambitions of predictive policing products like PredPol or sentencing software like Northpointe's COMPAS), the automated curation of media content practiced by Facebook through its Newsfeed algorithm or the spectacular vision of a unified citizen score that currently haunts the newspapers with regards to the plans and actions of the Chinese government.

Politicization

Another advantage of this framework is that it sheds light not only on the ways in which algorithmic regulation operates, but also on the ways in which it is contested and politicized. Many of the conflicts around algorithmic regulation can be attributed to one of the three components.

Some conflicts mainly focus on the gathering and the modeling of data. For instance, many privacy debates centre on the question who has the right to use which information, or which categories of information are really necessary for providing a service (for the case of Uber, see Zakrzewski 2015). In other cases, users request not less but more categories, for example

concerning gender identities on Facebook (Bivens 2017). In a third group of cases, users dispute the validity of inferred categories, for example the prediction of sexual orientation from Facebook posts.

Standard setting is also a major site of contestation. Often, there are conflicts about the purposes that are being served and about the indicators against which success is measured. Many of debates also focus on the transparency and accountability of algorithmic decisions (Pasquale 2015; Ananny & Crawford 2018), for instance when people demand knowing how their creditworthiness is determined.

When it comes to behaviour modification, conflicts arise about what instruments are legitimate and adequate. The current debates over the legitimacy of nudges (White 2013; Sunstein 2016) or about political microtargeting (Zuiderveen Borgesius et al. 2018) provide vivid examples. In essence, these are debates about whether certain forms of exerting influence can be reconciled with human dignity or democracy.

The conflicts surrounding each of the three components also point towards what different forms of algorithmic regulation might look like. They show that there are other possible ways of gathering and processing information, other ways of defining goals, and other ways of influencing people. By criticizing the status quo, and by articulating other possibilities, the persons involved insist that there is a choice between different forms of establishing social order. In this sense, each of the three components, or all of them, can become politicized.

Conclusion

In this contribution, we have, in due brevity, sketched a framework for analysing regulation in different spheres of society. As an illustration of its applicability, we have shown cursorily how the regulation of drivers by Uber can be made sense of. Additionally, we have pointed towards other examples of information gathering, standard setting, and behaviour modification. We think that the framework presented above can make at least four contributions to science, technology and society studies. Firstly, it further differentiates the ways in which behaviour can be influenced through technology by taking into account a number of different theoretical angles. Secondly, focusing not only on influence, but also on data, models, and standards allows us to trace how different kinds of regulation are composed by establishing links between different building blocks. Thirdly, this framework helps us make sense of the digital transformation precisely because it is not limited to it; rather, we can compare digital and non-digital ways of regulation, and can thus determine what is and what isn't unique about the digital transformation. Lastly, it allows us to distinguish various forms of political struggles around algorithmic regulation by directing scholarly attention to the regulatory components that are being politicized.

Of course, the framework is no end in itself, but has to prove itself in empirical work. Future research will therefore be dedicated to refining it and using it to conduct comparative research. As a result of this, we hope to identify typical combinations of attributes across the three components. Such clusters would then allow a more detailed and contextualized understanding of algorithmic regulation and might point to strategies typical for specific spheres of society or levels of organization. Finally, such an analytical approach therefore promises a better informed diagnosis about how social order is established and maintained in the digital age.

Literature

Akrich, Madeleine (1992), 'On the De-Scription of Technical Objects', in Bijker, Wiebe E. and John Law (Eds.), *Shaping Technology / Building Society*, Inside Technology. Cambridge, MA: MIT Press, 205–224.

Ananny, Mike and Kate Crawford (2018), 'Seeing without Knowing: Limitations of the Transparency Ideal and Its Application to Algorithmic Accountability', *New Media & Society* 20 (3): 973–989.

Aneesh, Aneesh (2009), 'Global Labor: Algocratic Modes of Organization', *Sociological Theory* 27 (4): 347–370.

Berger, Peter L. and Thomas Luckmann (1991), *The Social Construction of Reality: A Treatise in the Sociology of Knowledge*, London: Penguin.

Berlin Script Collective (2017), 'Comparing Scripts and Scripting Comparisons. Toward a Systematic Analysis of Technologically Mediated Influence', *Technical University Technology Studies Working Papers*, Berlin: Technische Universität Berlin, http://www.ts.tu-berlin.de/fileadmin/i62_tstypo3/TUTS-WP-1-2017_ComparingScripts.pdf [downloaded 22 July 2018].

Bivens, Rena (2017), 'The Gender Binary Will Not Be Deprogrammed: Ten Years of Coding Gender on Facebook', *New Media & Society* 19 (6): 880–898.

Black, Julia (2002), 'Critical Reflections on Regulation', *Australian Journal of Legal Philosophy* 27: 1–37.

Fogg, B. J. (2003), *Persuasive Technology: Using Computers to Change What We Think and Do*, Amsterdam/Boston, MA: Interactive Technologies.

Foucault, Michel (1990), *The History of Sexuality: The Use of Pleasure*, New York: Vintage Books.

Foucault, Michel (1995), *Discipline and Punish: The Birth of the Prison*, New York: Vintage Books.

Hood, Christopher, Henry Rothstein, and Robert Baldwin (2001), *The Government of Risk: Understanding Risk Regulation Regimes*, Oxford/New York: Oxford University Press.

Just, Natascha and Michael Latzer (2017), 'Governance by Algorithms: Reality Construction by Algorithmic Selection on the Internet', *Media, Culture & Society* 39 (2): 238–258.

Latour, Bruno (1990a), 'Drawing Things Together', in Lynch, Michael and Steve Woolgar (Eds.), *Representation in Scientific Practice*, Cambridge, MA: MIT Press, 19–68.

Latour, Bruno (1990b), 'Technology Is Society Made Durable', *The Sociological Review* 38 (1 (Suppl.)): 103–131.

Latour, Bruno (1992), 'Where Are the Missing Masses? The Sociology of a Few Mundane Artifacts', in in Bijker, Wiebe E. and John Law (Eds.), *Shaping Technology / Building Society*, Inside Technology. Cambridge, MA: MIT Press, 225–258.

Latour, Bruno (2005), *Reassembling the Social: An Introduction to Actor-Network-Theory*, Oxford: Oxford University Press.

Lee, Min Kyung, Daniel Kusbit, Evan Metsky, and Laura Dabbish (2015), 'Working with Machines: The Impact of Algorithmic and Data-Driven Management on Human Workers', in Begole, Bo and Jinwoo Kim (Eds.), *Proceedings of the 33rd Annual ACM Conference on Human Factors in Computing Systems*, New York: ACM, 1603–1612.

Lessig, Lawrence (2006), *Code: And Other Laws of Cyberspace: Version 2.0*, New York: Basic Books.

Lupton, Deborah (2016), *The Quantified Self: A Sociology of Self-Tracking*, Cambridge: Polity.

Mackenzie, Adrian (2015), 'The Production of Prediction: What Does Machine Learning Want?', *European Journal of Cultural Studies* 18 (4–5): 429–445.

Mahr, Bernd (2003), 'Modellieren. Beobachtungen Und Gedanken Zur Geschichte Des Modellbegriffs', in Krämer, Sybille and Horst Bredekamp (Eds.), *Bild - Schrift - Zahl*, Paderborn: Fink, 59–86.

Mau, Steffen (2017), *Das metrische Wir: Über die Quantifizierung des Sozialen*, Berlin: Suhrkamp.

O'Reilly, Tim (2013) 'Open Data and Algorithmic Regulation'. In Goldstein, Brett and Lauren Dyson (Eds.), *Beyond Transparency: Open Data and the Future of Civic Innovation*, San Francisco: Code for America Press, 289–300.

Parsons, Talcott (1966), *The Structure of Social Action: A Study in Social Theory with Special Reference to a Group of Recent European Writers,* New York/London: The Free Press; Collier-Macmillan.

Pasquale, Frank (2015), *The Black Box Society. The Secret Algorithms That Control Money and Information*, Berlin/Boston, MA: Harvard University Press.

Raffetseder, Eva-Maria, Simon Schaupp, und Philipp Staab (2017), 'Kybernetik und Kontrolle. Algorithmische Arbeitssteuerung und betriebliche Herrschaft', *PROKLA* 187: 229–248.

Rosenblat, Alex and Luke Stark (2016), 'Algorithmic Labor and Information Asymmetries: A Case Study of Uber's Drivers', *International Journal of Communication* 10: 3758–3784.

Schaupp, Simon (2016), 'Measuring the Entrepreneur of Himself', in Selke, Stefan (Ed.), *Lifelogging*, Wiesbaden: Springer, 249–266.

Scheiber, Noam (2017), 'How Uber Uses Psychological Tricks to Push Its Drivers' Buttons', *The New York Times*, https://www.nytimes.com/interactive/2017/04/02/technology/uber-drivers-psychological-tricks.html [22 June 2018].

Scott, James C. (1998), *Seeing like a State: How Certain Schemes to Improve the Human Condition Have Failed*, New Haven, CT: Yale University Press.

Slota, Stephen C. and Geoffrey C Bowker (2016), 'How Infrastructures Matter', in Felt, Ulrike, Rayvon Fouché, Clark A. Miller, and Laurel Smith-Doerr (Eds.), *The Handbook of Science and Technology Studies*, Cambridge, MA: MIT Press, 529–554.

Star, Susan Leigh (1995), 'The Politics of Formal Representation: Wizards, Gurus, and Organizational Complexity', in Star, Susan Leigh (Eds.), *Ecologies of Knowledge: Work and Politics in Science and Technology*, Albany, NY: State University of New York Press.

Sunstein, Cass R. (2016), *The ethics of influence: government in the age of behavioral science*, New York: Cambridge University Press.

Thaler, Richard H. and Cass R. Sunstein (2008), *Nudge: Improving Decisions about Health, Wealth, and Happiness*, New Haven: Yale University Press.

White, Mark D. (2013), *The manipulation of choice: ethics and libertarian paternalism*. New York: Palgrave Macmillan.

Yeginsu, Ceylan (2018), 'If Workers Slack Off, the Wristband Will Know. (And Amazon Has a Patent for It.)', *The New York Times*, https://www.nytimes.com/2018/02/01/technology/amazon-wristband-tracking-privacy.html [29 June 2018].

Yeung, Karen (2008), 'Towards an Understanding of Regulation by Design', in Brownsword, Roger and Karen Yeung (Eds.), *Regulating Technologies: Legal Futures, Regulatory Frames and Technological Fixes*, London: Hart Publishing, 79–107.

Yeung, Karen (2017a), 'Algorithmic Regulation: A Critical Interrogation', *Regulation & Governance*, 1–19, https://doi.org/10.1111/rego.12158.

Yeung, Karen (2017b), '"Hypernudge": Big Data as a Mode of Regulation by Design', *Information, Communication & Society* 20 (1): 118–136.

Zakrzewski, Cat (2015), 'Senator Al Franken's Concerns About Uber's Privacy Policy Linger', *TechCrunch* (blog), http://social.techcrunch.com/2015/01/27/senator-al-frankens-concerns-about-ubers-privacy-policy-linger/ [22 July 2018].

Zuiderveen Borgesius, Frederik J., Judith Möller, Sanne Kruikemeier, Ronan Ó Fathaigh, Kristina Irion, Tom Dobber, Balazs Bodo, and Claes de Vreese (2018), 'Online Political Microtargeting: Promises and Threats for Democracy'. *Utrecht Law Review* 14 (1): 82–96.

Risk and Value: Design of a Framework to Resolve the Social Dilemmas of the World Wide Web

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Abstract

The rapid proliferation of the World Wide Web (WWW) has had a significant effect on society. There is considerable debate about the modalities to deal with sociological dilemmas that have emerged as a consequence of this proliferation. This study proposes the design of a framework that resolves sociological dilemmas through a sequence of activities that involve 1) identification of value; 2) risk analysis; 3) deployment of controls and 4) periodic monitoring and review on whether value is being accrued. This sequence and the various activities are elucidated. A method for validation of the framework is also suggested. The study concludes with recommendations on how to develop and deploy the design into a working model that will lead to a society more at peace with its virtual presence.

Introduction

The concept of risk has been well theorized in the context of reflexive modernization[1]. Althaus posited risk to be an "ordered application of knowledge into the unknown". Its epistemological roots may be traced to an inter-disciplinary core; wherein lies uncertainty and ordered randomness. Uncertainty of consequences characterizes most human endeavors in the current milieu. Risk impacts studies in numerous domains; salient amongst these being engineering, economics, finance, psychology, anthropology and sociology. DiMaggio et al reviewed the social implications of the internet on the issues of 1) inequality; 2) social capital formation; 3) political impact; 4) organizational transformation; and 5) cultural impact. One of their findings was that even though the internet presented a moving target, the study of the internet by sociologists was critical. They felt a requirement to "synthesize research findings on individual user behavior with macroscopic analyses of institutional and political-economic factors that constrain that behavior." In the seventeen years that have elapsed since their work, the study of identity and privacy as a 'right' in society have developed as realms of sociological focus vis-à-vis the internet. I posit that an iterative risk analysis based on analytics offers an effective tool to resolve the sociological dilemmas arising from the World Wide Web (WWW); and propose to design a framework to do so.

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1   the term is attributed to Ulrich Beck in **Risk Society: Towards a New Modernity, 1992;** refers to the way in which advanced modernity 'becomes its own theme', in the sense that 'questions of the development and employment of technologies (in the realms of nature, society and the personality) are being eclipsed by questions of the political and economic "management" of the risks of actually or potentially utilized technologies – discovering, administering, acknowledging, avoiding or concealing such hazards with respect to specially defined horizons of relevance.

The WEB Effect and Dilemmas

There is little debate on whether the internet[1] has affected society. There *is* however substantial debate on the modalities and the extent to which the internet is transforming our social structure. Gainous and Wagner (2014), while offering a social critique of the internet investigated various social dilemmas that are a consequence of the internet. They have examined the implications of the internet on: 1) techno-ethics of information technology in a digital society; 2) cyber-activism and potential failures in enhancing political institutions; 3) social cognition in the age of social networking; 4) requirements in informed consent for individuals participating in testing in the realm of scientific research; 5) web impact on political issues viz., election campaigns, political communication and public opinion; and 6) the dilemmas encountered in data sharing during academic research. David Souter (2012) observed that while the internet had enhanced the netizens' ability to exercise the basic human rights of freedom of expression, assembly, association and information, it had also led to new ways in which certain rights can be infringed:

> " …changes in expression, association and privacy, together with other societal changes resulting from the internet, have disrupted historic understandings of the relationships or balances between some rights within the international human rights regime... particularly so where new forms of expression and new scope for expression have enabled violations of protective rights such as those concerned with security, defamation, hate speech, discrimination, and child protection. In some cases, these relationships or balances may be fundamentally reshaped."

Akesson et al (2014) propose a large scale and inter-disciplinary approach to social and ethical challenges in the digital ecosystem – especially in instances with underlying conflict of interest. The conflict of interest of interests manifests itself in several ways globally; the nature of that conflict is diverse, yet distinctly local in its form and content.

The concept of a social dilemmas itself has been described by Kollock (1998) as "situations in which individual rationality leads to collective irrationality". In characterizing a dilemma he writes that

> "a group of people facing a social dilemma may completely understand the situation, may appreciate how each of their actions contribute to a disastrous outcome, and still be unable to do anything about it".

He has proposed several solutions to social dilemmas. Salient amongst these involve value orientation, communication, group reciprocity, social learning and even social structural changes after the cause has been identified. This paper attempts to resolve the social dilemma of the internet through a framework based on value identification, risk analysis, and judicious deployment of controls. The basic premise is that value systems vary as per divergent social structures. The manner in which these divergent social structures respond to disruptive

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1   The Internet is a massive network of networks, a networking infrastructure. It connects millions of computers together globally. The World Wide Web, or simply Web, is a way of accessing information and services over the medium of the Internet. It is an information-sharing model that is built on top of the Internet. In this paper, the terms WWW and internet are used interchangeably.

technologies like the internet varies greatly as per theses values. A universal set of rules cannot be applied without acknowledging this divergence in society. Furthermore, this divergence causes conflict, especially when carried forward to sub-groups within regional societies. Regions characterized by significant ethnic and cultural diversity (viz. Southeast Asia and central Africa) are especially vulnerable to these conflicts. Norms thus have to be adjusted to the needs of a society with an appropriate level of granularity. Risk analysis, when used to deploy the control structure to resolve the dilemmas (and possible conflicts) has the potential of not only reduce the probability of conflict, but also resolve instances of social dilemmas that arise from the proliferation of the WWW by society and its netizens.

Value, Risk, and Threats

Value. Alaine de Vulpian[1] developed a system for determining social value in French society in the 1960s. It was qualitative research, based primarily on in-depth, one-on-one interviews with respondents. Hameed (2011) has suggested a smart data filtration tool (SDF) for web-based education that filters data considered harmful from moral, religious and social perspective in Malaysia. Chung (2007), from S Korea predicted that information technology would serve as a catalyst for changes of society and culture as well as the development for new ways of life; positive or negative depending on how we use it. Without due analysis, incorrect inferences about the role of the internet in society may accrue as a consequence of sensational events.

The internet is often characterized as a risk-promoting environment. Risk management involves the identification and prioritization of threats; thus helping the stakeholders to better deal with risk that the netizen faces on the internet, and to provide the stakeholders a platform on which they can resolve their (occasionally) conflicting objectives. This will ultimately lead to increased empowerment for the vulnerable netizen. During my PhD research I used a questionnaire[2] (attached at Appendix 'A') to prioritize the threats in order of severity in urban India. A similar questionnaire can be used to locally obtain value judgments from the netizen. I posit that value attached to a specific issue is characterized by being primarily local – and highly temporal. It is critical however, to ascertain the value quotient of a social dilemma vis-à-vis the internet if the dilemma is to be resolved; primarily because the resolution involves the deployment of controls that require resources. Risk analysis, (a methodology under the overall realm of risk management) is used to determine the optimal deployment of these resources.

Risk Analysis. Among the several interpretations of risk detailed by Althus (ibid.), I choose the one where risk is the *threat* of a detrimental eventuality, the nature and extent of which can be stochastically forecast. For the framework, a methodology to 'operationalize' risk analysis is

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1   The social values assessment methodology developed in the 1960s was invented in response to a wish to understand the evolution and meaning of the spontaneous rejection of traditional values and institutions among youth in French society at that time. Details can be had at http://environicsresearch.com/what-are-social-values
2   The thesis was about the use of risk to protect the rights of the netizen in India. This paper is a continuation of my effort to use the internet for a fulfilled society that is more at peace with itself.

required. The probability, severity, and counter-measures[1], called **controls** are analyzed to enunciate a framework on which resources can be deployed. To manage the risk posed by threats, controls are deployed. ISO 27000:2005 describes a control as

> "any administrative, management, technical, or legal method that is used to manage risk. Controls are safeguards or countermeasures. Controls include things like practices, policies, procedures, programs, techniques, technologies, guidelines, and organizational structures."

They strengthen the ability of the asset to counter these threats. Non-deployment of controls to mitigate the threats may lead to the inadequate accrual of value. Controls have a cost as well as an overhead. They must therefore be applied judiciously. Furthermore, their deployment must inspire confidence in the netizen, while simultaneously having credibility with not only the local governing bodies, but also the concerned internet service providers (ISPs). The mechanism is illustrated in Figure 1.
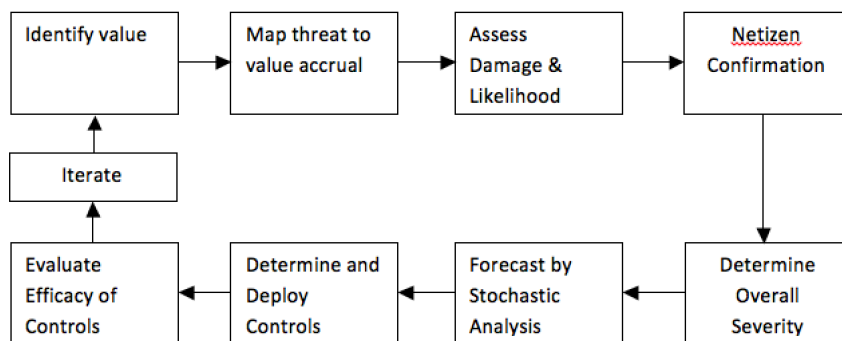
Figure 1 – Operationalizing Risk

Threats. According to the ISO 27005[2], risks emerge when "*threats abuse vulnerabilities of assets to generate harm for the organization*". For our purpose, 'asset' is the value identified. A threat is thus a specific scenario or a sequence of actions that exploits (through its vectors) a set of vulnerabilities associated with the accrual of value. Their identification is fundamental to risk analysis. There is a causal connection between the realization of a threat (or a threat vector) and the resolution of the dilemma. A threat can also be interpreted as any eventuality, if it occurs and goes unchecked will lead to the emergence of a dilemma. New forms and scope for expression by threat agents have also enabled violations of protective rights such as those concerned with security, defamation, hate speech, discrimination, and child protection. Advances in the Internet of Things (IoT) technologies and the ever increasing pervasiveness of digital services on the

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1   The Internet Engineering Task Force (IETF) RFC 2828 defines the term countermeasure as "an action, device, procedure, or technique that reduces a threat, vulnerability, or an attack by eliminating or preventing it, by minimizing the harm it can cause, or by discovering and reporting it so that corrective action can be taken."

2   ISO/IEC 27005 is part of a growing family of International Standards published by the International Organization for Standardization (ISO) and the International Electro-technical Commission (IEC) in the area of Information security management systems (ISMS) of International Standards is often referred to as the 'ISO/IEC 27000 series'; http://www.itgovernance.co.uk/

internet will render society increasingly vulnerable to threats. This will eventually enhance the volume and variety of the social dilemmas encountered[1]. The relationship between threats, vulnerabilities, and value is displayed in Figure 2.
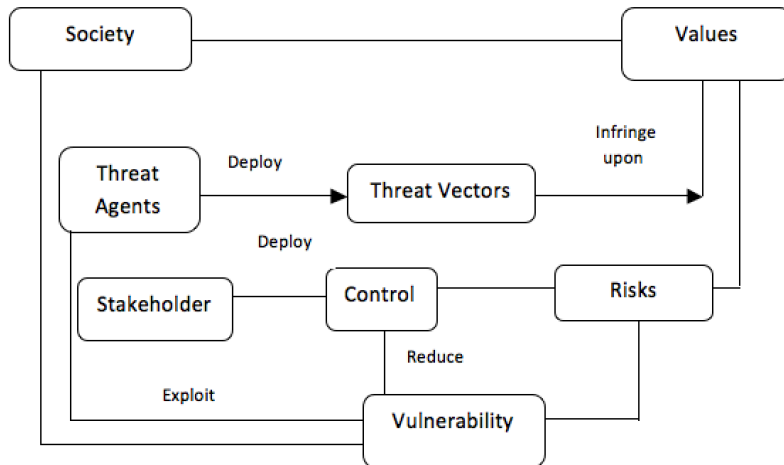
Figure 2: Threats, Vulnerabilities and Values

The primary stakeholders apart from the netizens in a society are: 1) the governing State, or regulatory authorities appointed by the State; 2) the application service providers (ASPs) who develop and deploy the service applications on the WWW and; 3) the internet service providers (ISPs) who provide the connectivity between the ASP and the netizen. There are several intermediaries apart from those identified. These intermediaries leverage state-of-the-art technologies like cloud computing and big data analytics. They can be grouped as sub-categories of the designated stakeholders however, for the purpose of designing the proposed framework.

The Framework

The design of a framework based on risk and values should be flexible enough to ride the inherent dynamism internet technologies. There have to be different approaches for handling the long and short fall-outs of a technology as pervasive as the WWW. I posit that in the short term, a utilitarian approach based on local preferences is more viable. Mill (1879) in his classic Utilitarianism has propounded the "the greatest-happiness principle"; while harmonizing it with basic morality. He opined that conventional morality is largely utilitarian in nature. Lucas and Galinsky (2005) have written that both risk and utilitarianism share common antecedent vis-à-vis the psychological basis of moral judgments, and that utilitarian choice is primarily studied in the context of moral dilemmas. Greene et al., (2001) have asserted that a utilitarian option optimizes benefits for the overall collective. It lays out a simple normative framework for maximizing

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1   An oblique threat for society stems from the fact that the instruments available to political sovereign states by the internet to pursue lawful objectives (e.g. crime prevention) are similar to those which the same governments might use to suppress rights (political dissent, freedom of speech, violation of privacy et al).

collective utility. While the accrual of happiness being the sole purpose of life is debatable, there is little doubt that ethical decision making should involve the participative effort of those it most affects. In the design of the proposed framework the primary objective is to be able to determine criteria for taking qualitative decisions on the nature of controls to be put in place for accruing the maximum value. The overall configuration of the framework is illustrated in Figure 3. This focus is on developing a consistent methodology for managing risk in accruing value. Regional diversity, netizen perception, expert opinion, and cost of controls to mitigate the risk due to consequent threats are factors that contribute to the accrual of pre-defined value thresholds. Assigning likelihood to, and damage caused by a specific threat requires the rationalization of conflicting aims and viewpoints of various agents in the information society. There is a risk of personal bias in assessing the risk itself. As Beck (1992) says "there is no expert on risk... many scientists do go to work with the entire impetus and pathos of their objective rationality, and their effort to be objective grows in proportion to the political content of their definitions." To facilitate communal harmony the design methodology has not only to be analytical, but necessarily deliberative. Webler (1999) argued that the judging the level of tolerable risk for a community should be the prerogative of the citizens; as they themselves are affected by the adverse effects of the technology. Security, especially cyber-security is an essential component of the design if the intended value is to be accrued through the process of risk analysis. Salvatti (2008) feels that security efforts are often more a "patchwork of concepts rather than a coherent framework". Security must be built into the design, and the framework continuously updated to keep it relevant to the prevailing threat scenario.
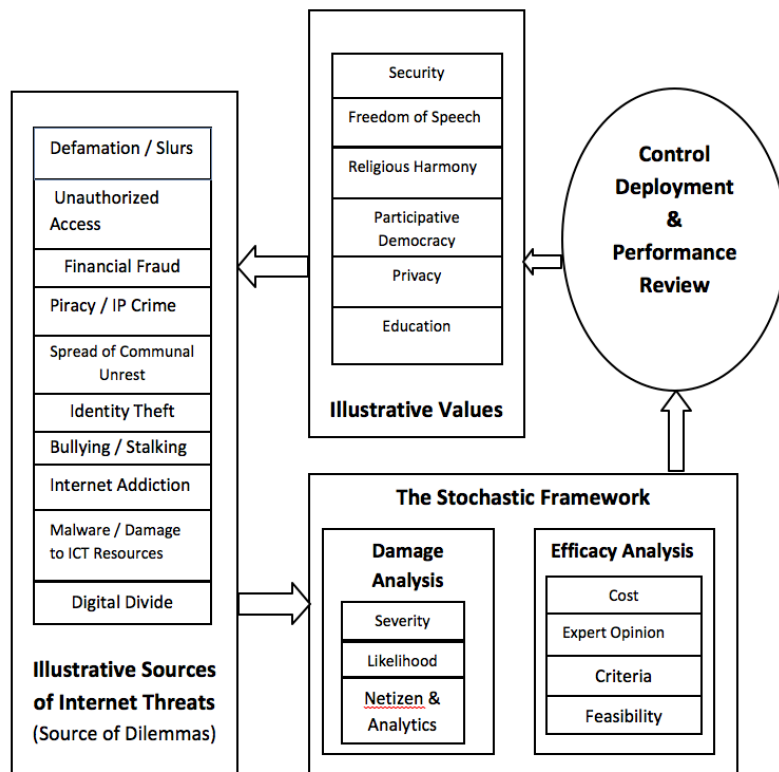
Figure 3: Overall Configuration of the Framework

The flow chart of the process is illustrated in Figure 4.
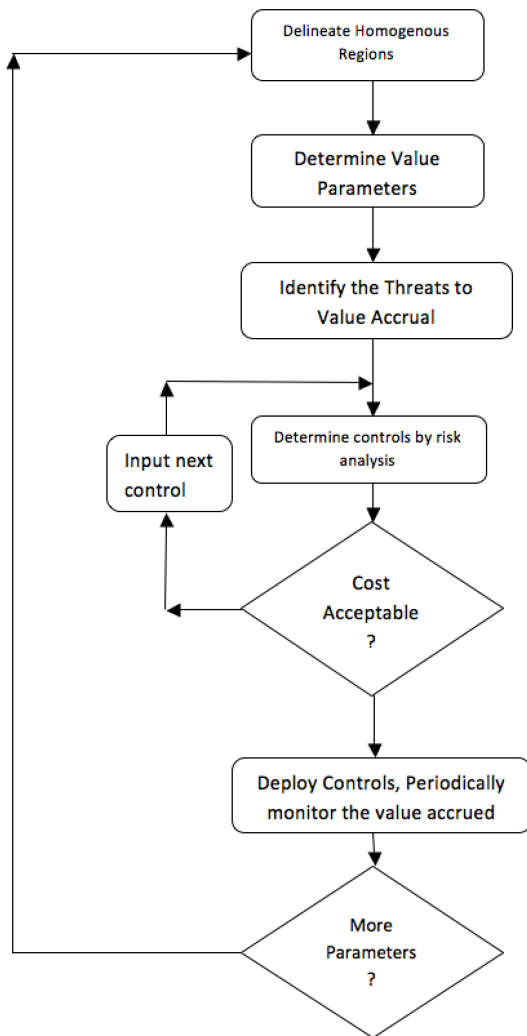
Figure 4: Flow Chart for Framework Design

The sequence of actions is detailed as follows:
- Define the geographical / social / economic bounds of a homogenously acceptable region. This is best done by the State or its designated representatives.
- Determine regional value parameters from the respective denizens of a region. The mechanics of the determination of value parameters and their relative priorities might go beyond mere polling, and involve the use of analytics and social media.
- Determine quantitatively the relative severity of the threats to each value parameter by conventional process of risk management. The severity is the product of the damage potential and the likelihood of the occurrence of the threat.
- Determine the bouquet of controls that will counter the threat. The controls finally deployed will depend upon the priority accorded to value parameter and the severity of the threat.

- Assess costs of each control and deploy optimally as per the value accrued.
- Monitor and review whether sufficient value has been accrued through netizen feedback, sentiment analysis, and social analytical tools. The value, threat and control parameters have to be continually tweaked till satisfactory results are obtained.

Validation Criteria

The validation criteria for a framework such as one described above is highly subjective and therefore to assess efficacy, it must be longitudinal in nature. It is critical that the same set of respondents assess the efficacy of controls as those who recommended the value criteria. Validation of a framework that is based on risk management concepts is empirical. The subjectivity of the sociological perspective is compounded by the personal bias of the netizen. Sjoberg (1999) claims that people tend to evaluate validity of a risk assessment on a large set of criteria; not all of which are universally applicable. Klinke (2002) feels that if public concerns are to be accepted, public studies should be the major heuristic rule for selecting the relevant criteria. The main criteria as relevant to this study are: 1) relative priority of threats; 2) credibility with the netizen; 3) risk aversion as a psychological phenomenon; and 4) degrees of trust and agreement amongst the various stakeholders. The internet tools of polling may be used for obtaining the 'voice of the netizen'. Advance analytics and big data processing techniques that are based on stochastic evaluation methods may be used to analyze the vast amount of web traffic to ascertain netizen sentiment. A time series analysis is preferable. Norms delineating stakeholder responsibility for deployment of specific set of controls must be specified and disseminated.

Conclusion

An attempt to resolve the social dilemmas emanating from the internet is primarily an interdisciplinary field of study. A more detailed study of the inter-relationship cost, efficacy, and the regressive risk involved in the deployment of controls may be carried out by use of techniques such as chi-square testing, multiple regression and multidimensional scaling. Data science algorithms based on statistical techniques need to confirm that the severities of threats and the efficacies of controls are effective from the perception of the netizen community. Any pilot study to that end must be a longitudinal, time series study with representative sample sizes. The benefit of expert opinion and experience may be accrued by the use of the Delphi technique in enhancing the integrity and reliability of the model as mentioned by Whitman and Mattord (2003) Only after due validation of its efficacy on the sample size (or necessary modifications therein) should it be deployed en masse; and even then constant monitoring and periodic review is required. Internet technology enables this. In this paper there is an amorphous delineation between value parameters, threats, and control efficacy. For realistic efficacy the delineation must be defined more lucidly. This is necessary if the framework is ever to be developed, tested, deployed and be useful.

Appendix 'A'
Research Survey Questionnaire: Basic Rights on the Internet

This research survey attempts to determine citizen opinion as to the extent the basic rights of the Indian citizen are threatened on the internet. On a scale of 1-10 (10 being the highest), please

grade the extent of the risk of violation of the rights mentioned that you feel when you are online (on the internet). For example if you feel that the risk of threat of online fraud is the highest, grade it as '10'; if you feel that the risk is minimal, grade it as '1'. Choose the appropriate value for partial risk; for example if you feel the risk is a medium level risk, choose '5"; or any value '1' to '10 which you feel is most appropriate for that right.

Ser. No.	Right that is under Threat	Grading
1	Protection from cyber crime; to include fraud, extortion, sabotage, vandalism, & terrorism	
2	Freedom of expression and association- arising from government censorship of the internet	
3	Equality arising by lack of opportunity due to non-availability of internet to certain sections of society	
4	Privacy (against governments, businesses, and other individuals)	
5	Protection of intellectual property rights	
6	Protection of social order and morality	
7	Protection against defamation	
8	Protection against promotion of caste and religious intolerance arising from the misuse of social networking sites on the internet	

Name (optional):   Age:

Qualification (highest):

Date:

References

Akesson M. and Thomsen M., *Digital Innovation and Social Dilemmas*, Creating Values For All Through IT: IFIP WG 8.6 International Conference on Transfer and Diffusion of IT, TDIT 2014, Aalborg, Denmark, June 2-4, 2014. Proceedings / [ed] Bergvall-Kåreborn, Birgitta & Nielsen, Peter Axel, Heidelberg; New York; Dordrecht; London: Springer Berlin/Heidelberg, 2014, p. 49-61.

Althus, C.,E., (2005), *A Disciplinary Perspective on the Epistemological Status of Risk,* Risk Analysis, Vol. 25, No. 3, 2005

Chung Inuk, *Roles and Impacts of IT on new Social Norms, Ethical Values and Legal Frameworks in Shaping a Future Digital Society* NSF/OECD Workshop – Washington, 31 Jan 2007, Social & Economic Factors Shaping The Future of the Internet https://www.oecd.org/sti/ieconomy/37985728.pdf

DiMaggio, P., Hargittai E., Neuman, W.R., and Robinson, J.P., *Social Implications of the Internet* Annual Review of Sociology August 2001. 27:307–36

Gainous J. and Wagner K., M., Tweeting to Power: The Social Media Revolution in American Politics copyright Oxford Univeristy Press 2014

Greene, J. D., Sommerville, R. B., Nystrom, L. E., Darley, J. M., & Cohen, J. D. (2001). *An fMRI investigation of emotional engagement in moral judgment.* Science, 2001 Sep 14;293(5537):2105-8

Klinke, A., and Renn O., *A new Approach to Risk Evaluation and Management: Risk-based, Precaution-Based, and Discourse-Based Strategies,* Risk Analysis, Vol 22, No 6 2002

Kollock P., *Social Dilemmas: The Anatomy of Cooperation,* Annual Review of Sociology. 1998 Aug;24(1):183–214.

Lucas, B.J., and Galinsky, A.D., *Is Utilitarianism Risky? How the Same Antecedents and Mechanism Produce Both Utilitarian and Risky Choices* Perspectives on Psychological Science 2015, Vol. 10(4) 541–548

Luppicini, R., *Moral, Ethical, and Social Dilemmas in the Age of Technology: Theories and Practice*, copyright 2013 by IGI Global, https://www.igi-global.com/book/moral-ethical-social-dilemmas-age/70670

Mill, J. S. (1879), *Utilitarianism*, London, England: Longman, Green.

Model D., *Perils of Technology: Dehumanization and Extinction* https://www.opednews.com/articles/Perils-of-Technology-Dehu-by-David-Model-Antibiotic_Climate_Dehumanization_Dioxin-140523-177.html

Scheliga K. and Friesike S., *The Social Dilemma of Putting The Idea of Open Science into Practice First Monday* Volume 19, Number 9 - 1 September 2014

Shihab A. Hameed, Effect of Internet Drawbacks on Moral and Social Values of Users in Education, Australian Journal of Basic and Applied Sciences, 5(6): 372-380, 2011 ISSN 1991-8178

Sjöberg, L., *Risk Perception by the Public and by Experts: A Dilemma in Risk Management* Human Ecology Review Vol. 6, No. 2 (Winter 1999), pp. 1-9

Souter D, *Human Rights and the Internet: A review of perceptions in human rights organizations* (2012), Association for Progressive Communications (APC), APC-01206-CIPP-R-EN-DIGITAL-148

Webler, T., & Tulor, S. (1999), *Designing a*n *analytic deliberative process in environmental health policy making in the US nuclear weapons complex,* Risk- Health, Safety and Environment 10(1) 65-87

Whitman Michael E and Mattord Herbert J. (2003) *Principles of Information Security*, Thomson Course Technology, 2003

The future of work: Effects of digital platform systems on the workforce from an interdisciplinary perspective

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1. Introduction

Digitization is ubiquitous and has influenced the social fabric to a high extent. It is enabled and supported by new socio-technical systems. The output of these systems leads to new innovative ideas and more efficient socio-technical implementations. Technological progress also gives rise to new ways of communication. At the same time, digitalization leads to new challenges. Social environments change faster than before due to new technologies (Zweck 2013, 128). Previous generations have not experienced anything alike. As a result, digitization is one of the most discussed phenomena of the 21st century. One area in which the effects of digitization are particularly noticeable is the working environment (Timonen and Vuori 2018; Carstensen 2015, 188). The emergence of new technologies is not only changing traditional employment, it is creating professions (Baxter and Sommerville 2011, 4; Mrass and Peters & Leimeister, 2018, 2). An example is online work. It is a collective term for various intermediary services made possible by technologies such as smartphones, computers and tablet PC´s. With these terminals, orders are offered on platforms such as Clickworker (https://www.clickworker.de/). Platforms are Internet-based portals, based on complex algorithms that offer a stage for interaction (Leimeister 2015). The differentiation of the field of online work – at least in Germany – is still in its very beginning, as current research shows (Diewald et al. 2017; Leimeister et al. 2015). One problematic aspect in this context is the fact that this form of work currently offers a legal vacuum, which is used by companies and clients to obtain favourable output to the disadvantage of platform employees (Däubler 2015). Relevant actors focus on technical necessities, economic necessities and employment policy opportunities (Tiemann 2016, 1). Self-determination, work-life balance, flexibility and the income of online workers are just a few examples for problems in the area of platform-based online work (Leimeister & Zogaj 2014, 212). However, due to these difficulties the creation of ergonomic, ethical, social and legal conditions is important for the people working on platforms, in order to establish online work as as a meaningful alternative to institutionalized concepts of work. It is important thereby to take the platforms and their current regulations into account. Especially in today's dynamic world, dealing with questions of the future is urgent, since the present is quite different from the past and at the same time it is increasingly influenced by visions of the distant future.

An attempt is made in the following to create an interdisciplinary interpretation of the phenomenon of online work. The chosen methodology combines elements from *Industrial Engineering* and sociology. According to Schlick et al (2010), the discipline of *Industrial Engineering* offers concrete methods and theories to view the phenomenon of work from different perspectives. As an interdisciplinary scientific discipline shaped by the industrial context and engineering science, it deals with work-related activities of individuals and groups and the consequences of work (Sydow & Helfen 2015, 225). It could be particularly useful in the analysis of potential risks

that may emerge in the newly differentiated field. This is supported by *Future and Innovation Research* anchored in sociology in the terms of Zweck (2003). One of the aims of *Future and Innovation Research* is to precisely record the current situation of certain phenomena in order to be able to assess possible, likely or desirable future developments. As a relatively new science in Germany, *Future and Innovation Research* aims for a professional development of a suitable set of instruments for systematic research of the future. For this purpose, it adopts instruments of innovation research. The authors of this article base their assumptions primarily on Luhmann's systems theory (1982) and on Münch's theory of action (1985) in order to enable a targeted assessment of the phenomenon platform-based work. It describes society as a social system that includes all other social systems (Luhmann 1997, 78).

The aim of the paper is to present the possibilities at the intersection of *Industrial Engineering* and *Future and Innovation Research*. The newly differentiated field of platform-based work will be examined with respect to the problems mentioned above of its current development phase. On the one hand, this could assist politics, law and business to create suitable regulations and measures for regulating and improving the new work forms. On the other hand, a methodological approach will be further developed in order to be used during e.g. case studies.

2. Theoretical Background

In order to understand the approach used in this paper, it is necessary to explain the basics of the underlying theories. Luhmann's *system theory* and Münchs *theory of action* are the superordinate analysis tools, with which the field of *Future and Innovation Research*, *Industrial En- gineering and Ergonomics* and the field of online work are examined. *Future and Innovation Research* is supposed to sketch possible developments in the field, while, *Industrial Engineering* is supposed to deliver the needed picture of the current state of the art in the field of platform-based work.

System Theory

The systems theory is a sociological theory, which describes society as a social system that includes all other social systems (Luhmann 1997, 78). Modern societies are not viewed in an individual-centred manner, but in a system-oriented manner. Social (sub)systems, such as the economy, follow their own logic and thereby develop their own momentum (Zweck 2006, 205; Luhmann 1984, 312; Münch 1994, 389). Social (sub)systems differentiate themselves from an environment and are constituted only through this (Luhmann 2011, 4-14; Kneer 2001, 417). The difference between systems and the environment is about reducing the complexity of the world (Münch 1974, 169). The operating method through which the difference between system and environment is created is communication (Kneer 2001, 413). New subsystems can differentiate from existing systems, which contain new elements as well as those formerly belonging to the old system (Kneer 2001, 412). Differentiation is a characteristic feature of dynamic and pluralistic societies (Zweck 2006, 205). The recursively referring, communicative operations form systems that, despite their interdependence, cannot communicate across their borders (Zweck 2009, 195; Kneer 2001, 409-413). Society in the Luhmannian sense is always a communication system that includes actions (Kneer 2001, 408; Bohnen 1994, 299). Actions lead to other actions, whereby a self-conditionedness of the actions as well as a self-reproduction, in the language of *system theory* an "autopoiesis", is given (Bohnen 1994, 299; Luhmann 1984, 311;

Kneer 2001, 416). Events are bound to the present and are already on the line to the past (Luhmann 1982, 369). Systems are bound to the double contingency in which mutual expectations are raised up (Kneer 2001, 418). The mutual exchange of subsystems is called "interpenetration" (Münch 1994, 288; Bohnen 1994, 300). Münch pointed out the interpenetration of systems as an important criterion and therefore the mechanisms of mutual influence (Zweck 2012, 64). As a result, the focus changes from the inherent dynamics of the subsystems to the consideration of transitions and boundaries and becomes the link between opposing systems (Münch 1994, 388; Zweck 2009, 196). Münch sees interpenetration as an opportunity for systems to achieve a higher level of self-development (Aretz & Lahusen 2005, 16).

Future and Innovation Research

As a relatively new science in Germany, *Future and Innovation Research* aims to develop a suitable set of instruments for systematic research of the future. The aim is to allow future-related statements to be made about circumstances and framework conditions that are as precisely defined as possible (Zweck2012, 61). In contrast to other sub-areas of social science, scientists in *Future and Innovation Research* have a professional and scientific interest in the future (Schüll 2009, 223; Steinmüller 2012, 7). The scientific system has a special role to play here, because statements about the future can be made within a limited scope through the generation of specific knowledge and knowledge gain, the identification of comprehensible connections and the dissemination of (scientific) results (Grunwald 2013, 22; Zweck 2010, 52). Academic *Future and Innovation Research* uses this fact by taking up findings from various disciplines and bringing them together with a focus on findings relating to specific future issues (Zweck 2010, 53; Graf 2003, 357). This leads Zweck (2010) to the assumption that the present and current state of various fields and disciplines is decisive for the conduct of *Future and Innovation Research*. In other words: "Whoever wants to talk about the future must know about the present" (Zweck 2010, 53). Both the interdisciplinary aspect within *Future and Innovation Research* and an exact research of past and present leads Zweck to his second thesis: Future research must always create a starting point before it answers future-relevant questions, and thus bears a double burden (Zweck 2012, 72). The identification of essential issues, relevant influencing factors and the design of a present image form the starting point for future research activities (Zweck 2010, 53; 2014, 19). In the approach of this paper this present image should be established by methods of the *Industrial Engineering* discipline, as explained later. Relevant questions beyond the scientific disciplines arise primarily from economy and politics, and from society itself. Due to the fact that *Future and Innovation Research* is still at the beginning of becoming a discipline (Zweck 2012, 65), the process of differentiation from other disciplines, characterized by specific needs from the community system – the political and economic system – is not yet complete (Zweck 2012, 65). The aim of *Future and Innovation Research* is therefore to develop a set of instruments, which can be used to capture defined facts and framework conditions of future-related questions as precisely as possible (Zweck 2012, 61). In this context, Zweck suggests a classification into a theory of innovation-accompanying measures. The triad consisting of technology forecasting, foresight and technology assessment is to be mentioned here (Zweck 2012, 63, 2013). This creates a starting point for future research as the sum of toolboxes that are already institutionalised and proven in practice (ibid.). At the same time, questions are made concrete that limit the variety of possible subjects of

investigation (Zweck 2010, 51). The three toolboxes offer different focus aspects of the analysis, although they are always linked to each other (Zweck 2003, 17; 2009, 197; 2012, 73; 2014, 21).

Industrial Engineering and Ergonomics

Industrial Engineering, as an interdisciplinary scientific discipline shaped by the industrial context and engineering science, deals with work-related activities of individuals and groups and the consequences of work (Sydow & Helfen 2015, 225). Both objective and subjective work aspects are considered (Schlick et al. 2010, 1). It follows the economic principle and has the goals of an optimal design of work tasks, work systems, workplaces, safety and health protection at the workplace. The analysis focuses on the human being and a general economic exploitation. Thus *Industrial Engineering* uses empirical methods as well as theoretical constructs to achieve this aim. In addition, *Industrial Engineering* makes use of other disciplines like psychology, economy, mathematics, statistics and their methods for research on work-related activities (Schlick et al. 2010). Important sociological sub-disciplines are sociology of work, industrial sociology, sociology of technology and industrial sociology (Schlick et al. 2010, 18). "ELSI" questions (Ethical, Legal and Social Aspects) have therefore gained importance in *Industrial Engineering*. Especially the research of ELSI consequences of technical innovations of an extended technology assessment are to be mentioned here (Bohn et al.2004). In this way, *Industrial Engineering* and *Future and Innovation Research* use similar methods to advance research in the sense of self-referentiality and interpenetration of their system.

3. New Forms of Organization in a Digital Environment

This chapter is about defining and describing the field of online work and differentiate it from institutionalized work and highlighting the opportunities and risks for society. In the process, reference is made throughout to the theories outlined above. At the end of this chapter, the need for further scientific research in this field is outlined.

Online Work

The term online work refers to new phenomenona that is made possible with the help of developed technologies such as smartphones, computers and tablet PCs. As a socio-technical system, it follows organizational, technical and social logics in the interpenetration process (Zweck 2014, 23). This creates a new innovative branch of work/occupation. These include intermediary services that provide affordable orders online via internet platforms. Platforms are Internet-based portals that offer a stage for interaction (Leimeister 2015). Using complex algorithms, they create a workspace (Kalkhake 2016). Leimeister (2016) proposes a subdivision into five groups: microtask-, marketplace-, design-, testing- and innovation-platforms. The platforms differ in the nature of the orders, as well as in the work forms. Criteria of differentiation are paid/unpaid work, online/offline, minor tasks/elaborate tasks, simple/complex eco- nomic/not economic, german/other languages. Established names for subgroups would be crowdwork or clickwork (Pongratz & Borman 2017, 160; Mrass et al. 2018, 2; Däubler 2015). Previous research in the field has shown that the extent of contract placement has been low and that only a few hundred thousand people use these platforms regularly. However, it is interesting to note that private persons in particular make use of it (Kalkhake 2016, 52). These persons usually earn only small sums of up to 500 euros per month, accordingly only a small part can live from their

earnings. The easy access to the platforms and a temporary usability effort makes this new market very attractive for specific group of people, such as, students and mothers. Apart from this, the anonymous competition, highly diverse qualified individuals, leads to a "price war", which is not regulated by an authority or legislation and as a result is equivalent to an undercutting competition (Pongratz & Borman 2017). The platforms are structured in anonymity between platform operators, companies and online workers (Kalkhake 2016, 52). Due to the fact that many forms of gainful employment offer the possibility of being outsourced digitally, it can be assumed that the phenomenon will spread in the future. This also involves aspects of new career opportunities, chances and risks (Kittur & Nickerson 2015, 174).

Risks of Working Online
Various aspects of the situation in Germany have already been discussed in previous research (Mrass Peter & Leimeister 2017; Ohnemus et al. 2016; Al-Ani & Stumpp 2015). The focus is on technical necessities, economic and employment policy opportunities (Tiemann 2016, 1). Self-determination, better work-life balance, flexibility and the possibility of increasing one's income are just a few examples for this (Leimeister & Zogaj 2014, 212). However, risks of online work should also being discussed, which include the following concrete problems:

- Potential refusal of payment without justification by the companies in case of performed work;
- Loss of rights of online workers when the completed work is handed over to the platform or company;
- Price dumping, as there are no recommended prices or minimum wages;
- An information imbalance, as platforms typically provide clients with significantly more information than online workers;
- The data protection, which typically favours the companies;
- Missing organisations, e.g. committee memberships;
- Monotonous work and additional burden to other responsibilities, such as the institutionalized workplace;
- Ergonomic aspects, such as the display size of the used device and workplace design of online workers (Leimeister & Zogaj 2014, 212; Carstensen 2015, 190; Pongratz & Borman 2017; Peinl, Lothar & Bildat 2017, 13).

Laws, ordinances, changes in collective agreements and works agreements in this field are visibly missing (Tiemann 2016, 4). However, target-oriented scientific research is needed to meet the needs of the people working in the platform-based field.

The Need for Conducting Scientific Research in the Field of platform-based work
Already in 2015, the Federal Ministry of Labour and Social Affairs in Germany stated that there is a need for basic empirical research regarding living conditions, working conditions, remuneration and fairness standards in the area of platform-based services (Bundesministerium für Arbeit und Soziales, Abteilung Grundsatzfragen des Sozialstaats, der Arbeitswelt und der sozi- alen Marktwirtschaft 2015, 66). Even though research is already being undertaken in these topics, it usually focuses on the perspective of employers, such as platform operators, clients of companies or other actors. Examples of research can be found from Mrass, Peters & Leimeister (2017) and Ohnemus et al. (2016). However, little is known about the concrete organization of

work, as well as about the work load, self-determination, communication and development of online workers (Leimeister et al. 2015, 35).

In addition, the different forms of online work present new technological, organisational, ethical, legal, social and ergonomic challenges for industry and politics, which have also not yet been researched (Leimeister et al., 77; Adolph et al. 2017, 3). On top there is the difficulty that online workers as a group are hardly included in the current discourse (Pongratz & Borman 2017, 174). A goal-oriented discussion that addresses the needs and desires of online workers is difficult. Hence, there is hardly any scientific research in the area yet (Zink 2017, 98). Therefore, a concept for the investigation of the field on platform-based work is presented in the following.

4. Own Conception

Looking at the explanations made here from a theoretical point of view, it can be concluded that the area of online work is in the process of differentiating itself as an independent system. The socio-technical work in the area of virtual space created by digitization represents autopoietic and self-contained units. This new differentiating system is different from its environment insofar as it has its own logics and rules (e.g. general terms and conditions) of the corresponding subsystems (clickworker and crowdworker etc.). At the same time, it is in a reciprocal determinism with other systems such as economy, law, science and politics. According to this, it is possible to speak of interpenetration. The problem, however, is that these other systems discuss, do research and do business on the system of online work; in other words, communicate without including the system itself in the discourse (Pongratz & Borman 2017, 174). This leads to a false expectation towards the system of online work. In order to support a positive differentiation of the system, communication with the system as well as communication between the systems is important. In this context, the system of science can act as a link between online work and economy, law and politics. Science can translate its results from the field of online work into a generally understandable language and thereby support decision-makers in economics, law and politics.

It is precisely at this point that the integration of *Industrial Engineering* and *Future and Innovation Research* is proving to be effective. Existing instruments of *Industrial Engineering* will be used on the phenomena of online work in order to analyse current problems and risks in depth. In practice, the methods of *Industrial Engineering* are used to analyse the current state of online work. The analysis will be deepened by implementing the methods of *Industrial Engineering* in the toolboxes of *innovation and future research*. At the same time, assessments, for example in the form of scenarios relating to the future development of the field, will be sharpened. The approach provides a testing and application in the field in order to interact with the relevant actors. One goal is to use methods of *Industrial Engineering* and the toolboxes technology forecasting, foresight and technology assessment to investigate the need for action for law, politics and business. A second objective is of theoretical nature. An implementation and validation of the methods of *Industrial Engineering* in *Future and Innovation Research* is planned. A process of verification or falsification and modification of the theoretical constructs behind the methods accompany this. A preparation for further areas of application is planned. This approach should help *Future and Innovation Research* to strengthen itself as an independent science.

For a concrete identification of the needs of online workers in the context of platforms, a first preliminary study was carried out. The results of the study will be used to sharpen the theoretical basis. At the same time, they should point out potential risks of online work that have not yet been taken into account. It is planned to apply use tools that explore ELSI topics on various platforms, which will take into account the results of the preliminary study. In addition, other concrete methods, such as scenario development, will be selected to identify potential solutions for the risks and needs of online workers. The operators of platforms and online platform workers are to be involved in the research. This will ensure that the specific needs of these groups are taken into account in the research.

5. Outlook

In this paper, the theoretical background to an investigation into the field of online workers was outlined. This theoretical basis will be further developed as a research project and sharpened in future work. Among other things, it is planned to concretize the scientific risk analysis for specific application steps. Afterwards, this will be evaluated by *Future and Innovation Research* in the sense of technology assessment.

In addition, initial data were collected in a first pilot study with online workers of platforms. These will be analysed and evaluated in detail as the next step. The results serve as the basis for further studies in this area and will be analysed in consideration of the theoretical components listed in this paper. In addition, it is planned to exploit the results of applying the risk tool on platforms.

References

Adolph, Lars, Britta Kirchhoff und Jan-Hendrik Geilen (2017), 'Sicherheit und Gesundheit in der digitalen Arbeitswelt' [Safety and Health in the Digital Workplace], in Maier, Günter W., Gregor Engels und Steffen Eckhard (Hrsg.), Handbuch Gestaltung digitaler und vernetzter Arbeitswelten, Berlin und Heidelberg: Springer Berlin Heidelberg, 1–14.

Al-Ani, Ayad; Stumpp Stefan (2015), 'Motivationen und Durchsetzung von Interessen auf kommerziellen Plattformen. Ergebnisse einer Umfrage unter Kreativ- und IT-Crowdworkern.' [Motivations and Enforcement of Interests on Commercial Platforms: A Survey among Creative- and IT-Crowdworkers.]. In: HIIG Discussion Paper Series (5), S. 1–45.

Aretz, Hans-Jürgen und Christian Lahusen (2005), 'Einleitung: Die Ordnung der Gesellschaft zwischen lokalen Lebenswelten und Weltgesellschaft' [Introduction: The order of society between local living environments and world society], in Aretz, Hans-Jürgen und Christian Lahusen (Hrsg.), Die Ordnung der Gesellschaft. Festschrift zum 60. Geburtstag von Richard Münch, Frankfurt am Main: Lang, 11-31.

Baxter, Gordon und Ian Sommerville (2011), Socio-technical systems: 'From design methods to systems engineering', Interacting with computers 23 (1): 4–17.

Bohn, Jürgen, et al (2004), "Living in a world of smart everyday objects—social, economic, and ethical implications." Human and Ecological Risk Assessment 10.5, 763-785.

Bohnen, Alfred (1994), 'Die Systemtheorie und das Dogma von der Irreduzibilität des Sozialen' [Systems theory and the dogma of the irreducibility of the social], Zeitschrift für Soziologie 23: 292–305.

Bundesministerium für Arbeit und Soziales, Abteilung Grundsatzfragen des Sozialstaats, der Arbeitswelt und der sozialen Marktwirtschaft (Hg.) (2015), Grünbuch. Arbeiten 4.0 [Work 4.0].

Bundesministerium für Arbeit und Soziales, Abteilung Grundsatzfragen des Sozialstaats, der Arbeitswelt und der sozialen Marktwirtschaft. Berlin.

Carstensen, Tanja (2015), 'Neue Anforderungen und Belastungen durch digitale und mobile Technologien' [New requirements and loads due to digital and mobile technologies], WSI Mitteilungen 68 (3), 187–193.

Däubler, Wolfgang (2015), 'Crowdworker - Schutz auch außerhalb des Arbeitsrechts? Eine Bestandsaufnahme' [Crowdworker - Protection outside labour law? An inventory]. In: Christiane Benner (Hg.): Crowdwork - zurück in die Zukunft? Perspektiven digitaler Arbeit. Wien: ÖGB-Verl., S. 243–274.)

Diewald, Martin, Björn Andernach und Eva S. Kunze (2017), 'Entwicklung der Beschäftigungsstruktur durch Digitalisierung von Arbeit' [Development of the employment structure through the digitalisation of work], in Günter, W. Maier, Gregor Engels und Steffen Eckhard (Hrsg.), Handbuch Gestaltung digitaler und vernetzter Arbeitswelten, Berlin und Heidelberg: Springer Berlin, Heidelberg, 1–17.

Graf, Hans G. (2003), 'Was ist eigentlich Zukunftsforschung?' [What is futurology?], Sozialwissenschaften und Berufspraxis 26: 355–364.

Grunwald, Armin (2013), 'Wissenschaftliche Validität als Qualitätsmerkmal der Zukunftsforschung' [Scientific validity as a quality feature of futurology], Zeitschrift für Zukunftsforschung 2: 22–33.

Kalkhake, Paulo (2016), 'Plattformökonomie' [Platform economics], in Bundesministerium für Arbeit und Soziales, Abteilung Grundsatzfragen des Sozialstaats, der Arbeitswelt und der sozialen Marktwirtschaft (Hrsg.), Werkheft 01. Digitalisierung der Arbeit, Berlin:52–57.

Kittur, Aniket und Nickerson (2015), 'Die Zukunft der Crowdarbeit. Zentrale Forschungsfragen' [The future of Crowdwork. Central research questions], in Benner Christiane (Hrsg.), Crowdwork – zurück in die Zukunft? Perspektiven digitaler Arbeit., Wien: ÖGB-Verlag, 173–229.

Kneer, Georg (2001), 'Organisation und Gesellschaft. Zum ungeklärten Verhältnis von Organisations- und Funktionssystemen in Luhmanns Theorie sozialer Systeme' [Organization and Society. On the unexplained relationship between organizational and functional systems in Luhmann's theory of social systems], Zeitschrift für Soziologie 30: 407–428.

Leimeister, Jan M. und Shkodran Zogaj (2014), 'Crowdsourcing – Neue globale Wertschöp-fungskonzepte' [Crowdsourcing – New global value creation conceptions], in Boes Andreas (Hrsg.), Dienstleistung in der digitalen Gesellschaft. Beiträge zur Dienstleistungstagung des BMBF im Wissenschaftsjahr 2014, Frankfurt am Main: Campus-Verlag, 211–221.

Leimeister, Jan M., Shkodran Zogaj und Ivo Blohm (2015), 'Crowdwork - digitale Wertschöpfung in der Wolke. Grundlagen. Formen und aktueller Forschungsstand' [Crowdwork - digital value creation in the cloud. Basics. Forms and current state of research], in Benner Christiane (Hrsg.), Crowdwork - zurück in die Zukunft? Perspektiven digitaler Arbeit., Wien: ÖGB-Verl., 9–41.

Leimeister, Jan Marco, Shkodran Zogaj, David Durward und Ivo Blohm (2015), 'Crowdsourcing und Crowdwork als neue Arbeits- und Beschäftigungsformen' [crowdsourcing and crowdwork as new forms of work and employment], Arbeit und IT: ver.di – Vereinte Dienstleistungsgewerkschaft. Gute Arbeit und Digitalisierung: Prozessanalysen und Gestaltungsperspektiven für eine humane digitale Arbeitswelt: 66–79.

Leimeister, Jan Marco; Zogaj, Shkodran; Durward, David; Bretschneider, Ulrich (2015), Neue Geschäftsfelder durch Crowdsourcing: Crowd-basierte Start-ups als Arbeitsmodell der Zukunft. [New business fields through crowdsourcing: crowd-based start-ups as the working model of the future] In: Reiner Hoffmann und Claudia Bogedan (Hg.): Arbeit der Zukunft – Möglichkeiten nutzen –

Grenzen setzen. Frankfurt am Main: Campus Verlag, S. 141–158.

Leimeister, Jan Marco; Zogaj, Shkodran; Durward, David; Blohm, Ivo (2016), Systematisierung und Analyse von Crowd-Sourcing-Anbietern und Crowd-Work-Projekten. [Systematization and analysis of crowd sourcing providers and crowd work projects] Düsseldorf, Hans-Böckler-Stiftung (Reihe Praxiswissen Betriebsvereinbarungen, Nr. 324).

Luhmann, Niklas (1982), 'Autopoiesis, Handlung und kommunikative Verständigung' [Autopoiesis, action and communicative communication], Zeitschrift für Soziologie 11: 366–379.

Luhmann, Niklas (1984), 'Die Wirtschaft der Gesellschaft als autopietisches System' [The economy of society as an autopoietic system], Zeitschrift für Soziologie 13: 308–327.

Luhmann, Niklas (1997), Die Gesellschaft der Gesellschaft [The Society of the Society], 2 Band, Frankfurt am Main: Suhrkamp.

Luhmann, Niklas (2011), 'Strukturauflösung durch Interaktion. Ein analytischer Bezugsrahmen' [Structure resolution through interaction. An analytical reference framework], Soziale Systeme 17: 3–30.

Mrass, Volkmar, Christoph Peters und Jan M. Leimeister (2017), 'One for All? Managing External and Internal Crowds through a Single Platform – A Case Study', Proceedings of the 50th Hawaii International Conference on System Sciences: 4324–4333.

Mrass, Volkmar, Christoph Peters und Jan M. Leimeister (2018), 'Managing Complex Work Systems via Crowdworking Platforms: How Deutsche Bank Explores AI Trends and the Future of Banking with Jovoto', Hawaii International Conference on System Sciences: 1–11.

Münch, Richard (1974), 'Soziologische Theorie und historische Erklärung' [Sociological theory and historical explanation], Zeitschrift für Soziologie 2: 163–181.

Münch, Richard (1985), 'Die sprachlose Systemtheorie. Systemdifferenzierung, reflexives Recht, reflexive Selbststeuerung und Integration durch Indifferenz' [The Speechless Systems Theory. System differentiation, reflexive law, reflexive self-control and integration through indifference], Zeitschrift für Rechtssoziologie 6 (1): 19-28.

Münch, Richard (1994), 'Zur Interpenetration von Ökonomie und Moral' [On the interpenetration of economy and morality], Zeitschrift für Soziologie 23: 388–411.

Ohnemus, Jörg, Daniel Erdsiek und Steffen Viete (2016), 'Nutzung von Crowdworking durch Unternehmen: Ergebnisse einer ZEW Unternehmensbefragung' [Use of crowdworking by companies: Results of a ZEW company survey], in Bundesministerium für Arbeit und Soziales; Zentrum für Europäische Wirtschaftsforschung (ZEW) GmbH (Ed.), Mannheim.

Peinl, Iris und Lothar Bildat (2017), 'Forschungsdesiderate. Bezahlte repetitive Crowdarbeit und Gesundheit' [Academic void: paid repetitive crowdwork and health], Leibniz-Informations-zentrum Wirtschaft Leibniz Information Centre for Economics.

Pongratz, Hans J. und Sarah Borman (2017), 'Online-Arbeit auf Internet-Plattformen. Empirische Befunde zum ‚Crowdworking' in Deutschland' [Online work on Internet platforms. Empirical findings on crowdworking in Germany], AIS Arbeits- und Industriesoziologische Studien 10 (2): 158–181.

Schlick, Christopher, Holger Luczak und Ralph Bruder (2010), Arbeitswissenschaft [work science], Heidelberg: Springer Verlag.

Schüll, Elmar (2009), 'Zur Forschungslogik explorativer und normativer Zukunftsforschung' [The research logic of explorative and normative futurology], in Popp, Reinhold und Elmar Schüll (Hrsg.),

Zukunftsforschung und Zukunftsgestaltung, Berlin und Heidelberg: Springer Berlin Heidelberg, 223-234.

Steinmüller, Karlheinz (2009), 'Virtuelle Geschichte und Zukunftsszenarien. Zum Gedankenexperiment in Zukunftsforschung und Geschichtswissenschaft' [Virtual history and future scenarios. To the thought experiment in futurology and historiography], in Popp Reinhold, und Elmar Schüll (Hrsg.), Zukunftsforschung und Zukunftsgestaltung, Berlin und Heidelberg: Springer Berlin Heidelberg, 145-159.

Sydow, Jörg und Markus Helfen (2015), 'Arbeit in Netzwerkorganisationen - Wertschaffung durch Verzicht auf Wertschöpfung?' [Working in network organisations - creating value by foregoing value creation?], Zeitschrift für Arbeitswissenschaft 69 (4): 223–226.

Tiemann, Heinrich (2016), 'Digitalisierung der Arbeit' [Digitisation of the work], Managerkreis der Friedrich Ebert Stiftung: 1-4.

Timonen, Hanna und Johanna Vuori (2018), 'Visibility of Work: How Digitalization Changes the Workplace', Proceedings of the 51st Hawaii International Conference on System Sciences.

Zink, Klaus J. (2017), 'Nachhaltige Arbeitssysteme in (internationalen) Wertschöpfungsketten und die Rolle der Arbeitswissenschaft' [Sustainable work systems in (international) value chains and the role of labour science], Zeitschrift für Arbeitswissenschaft 71 (2): 92–100.

Zweck, Axel (2003), 'Technologiefrüherkennung für die Praxis – Vom Räsonieren zum Entscheiden' [Early detection of technology in practice – from reasoning to decisions], Ökologisches Wirtschaften: 15–17.

Zweck, Axel (2006), 'Nanotechnologie: Technologiefrüherkennung, Innovationsmanagement und Perspektiven' [Nanotechnology: Early detection of technology, innovation management and perspectives], in Gausemeier, Jürgen (Hrsg.), Vorausschau und Technologieplanung, Paderborn: Heinz-Nixdorf-Institut Universität Paderborn: 193-218.

Zweck, Axel (2009), 'Foresight, Technologiefrüherkennung und Technikfolgenabschätzung' [Foresight, early technology detection and technology assessment], in Popp, Reinhold und Elmar Schüll (Hrsg.), Zukunftsforschung und Zukunftsgestaltung, Berlin und Heidelberg: Springer Berlin Heidelberg, 195-206.

Zweck, Axel (2010), 'Zukunftsforschung – quo vadis? Qualitätsstandards für eine methodisch fundierte Zukunftsforschung' [Futurology – quo vadis? Quality standards for methodologically sound future research], Wissenschaftsmanagement 16: 50–54.

Zweck, Axel (2012), 'Gedanken zur Zukunft der Zukunftsforschung' [Thoughts about the future of futurology], in Popp, Reinhold (Hrsg.), Zukunft und Wissenschaft, Berlin und Heidelberg: Springer Berlin Heidelberg, 59-80.

Zweck, Axel (2013), 'Towards An Integrated Technology And Innovation Management', International Journal of Innovation and Technology Management 10.02: 1340002.

Zweck, Axel (2014), 'Beiträge der Innovationsforschung für die Zukunftsforschung' [Towards An Integrated Technology And Innovation Management], Zeitschrift für Zukunftsforschung 18: 18–40.

STREAM: Life Sciences / Biotechnology

Treating the Infection: Hepatitis C in Ethnographic Perspective
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From Hepatitis C to a Cure: From Elusiveness to Finality

Hepatitis C is a viral disease spread from human-to-human by a blood-borne single-stranded RNA-virus. The virus, like its kin, attacks the human liver. Hepatitis C as such was not formally "discovered" until 1989. This "discovery" came late compared to Hepatitis B in the 1960s and Hepatitis A in the 1970s (Choo et al. 1989; Kuo et al. 1989; Alter 1991). For decades this obscure third Hepatitis became known as "non-A/non-B"-Hepatitis – a disease known only by its negation. As Fraser and Seear (2011, 32) have demonstrated, HCV is and has long remained a virus frequently shrouded in "metaphors of mystery and elusiveness."

The "non-A/non-B"-Hepatitis-Virus staunchly eluded us for decades. "It took us decades to even see the virus in the first place," Dr. Holzmann at the Vienna Institute for Virology remarked to me, a glint of fascination in her eyes. Eventually, HCV was not even observed microscopically or identified serologically but genetically manufactured. It was built to be known. Yet even after its description in 1989, after it had been pinned down just enough, HCV has remained a mysterious fellow.

HCV mutates very quickly and is prone to errors and transformations. It constantly produces, as is the normal modus operandi for viruses, *quasi-species*: replications of itself that are always a little different. Quasi-species are the "motor of virus evolution," if you ask Tim Skern at the Vienna Perutz Labs, but HCV specifically has "very active quasi-species." So, the HC-Virus in our body is never one, always many: Not only are there a hundred different genotypes and subtypes to start with, but then also countless wonky transformations with every cycle of reproduction. Such, HCV has proven hard to control and conquer. "One-size-fits-all" approaches to treatment proved impossible for the longest time. Its mutations and transformations made Hepatitis C remarkably resilient. In fact, our immune system has such a hard time keeping up that HCV, unlike other hepatitides, develops into a *chronic* condition in the majority of cases – a chronic condition that tends to go unnoticed and remains asymptomatic for decades. This has earned Hepatitis C the label of a "silent killer."

With its "silent" and "slow progression," Hepatitis C appeared only low on the list of diseases health institutions vow to fight and eradicate. For decades, more pressing epidemics were far more important. And yet Hepatitis C has been curiously loud and dominant in the past five to six years; called a "ticking time bomb" by the Lancet, an "epidemic" by the New York Times (Goodnough 2015; Sachs 2015; The Lancet 2013). On top of that, the WHO (2016) issued its first-ever "Global Health Sector Strategy on Hepatitis" in 2016. Its core target: eliminate the Hepatitis C-threat.

This WHO strategy marks a milestone on Hepatitis C's rise to the status of an "epidemic" in recent years: an "epidemic" without an outbreak. What has made Hepatitis C an epidemic of

global reckoning is the availability of "the cure." In the last few years, Hepatitis C has become a "curable" disease and the emergence of this "cure" has put it on global agendas.

This cure has the power of finality – of settling the score with a mysterious and elusive disease. It promises and has actualized "cure rates" – that is, *sustained virological response* rates in 95% to 99% of cases. "Numbers we aren't used to", Dr. Ferenci from the AKH declared in the first-ever presentation of clinical results I attended in 2016. The powerful seductiveness of its cure cannot be understood without recognizing HCV's biography as a virus that had proven particularly challenging to deal with in the past.

Chronic or Infectious?

So, what is this cure? Already the wrong question to ask in many ways, because it assumes "the cure" is a reality separate from the disease. Instead, we have to conceive of Hepatitis C and its cure as mutually constituted and co-emergent. In this, I am following specifically Ludwik Fleck's (1979) often terribly neglected study on the syphilis-virus. For my argument, this means that the makeup and characteristics of "the cure" have been changing the very ontology of the disease itself.

"The cure" has been transforming Hepatitis C treatment: In a practical-material sense, it has transformed *how* Hepatitis C is treated and what it is treated *with.* But it has also transformed it in a more symbolic-semiotic sense: what Hepatitis C is treated *as* by doctors, insurance companies, governments, international agencies, and the like.

In their edited volume, Lenore Manderson and Carolyn Smith-Morris (2010, 2) have collected discussions on the phenomenology of *chronic illness*, critiquing how "the global rhetoric takes the definition of *chronic* as given and its epidemiology as stable." Let me follow their critical attention to the powerful but reductive epidemiological dichotomy of *chronic vs. infectious*. But let me also flip it around and focus on the material-semiotic consequences of enacting this rhetoric in practice with a case like Hepatitis C, whose definition, I argue, has markedly changed.

I argue that Hepatitis C is being treated now less as a *chronic* disease, and more as an *infectious* disease – with lasting consequences for patients, policies, and institutions. The metaphor I want to work with here is not one of revolution. Instead, Hepatitis C has always been operating on a curious double-register of being both and at the same time: chronic *and* infectious. In the times of "a cure," however, Hepatitis C's chronic character is receding into the background while its infectious character is being enacted and acted upon more and more. And this change was set off "the cure": so-called Direct-Acting Antivirals or DAAs.

Before DAAs, Hepatitis C was treated with *Interferon*: a substance meant to boost our immune response to fend off the virus. Interferon was also notorious for its side effects, often compared to chemotherapy. These cumbersome treatments were administered and overseen by hepatologists. Mind you, Hepatologists are liver specialists; they are not infectious disease specialists. Given Hepatitis C's slow asymptomatic progression, the livers of their patients were often in advanced stages of scarring. While taking care of Hepatitis C, hepatologists also had to care for the state of the liver and manage side effects of the treatment. If the treatment did not lead to a cure, care shifted to monitoring the liver on its slow progression towards liver transplantation.

In other words, Hepatitis C, *if* treated, was treated as a *chronic* affliction: as a disease of the *whole body*, the *whole person*. But in only the last five years, things have profoundly changed. In 2013, U.S. and European medical agencies approved a Hepatitis C-drug called *Sovaldi* by industry giant Gilead (EMA 2013). Today – just five years later – treatment standards are based exclusively on DAAs. They promise to "cure" Hepatitis C as a single viral infection – no more mystery, no more elusiveness. As Dr. Peck of Klagenfurt Hospital, told me:

> "[...] these are developments [finding a cure] you will really **only see with infectious diseases**. Because I will never [...] in the area of **other chronic diseases**, such as obesity [*Fettsucht*], diabetes [...], see similar developments. Because those are **multi-factorial things** [*multi-faktorielle Dinge*]. [...] The effect can never be as strong as with infectious diseases, where I can really just get a handle on this thing from one day to the next. Because the **target is entirely clear**."

DAAs like Sovaldi inhibit viral reproduction *directly*. The target is entirely clear. "The cure" for Hepatitis C is therefore a cure associated with the virus–not with the disease, with a body, or a person. The target is to get rid of the virus, not manage a chronically ill body or the patient afflicted with it.

The *locus* of treatment has shifted to the virus, and so has the *temporality* of Hepatitis C. A chronic affliction is long-term. But by concentrating on the virus, treatment is oriented towards the earliest moments of infection, thus presenting ever earlier needs for testing. In other words, action needs to be taken as *early* as possible. This is the kind of action that instills a sense of urgency and emergency.

The shift to treat Hepatitis C more and more *like* an infectious disease reverberates in the "global health" strategies attached to it, like the *"Finding the Missing Millions"* campaign run by the *World Hepatitis Alliance* at this very moment. Infections carry a threat in a way that chronic diseases do not. It is only such that we can better understand a discourse about "epidemics" and ticking "time-bombs." Where the "creeping" effects of a "silent" killer are aligned with a chronic disease, infections demand immediate intervention.

Discussion

At first glance, the Hepatitis C-"epidemic" appears to fit neatly with what Collier and Lakoff (2008, 17) have called the "emergency modality of intervention." As a functional regime, this modality describes the way in which contemporary global health efforts are implemented to prevent infectious biothreats. In that sense, we could see this shift in Hepatitis C-ontology as a functional, strategic move on the side of transnational agencies like the WHO (see also Brown, Cueto, and Fee 2006). That, however, is only one part of a larger story.

In a time where Nicholas King (2002) has found global public health to be dominated by a "(re)emerging disease worldview," Hepatitis C is, strictly speaking, neither an emergent nor a re-emergent disease. In fact, Hepatitis C's *shifting* ontology makes visible the intricate and practical logics attached to this worldview. The Hepatitis C case highlights what it takes to turn a silent and complex viral disease into an object of global health efforts in *this* historical moment. As such, it can also make visible the lived consequences for individual subjectivity and where these transformations leave gaps or incite struggles.

Hepatitis C strikingly highlights, for instance, the important role of pharmaceutical drugs – less so on a level of production, consumption, and institutions, but more so in the way pharmaceutical drugs have effects beyond the body's biochemistry (see Oudshoorn 2003; Whyte, van der Geest, and Hardon 2002). Medicines *act* within the world; they embody something and they change social relationships. As active agents, they can also change what a disease is.

In particular, as I alluded to earlier, if we attend to an "ontological multiplicity" of Hepatitis C, we are better prepared to understand disease identities and definitions as day-to- day *enactments* rather than paradigmatic revolutions set off by "the cure." In this way we can then reveal struggles over which ontologies count and which do not – what Annemarie Mol (2002) described as an "ontological politics." DAAs can then be said to enact Hepatitis C as located *in the virus*, and only there; as an urgent infection. HCV's chronic assault on failing livers is made less and less into a reality Austrian hepatologists need to deal with. As of 2018, I have just returned from a roundtable connecting policy, medicine, and patient advocacy for hepatitis in Austria, and our concerns too are about *locating and eliminating.*

Make no mistake, "the cure" is everything Byron Good (1993, 86) has called biomedicine's "soteriological core." The hope engendered by pharmaceuticals is real. DAAs are, in every sense of the word, "magic bullets," and this magic too is real for people afflicted with Hepatitis C. At the same time, patient advocacy groups in Austria are fighting for federally administered treatment registries to follow up on the long-term consequences of Hepatitis C and "the cure." Every patient I have talked to *does* worry about the effects of the drugs they received, the damage to their livers they sustained over decades of silent infection, and the fact they are "cured, but not healthy." This phenomenology of sustained Hepatitis C has material, powerful offshoots. Will these experiences be taken seriously by the next doctor patients face, when official biomedicine so clearly tells us that the cure equals health equals the end of disease? And what about patients who are battling in court to continue receiving a workers' compensation pension for the lasting effects of Hepatitis C, when *cured* is what they are *now*?

One of the questions that drives my research is an interest in the gaps that are obscured by "*the fetish* of the cure," its "thingness" and "directness." When doling out pills, for instance, is all it takes, I worry no one will stop to ask *why* the pills are even needed or what the alternatives might be. I worry about the consequences to welfare, social insurance, and the kind of "sick role" people may take, or *cannot take*, within their immediate surroundings as much as when they are facing medical institutions. Far from certain or final, it is these open questions that continue to power my research.

A problematic subject for technology assessment: Gene Drives as a revolution in GMO-handling

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Gene drives represent a revolution in genetic engineering because they enable the genomic manipulation of the fate of entire wild populations in an as yet unmatched extent. This potential is achieved by so-called super-mendelian inheritance which facilitates an increased spread of their genetic elements within populations of sexually reproducing species. Gene drives are in particular relevant for species with a comparably short generation time like insects. Within a time course of about 2-3 years, a new trait could then be adopted by nearly all individuals due to vertical gene transfer (i.e. from parent to offspring). If the trait delivered by the drive represents a fitness burden or renders the male or female offspring infertile, an entire population may go extinct after some generations. Many applications are considered for gene drives in agriculture, ecosystem-engineering or to fight infectious diseases. In agriculture, weeds and crop pests could be altered, suppressed or eliminated. Two potential applications of gene drives even serve issues of nature conservation, namely the eradication of invasive species and the conservation of endangered species (Esvelt et al. 2014; Webber, Raghu, and Edwards 2015). Endangered species may become immunized against pathogens by a genomic modification which is transferred by a gene drive. With regard to infectious diseases, especially malaria- or dengue-carrying mosquitoes are potential targets (Dong et al. 2018; Burt et al. 2018; Marshall and Akbari 2016)[1]. In many potential applications, gene drives should be used as a kind of self-propagating delete-function. Even for applications against infectious diseases, besides an immunization of mosquitoes against the pathogen, the suppression of the vector population is an intended aim. Gene drives have not been released so far, but an increasing number of laboratories and projects are developing systems whose applications involve a release of gene drive carrying organisms.

This contribution serves as an introduction into the field of gene drives. It explains the qualitative difference that genetic engineering has achieved with this technology and highlights potential influences on ecosystems. Furthermore, an approach of technology characterization is presented which helps to estimate the potential power and the corresponding extent of non-knowledge associated with gene drive systems.

A revolution in GMO-release[2]

Gene drives can be understood as 'selfish' genetic elements that are able to spread their genetic information faster than Mendel's Principles of Heredity permit, according to which a trait

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1   Cp. the STS proceedings paper "CRISPR/Cas9 based gene drives for fighting malaria: aspects of prospective technology assessment" of Wolfgang Liebert. (cf. S. 107)
2   Cp. the STS proceedings paper "Technology Assessment of Gene Drives" of Johannes Frieß et al. for a characterization of gene drive systems and its potential applications. (cf. S. 99)

can be passed on to at most half of the offspring (Burt 2003). In laboratory experiments with gene drives, almost 100% of the offspring were converted to genetically modified organisms (GMOs) (Gantz et al. 2015). When organisms have a short generation time like insects, then already after a few months, a large part of the population could have a new property transmitted by the gene drive. In particular, very invasive gene drives may be able to impose properties on entire populations that would otherwise not spread.

But gene drives not only affect the environment, the environment may affect gene drives as well. One of the main hurdles is the ability of organisms to change their genetic code and undergo mutational changes over time. So far, gene drives prove to be only partially successful in laboratory approaches (Lin and Potter 2016; Marshall et al. 2017). In addition, it is still unclear whether gene drives are manageable at all (Noble et al. 2018).

Among the gene drive-mechanisms known so far, rather 'passive' techniques and more 'active' systems can be distinguished. Passive systems deliver certain genes to subsequent generations, because only offspring carrying a particular combination of genetic elements (e.g., a toxin and its antidote) survives. In active drive-systems, a bias of the sex ratio by (enzymatic) mechanisms or "copying" of genetic information between homologous chromosomes by Homing Endonuclease Genes (HEG) generates genomic modifications.

The development of new gene drive variants is closely linked to the upswing that genome editing methods have taken by the recent use of the CRISPR/Cas "gene scissors". Since its first description as a new molecular "gene scissors" in 2012, the CRISPR/Cas methodology has been widely used as an effective method of genome editing (Jinek et al. 2012; Doudna and Charpentier 2014). With CRISPR/Cas as homing-endonuclease the gene drive technology has become cheaper and easier to customize (Courtier-Orgogozo, Morizot, and Boëte 2017b).

Progress is also evident in the semantics chosen by the participating researchers: Since the use of CRISPR/Cas, gene drives are called a 'mutagenic chain reaction' because of the self-propagating character and the high efficiency that could be achieved with this system (Gantz and Bier 2015). Gene drives based on CRISPR/Cas are comparably easy to handle, but the effectiveness of this system is still hampered by some problems, which however, could soon be solved in view of the rapid development in this area.

For most applications gene drives are intended to spread in wild populations. Thereby they represent a shift of paradigms in the handling of GMOs. At least for the European Community, the current regulation of intended releases of GMOs assumes that for specific periods of time a certain amount of GMO will be released in a particular region[1]. With gene drives, a new type of genetic engineering appears whose aim requires an approach that exceeds these limits. A once-released gene drive represents an artificial intervention into ecosystems. Its 'invasive' character causes an inherent tendency to spread. Therefore, a loss of control is by far more probable than with common GMOs. Uncertainty concerning the potential consequences within ecosystems is growing with the spread of artificially induced changes. Technology assessment therefore refers to an increasing 'ignorance' associated with such powerful technologies.

Options to reverse or restrict the spread and function of a technological intervention when things go wrong, as well as options to mitigate adverse effects are important for an effective risk

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1   Cp. Annex III A and Annex III B of the Directive 2001/18/EC of the European Parliament and of the Council on the deliberate release into the environment of genetically modified organisms.

management. The creation of low risk development paths should therefore be an important element in prospective and precautionary risk management. It is not yet possible to make reliable statements about the effectiveness of options for limiting or reversing the changes caused by gene drives. Different measures for the inhibition of their spread as well as for the inactivation of the induced functionalities have already been proposed and also a first experiment in yeast to inactivate a CRISPR/Cas-based drive has been performed (Esvelt et al. 2014; DiCarlo et al. 2015). However, a proof of their efficacy when used in insects or other higher organisms has not yet been established. In addition, there is still no possibility for the complete restoration of the natural gene sequence after the spread of homing endonuclease-based gene drives.

The development of gene drives has shown considerable progress in recent years. Financed by private investments and public funds, an increasing number of research groups are working on gene drives. Already in 2014, the World Health Organization (WHO) published a „Guidance framework for testing of genetically modified Mosquitoes" (WHO/TDR and FNIH 2014) and observes the development of improved drive systems with favorable consideration[1]. Among public investments the gene drive-budget of the DARPA (US-Defense Advanced Research Projects Agency) is remarkable: 100 Mio USD shall be invested. According to DARPA the lion`s share is dedicated to the investigation of consequences of gene drive-application and effective countermeasures[2].

The largest private funding is dedicated to support the fight against malaria. „Target Malaria" is mainly financed by the Bill and Melinda Gates-Foundation and the „Open Philanthropy Project". In 2016, the Gates-Foundation raised the budget of the Target Malaria-program from 40 to 75 Mio USD[3]. Moreover, the Gates-Foundation is also involved in lobbying for the application of gene drives. In 2017, it became known that the foundation invested 1.6 Mio USD for lobbying in the course of an expert consultation of the Convention on Biological Diversity[4]. Besides these investors, the Indian industry holding TATA invested in research for gene drives (Cp. Courtier-Orgogozo, Morizot, and Boëte 2017a) and Alphabet (former known as Google) is interested in using *Wolbachia*-bacteria to suppress populations of disease transmitting insects[5].

Potential Ecological Effects

For an investigation of the directly and indirectly affected ecological interactions the number of ecosystem processes that depend on gene drive-bearing species is of central importance. The species directly affected by the gene drive has to be investigated with regard to its role in the ecosystem. For instance the 'target' species can be a resource, a consumer or an ecosystem engineer. It may play a role in information processing and it could also compete with other

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1   Cp. https://www.paho.org/hq/index.php?option=com_content&view=article&id=14191%3Athe-road-to-malaria-eradication-update-2018&catid=6601%3Acase-studies&Itemid=40275&lang=en [accessed June 27, 2018]
2   Cp. https://eandt.theiet.org/content/articles/2017/12/darpa-invests-100-million-in-gene-drive-technology/ [accessed June 27, 2018]
3   Cp. https://www.technologyreview.com/s/602304/bill-gates-doubles-his-bet-on-wiping-out-mosquitoes-with-gene-editing/ [accessed June 27, 2018]
4   Cp. http://genedrivefiles.synbiowatch.org [accessed June 27, 2018]
5   Cp. https://www.technologyreview.com/s/602470/alphabets-latest-project-is-birth-control-for-mosquitoes/ [accessed June 27, 2018]

species. These relationships could lead to cascading effects in ecosystems when strong dependencies on the species are concerned (Fang 2010). Additionally, indirect effects have to be taken into consideration, for example when a species is suppressed or even driven to extinction by a gene drive and its ecological niche is filled by another species (David et al. 2013). For example eradication of the mosquito species *Aedes aegypti* to eliminate dengue would result in an open niche for *Aedes albopictus* which may transmit dengue as well. Moreover, non-intended effects such as a transfer of the gene drive to non-target species (due to interspecific mating or other potential routes of DNA transfer) must also be taken into account. In the end, besides an adverse influence on ecosystem functions, ecosystem services (i.e. services for mankind) may also be affected by changes in the concerned ecosystems. The biting midges of the family *Ceratopogonidae* which bite humans and thereby transmit diseases are a good example, because they are also pollinators for tropical crops such as cacao. Eradication may in an extreme scenario "result in a world without chocolate" (Fang 2010, 433).

Moreover, gene drives potentially lead to a loss in diversity. Since a gene drive essentially equips a whole population with the same set of genes or eradicates the population as a whole, it can be viewed as a reduction in diversity.

Apart from ecological interactions of the gene drive affected species, evolutionary effects should be considered with regard to the potential impact of gene drives on ecosystems. A released gene drive is also exposed to evolutionary processes. These in turn may affect the function and the gene flow of the drive. Gene flow between populations of the target species could influence the fitness of these populations. The establishment of a gene drive in a population can cause the formation of subpopulations and on a greater time scale favor speciation or extinctions. Interspecific gene flow between the target species and related species can occur if mating between viable offspring is possible (National Academies of Sciences 2016). Thereby the fitness of these 'non-target' species may be altered.

Besides these effects of gene flow, mutations of the drive may lead to unforeseeable effects within directly or indirectly affected species and subsequently in the respective ecosystem. But mutations can cause a resistance against the gene drive as well. It was already shown for CRISPR/Cas-based gene drives that unsuccessful conversion usually leads to the formation of resistance alleles (Unckless, Clark, and Messer 2016; Callaway 2017). Resistance alleles potentially increase in frequency and would thereby limit the further spread of drives within or between populations.

Technology assessment

The modification of controlling structures like a genome represents a high depth of intervention which tends to trigger long chains of effects in time and space. Moreover, an increasing depth of intervention provides more degrees of freedom for the design or manipulation of functionalities and may thus result in a higher level of technological power and range of exposure. Accordingly, uncertainty and ignorance may increase as well.

Technology characterization should therefore consider at least the following criteria (von Gleich, Pade, and Wigger 2013; von Gleich 2013, 60ff):

1. The depth of intervention into systems or organisms resulting in

    a. High technological power due to the modification of controlling structures (like genes) and additionally the specific power of the altered trait. With regard to risk as a function of hazard and exposure, technological power is related to the hazard potential of a technology.

    b. High range based on capabilities of altered organisms like persistence, capability of self-replication, mobility, advantages in fitness, life-expectancy, invasiveness, travel distance and self-limiting or self-sustaining qualities. The range of a technology determines the potential risk of applications via the exposure potential or the potential of contamination, respectively.

2. The intensity of intervention with the quantity and frequency of application and release as relevant factors. Quantity and frequency both have an influence on the hazard potential as well as the exposure potential.

3. The reliability of the technology in practice or in other words: its probability of failure.

4. The corrigibility (damage limitation, reconstitution) in case of failure.

A general technology characterization is fruitful as a source of knowledge for precautionary action in earliest phases of innovation including basic research without any regard to possible applications. In later phases, when applications of emerging technologies can be identified more clearly, not only the technology itself serves as a basis for the estimation of potential risk-determining properties. Concrete applications enable an analysis of the vulnerability of potentially affected ecological, socio-economic or socio-ecological systems in which respective applications take place.
Such an analysis of affected systems can be differentiated into a:

    a. general, 'structural' analysis of vulnerability, focusing on weak points independent of any expectable external disturbing intervention and

    b. a rather application-oriented, 'event-based' vulnerability analysis with regard to a specific disturbing event, e. g. the release of GMOs. (cp. Gößling-Reisemann et al. 2013)

Both determine the sensitivity of potentially affected systems either by theoretically analyzing the impact of possible adverse effects of a technology (b) or a general analysis of elements that are critical for the systems integrity and function (a) (Gößling-Reisemann et al. 2013).

Conclusion

By now not only the initial theoretical concept of gene drives reveals the new quality of genetic engineering that comes along with this new technological stage: First experiments in yeast and insects gave an impression of their effectiveness (cp. Champer, Buchman, and Akbari 2016). Power and range of gene drives potentially exceed the capabilities of previous stages in genetic engineering. Therefore, it seems to be justified to call this stage „active genetics" as suggested by Gantz and Bier (Gantz and Bier 2016). In contrast to previous releases of GMO, a release of gene drive modified organisms (GDMO) and the spread of their drives is intended to actively

control wild populations by a modification of their genotype and accordingly engineer ecosystems by the conversion or suppression of wild populations.

With the potentially increased power and range of GDMO in comparison with GMO many open questions arise regarding effects, control and reversibility. In particular actively replicating drives based on homing endonuclease genes (e.g., CRISPR/Cas9) are probably highly invasive and may thus be not confineable to a target population. Hence, there is an urgent demand for a prospective analysis of impact, side effects, countermeasures and the feasibility of low-risk approaches. An early analysis of gene drive technologies as well as affected systems by prospective technology assessment and a vulnerability analysis of potentially exposed systems may give indications for critical functionalities of the technology and weak elements of the surrounding environment. As with most areas of technoscience, basic research and application-oriented alignment are closely related and difficult to separate. Therefore, if there is evidence for low risk development paths, these improvements should be considered and implemented early in the development of new drive systems.

Given the high potential of gene drives as a new stage in genetic engineering, a public discussion on potential risks and benefits as in the advent of genetic engineering and first releases of GMO is still missing[1]. Nonetheless a broad debate is urgently needed to clarify the issues associated with the use of gene drives. Their range and their potential consequences are too significant to remain disregarded.

References

Burt, Austin. 2003. "Site-Specific Selfish Genes as Tools for the Control and Genetic Engineering of Natural Populations." *Proceedings of the Royal Society B: Biological Sciences* 270 (1518): 921–28. https://doi.org/10.1098/rspb.2002.2319.

Burt, Austin, Mamadou Coulibaly, Andrea Crisanti, Abdoulaye Diabate, and Jonathan K. Kayondo. 2018. "Gene Drive to Reduce Malaria Transmission in Sub-Saharan Africa." *Journal of Responsible Innovation* 5 (sup1): S66–80. https://doi.org/10.1080/23299460.2017.1419410.

Callaway, Ewen. 2017. "Gene Drives Meet the Resistance." *Nature* 542: 15. https://doi.org/10.1038/542015a.

Champer, Jackson, Anna Buchman, and Omar S. Akbari. 2016. "Cheating Evolution: Engineering Gene Drives to Manipulate the Fate of Wild Populations." *Nature Reviews Genetics* 17 (3): 146–59. https://doi.org/10.1038/nrg.2015.34.

Courtier-Orgogozo, Virginie, Baptiste Morizot, and Christophe Boëte. 2017a. "Agricultural Pest Control with CRISPR-based Gene Drive: Time for Public Debate: Should We Use Gene Drive for Pest Control?" *EMBO Reports*, May, e201744205. https://doi.org/10.15252/embr.201744205.

———. 2017b. "Using CRISPR-based Gene Drive for Agriculture Pest Control." *EMBO Reports*, August, e201744822. https://doi.org/10.15252/embr.201744822.

David, Aaron S., Joe M. Kaser, Amy C. Morey, Alexander M. Roth, and David A. Andow. 2013. "Release of Genetically Engineered Insects: A Framework to Identify Potential Ecological Effects." *Ecology and Evolution* 3 (11): 4000–4015. https://doi.org/10.1002/ece3.737.

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1   Cp. the STS proceedings-paper "A world without mosquitos?" of Julia Diekämper for a survey of newspaper articles on genome editing and gene drives. (cf. S. 90)

DiCarlo, James E., Alejandro Chavez, Sven L. Dietz, Kevin M. Esvelt, and George M. Church. 2015. "Safeguarding CRISPR-Cas9 Gene Drives in Yeast." *Nature Biotechnology* 33 (12): 1250–55. https://doi.org/10.1038/nbt.3412.

Dong, Yuemei, Maria L. Simões, Eric Marois, and George Dimopoulos. 2018. "CRISPR/Cas9 - Mediated Gene Knockout of Anopheles Gambiae FREP1 Suppresses Malaria Parasite Infection." Edited by Kenneth D Vernick. *PLOS Pathogens* 14 (3): e1006898. https://doi.org/10.1371/journal.ppat.1006898.

Doudna, Jennifer A., and Emmanuelle Charpentier. 2014. "The New Frontier of Genome Engineering with CRISPR-Cas9." *Science* 346 (6213). https://doi.org/10.1126/science.1258096.

Esvelt, K. M., A. L. Smidler, F. Catteruccia, and G. M. Church. 2014. "Concerning RNA-Guided Gene Drives for the Alteration of Wild Populations." *Elife* 3 (July). https://doi.org/10.7554/eLife.03401.

Fang, J. 2010. "Ecology: A World without Mosquitoes." *Nature* 466 (7305): 432–34. https://doi.org/10.1038/466432a.

Gantz, Valentino M., and Ethan Bier. 2015. "The Mutagenic Chain Reaction: A Method for Converting Heterozygous to Homozygous Mutations." *Science* 348 (6233): 442–44. https://doi.org/10.1126/science.aaa5945.

———. 2016. "The Dawn of Active Genetics." *BioEssays* 38 (1): 50–63. https://doi.org/10.1002/bies.201500102.

Gantz, Valentino M., Nijole Jasinskiene, Olga Tatarenkova, Aniko Fazekas, Vanessa M. Macias, Ethan Bier, and Anthony A. James. 2015. "Highly Efficient Cas9-Mediated Gene Drive for Population Modification of the Malaria Vector Mosquito Anopheles Stephensi." *Proceedings of the National Academy of Sciences* 112 (49): E6736–43. https://doi.org/10.1073/pnas.1521077112.

Gleich, Arnim von. 2013. "Prospektive Technikbewertung und Technikgestaltung zur Umsetzung des Vorsorgeprinzips." In *Konzepte und Verfahren der Technikfolgenabschätzung*, edited by Georg Simonis, 51–73. Wiesbaden: Springer Fachmedien Wiesbaden. https://doi.org/10.1007/978-3-658-02035-4_4.

Gleich, Arnim von, Christian Pade, and Henning Wigger. 2013. "Indizien Und Indikatoren Zur Umsetzung Des Vorsorgeprinzips" 22 (3): 16–24.

Gößling-Reisemann, Stefan, Jakob Wachsmuth, Sönke Stührmann, and Arnim von Gleich. 2013. "Climate Change and Structural Vulnerability of a Metropolitan Energy System: The Case of Bremen-Oldenburg in Northwest Germany." *Journal of Industrial Ecology* 17 (6): 846–58. https://doi.org/10.1111/jiec.12061.

Jinek, M., K. Chylinski, I. Fonfara, M. Hauer, J. A. Doudna, and E. Charpentier. 2012. "A Programmable Dual-RNA-Guided DNA Endonuclease in Adaptive Bacterial Immunity." *Science* 337 (6096): 816–21. https://doi.org/10.1126/science.1225829.

Lin, C. C., and C. J. Potter. 2016. "Non-Mendelian Dominant Maternal Effects Caused by CRISPR/Cas9 Transgenic Components in Drosophila Melanogaster." *G3 Genes, Genomes, Genetics* 6 (November 2016): 3685–91. https://doi.org/10.1534/g3.116.034884.

Marshall, John M., and Omar S. Akbari. 2016. "Gene Drive Strategies for Population Replacement." In *Genetic Control of Malaria and Dengue*, 169–200. Elsevier. https://doi.org/10.1016/B978-0-12-800246-9.00009-0.

Marshall, John M., Anna Buchman, Héctor M. Sánchez C., and Omar S. Akbari. 2017. "Overcoming

Evolved Resistance to Population-Suppressing Homing-Based Gene Drives." *Nature Scientific Reports* 7: 1–12. https://doi.org/10.1038/s41598-017-02744-7.

National Academies of Sciences. 2016. *Gene Drives on the Horizon: Advancing Science, Navigating Uncertainty, and Aligning Research with Public Values*. Washington, DC: The National Academies Press. https://doi.org/10.17226/23405.

Noble, Charleston, Ben Adlam, George M Church, Kevin M Esvelt, and Martin A Nowak. 2018. "Current CRISPR Gene Drive Systems Are Likely to Be Highly Invasive in Wild Populations." *eLife* 7 (June). https://doi.org/10.7554/eLife.33423.

Unckless, Robert L., Andrew G. Clark, and Philipp W. Messer. 2016. "Evolution of Resistance Against CRISPR/Cas9 Gene Drive." *Genetics*, January, genetics.116.197285. https://doi.org/10.1534/genetics.116.197285.

Webber, B. L., S. Raghu, and O. R. Edwards. 2015. "Opinion: Is CRISPR-Based Gene Drive a Biocontrol Silver Bullet or Global Conservation Threat?" *Proc Natl Acad Sci U S A* 112 (34): 10565–67. https://doi.org/10.1073/pnas.1514258112.

WHO/TDR and FNIH. 2014. "Guidance Framework for Testing Genetically Modified Mosquitoes." WHO Document Production Services (DUP), Geneva, Switzerl. http://www.who.int/tdr/publications/year/2014/guide-fmrk-gm-mosquit/en/.

A world without mosquitos? Communication aspects on one of the latest techniques

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Abstract

The research project GenomELECTION is a collaborative project involving the University of Halle and the Museum für Naturkunde Berlin. It is funded by the Ministry of Education and Research in the so called ELSI-program: Observing the ethical, legal, social aspects of life science. The museums task in the consortium is to investigate aspects of communication science with regard to the methods of genome editing. In this context, we have developed various formats that address the question of a world without mosquitoes against the background of gene-drive-systems. In our paper we present first findings and reflect on their significance, for example when reflecting processes of public negotiations. And it includes the question why a place like a natural history museum is suitable to reflect on these issues.

Genome Editing goes public?

Reflecting where – physically – debates and negotiations on challenging techniques impacting nature-humans relations can take place, we argue that the Museum für Naturkunde (MfN) can be used as a hub for the endeavor to communicate genome editing to and with a broader public. Our key argument is that here an audience can be encountered that is different from those who already have shown a long-standing interest for the specific topics. In concrete terms: In concrete terms: it is a matter of freeing genome editing from the embrace of solely science-driven debates on the one hand and theory-driven moral reflections on the other (Vohland et al. 2017).

In the debates on genome editing references to "nature" or "naturalness" play a central role. Here, the museum offers very different readings of the related concepts paired with a multi-sensory approach, thus preparing the ground for a fruitful discussion. The museum site provides a contextualized space that places participants within natural history and science; the tactile and visual cues of this dedicated and safe space support, enhance, and inspire the discussions. With its public exhibitions and its educational program, the MfN is an ideal place to authentically convey current scientific research results and to enter into dialogue with various demographic groups. The MfN is undergoing a period of upheaval, in which it is rethinking its relationship with its visitors and the public as part of a participatory turn, both in its museum work (especially Simon 2010) and its scientific communication and policy (Jasanoff 2013). At the same time, museum visitors increasingly see museums as a platform for public participation in political decision-making processes (Bandelli and Konijn 2015).

The MfN is one of the most visited museums in Berlin, 800.000 visitors came here in recent years on average (Museum für Naturkunde 2016). Although the visitors structure is diverse in relation to for example age or education – we do not assume that these visitors represent "the" public. However, the fact that the visitors are probably different from those who are searching directly for topics in the field of genome editing, gives us the first clues. In this sense it might be helpful to distinguish between a "public" who is created by meeting the issues and an interested public,

who looks specifically for the topics or exchanges. In this sense, the historical concept of the large public sphere (Habermas 1990) is an outdated one. Instead we prefer to speak of a structural change of the public sphere: it has been divided into a multitude of communities in which issues are negotiated or suppressed (Reckwitz 2017). So if communication does not affect *one* public, then it is crucial to build discourse spaces that can create something like "chance acquaintance": initial contacts with these topics that, in the best case scenario, generate interest and create entry into discussing. And this is something that could also become the task of the MfN. To understand a museum as a place of debate, as a political place, it is necessary – according to our thesis – not only to hold debates, but also create experiences with the course and momentum of debates in order to make them fruitful and transfer the knowledge about important ingredients for these debates.

By evaluating all the formats we are performing, we gain a deeper insight into the visitors' attitudes underlying beliefs and intuitions. And these value judgments often feed on completely different sources than the logical rational arguments. In short interviews we ask the participants about their approaches (*have you already dealt with the questions discussed here before today's event?*), their perception (*what do you associate with the topic?*), the consequences of the format (*stimulating to discuss it? Suggestions for other formats*?) and their demographic data (age? gender? highest level of education?). We try to produce novel and more diverse forms of objects and knowledge for all participants (Balmer et al. 2015, 8).

Debate structure

None of the questions related to genome editing is a genuine subject of the natural science but belongs to the field of morality. *Nature* pointed out recently, that current debates are characterized by an awareness for interdisciplinary approaches. But they added,– nevertheless: It takes place more as accumulation than as dialogue (Jasanoff and Hurlbut 2018). In addition to the question of disciplinarity, however, the debate is also characterized by the fact that the questions linked to the development of these techniques are so practically interwoven in everyday life that it is essential to discuss them beyond scientific access. For engaging in norms (e.g., "what to do?") and values (e.g., "how to live?") a holistic approach is necessary – across various disciplines and together with various non-scientific stakeholders. The public should not only be included because there is a common moral problem, for example whether one should be allowed to invent life, but also because a potential usage would reach deep into everyday life of almost every human being and poses questions of good life and wellbeing. This means in the classical sense "eudemonia". In this sense we can distinguish a moral argument from ethical deliberation.

Looking at the negotiations regarding genome editing, it is obvious that the creation of new spaces of deliberation and calls for public participation in political decision-making processes of new technologies have become widespread in recent years. Despite a repeated request for public engagement on this topic, the claim for seeking an open dialog on regulatory questions has not been complied with so far. In a final statement, representatives of the leading academies from the US, the United Kingdom, and China concluded that it would be irresponsible to continue clinical research and the development of germline editing unless

and until "there is broad societal consensus about the appropriateness of the proposed application" (NASEM 2015). In Europe scientific and political bodies called for public

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conversation on gene editing, e.g. in the UK the Nuffield Council (Nuffield Council on Bioethics 2016) or the Royal Society (Van Mil, Hopkins, and Kinsella 2017). In Germany major societies (Leopoldina, Acatech, and Union der deutschen Akademien der Wissenschaften 2015, Reich et al. 2015, Acatech 2017), as well as the national ethics committee (Deutscher Ethikrat 2017), picked up the topic.[1]

Nevertheless we argue that the narrow focus of the debate seeks to produce public opinion in a strategic way, and by doing so, prevents alternative narratives from surfacing in the debate. We are confronted with a dilemmatic situation: If we look at the many events that make genome editing a topic, there is no shortage of "information". German media additionally regularly use the technology as an occasion. Interestingly enough – at least in the beginning – a technique *as such* is up for negotiation. In this sense, CRISPR makes the front pages. If we look at the different applications (see figure 1), we can still see that gene-drive systems more or less take up a blank space.

germ line (29 %)
somatic treatment (30 %)
agriculture (21 %)
general information (7 %)
gene drive (5 %)
research (4 %)
other (8 %)

the % are rounded

"Other" = animals, extinct animals, public perception, media processing, storing data in DNA, biotechnology, bacteria, synthetic biology
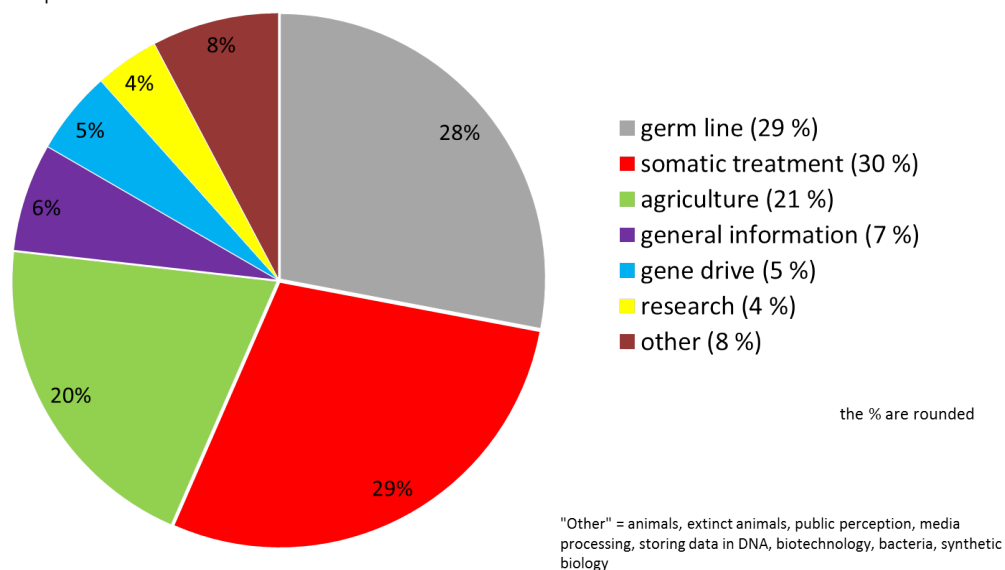
Figure 1: Areas of application between 2013 and 2018, own collection.

Out of 206 articles in the field, only four focus on the gene-drive-systems exclusively. It usually only appears as a marginal note, often without using the term "gene drive". In general, it can be stated within the media discourse that a general moral problem situation is followed by an eudaimonistic one that concerns "good life". These are two different normative discourse strands which follow other normative premises or can be located in different value horizons – concerning the genre or the good life.[2]

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1   Events of German Ethics Council in 2017: http://www.ethikrat.org/veranstaltungen/jahrestagungen/zugriff-auf-das-menschliche-erbgut; http://www.ethikrat.org/veranstaltungen/weitere-veranstaltungen/gene-drive, 2018: http://www.ethikrat.org/veranstaltungen/jahrestagungen/des-menschen-wuerde-in-unserer-hand

2   This consideration was presented at the autumn meeting of the German Ethics Council in 2017. [http://www.ethikrat.org/veranstaltungen/weitere-veranstaltungen/gene-drive].

Whereas in other areas of application of genome editing an eudaimonistic perspective proved dominant over a moral one, in talking about gene drives the two interlock and block each other in this early stage of negotiating. Based on our assumption this is due to the fact that, firstly, people do not recognize themselves as affected directly and, secondly, because – unlike genome editing in general – a highly charged concept of nature comes into play.

Nevertheless, in a nutshell: in terms of media attention and reporting, there is no lack of interest in the topic of genome editing. At the same time, surveys conclude that genome editing is unknown to large parts of the diverse public spheres (Bundesinstitut für Risikobewertung 2017). But if we now assume that the technologies are as significant as advertised, then this gap has to be filled. The existing narratives do not yet seem to be sufficient for this.

Therefore, the aim is therefore to create deliberative places of debate and sensuously gripping narratives that, on the one hand, create a relationship between the charged concept of nature in these debates and questions of good life that can be connected to everyday life beyond simply imagined scientific communication and, on the other hand, preformatted moral patterns of argumentation.

Trials and practice at MfN

In our view CRISPR represents an opportunity to engage creatively with science outside well-known patterns of promises and fears and beyond the current debate. We would like to present one narrative line we performed in the museum, beginning in autumn 2017.

What do you think?

1. **IS IT LEGITIMATE TO KILL THE MOSQUITOES IN MY GARDEN?**
   Yes, that way I can avoid being stung.
   No, because other animals in my garden (e.g. songbirds) might not find enough food.
   It depends on the associated consequences for my garden.

2. **IS IT LEGITIMATE TO CHANGE MOSQUITOES VIA GENE TECHNOLOGY SO THAT THEY CANNOT TRANSMIT THE ZIKA-VIRUS IN SOUTH AMERICA ANYMORE?**
   Yes, because no more humans would be infected.
   No, mosquitoes belong to natural ecosystems and are thus is why they must not be changed.
   It depends on the associated consequences of gene technology for the plants, animals and humans in the area.

3. **WOULD IT BE LEGITIMATE TO ELIMINATE THE MOSQUITOES IN MY GARDEN, IF THEY TRANSMITTED DISEASES?**
   Yes, that way my friends, family and I would be safe.
   No, because I am not allowed to intervene in nature.
   It depends on the associated consequences of gene technology for my garden and its animals.

COMMENTS:

MUSEUM FÜR NATURKUNDE BERLIN

Figure 2: Postcard, MfN 2017.

The first question ties in with an experience that we all know: Buzzing and stinging mosquitoes in summer: The answers point to different dimensions: Avoidance of damages, which focus specifically on the respondents. In addition, the damage is disruptive but not serious. The consequences are also central to the second answer, which in a first step does not concern humans, but those animals that have mosquitoes in their diet. Ecological consequences on a third level.

A concrete geographical level opens up the second question, which asks about the admissibility of altering the mosquitoes transmitting ZIKA viruses in South America. How does the perception of interventions change when it no longer directly affects us? The response options then also refer to infection in the context of damage avoidance. The focus there is on benefit for an international community. In contrast, the second answer two negates the possibility of referring a value to nature itself. Relatively, answer option number three links admissibility to the consequences of other plants, animals, and people in the region.

Since the first question is based on shared experiences and the second question is aimed at consequences that would not directly affect visitors, question number three brings together both perspectives in a fictitious scenario. The focus on damage prevention, which takes account of individuals and their close social environment, justifies the intervention; a strong concept of nature prohibits it. Answer three, on the other hand, considers the intervention to be permissible only in terms of the consequences for the garden and other living beings.

Discussing this in a context of genome editing inevitably leads to one of the possible applications: Gene-drive-systems.[1] In this regard CRISPR can be used to influence populations and thus possibly reduce species to the extent that they are made infertile. A "world without mosquitoes" is certainly not propagated by any scientist. For us, the questions are an invitation to imagine; it forms a hinge to everyday experience. And it puts the respondents in the position of experts. It is not a matter of "right" or "wrong". Technology is not in the foreground here (it is not mentioned explicitly at all). The point is to shift perspectives. As striking as these questions are, they contain dimensions that are relevant for the attitude to certain procedures: here it is also a question of loss prevention, risk assessment and categorical questions of admissibility.[2]

Public event

A public event which was entitled "World without mosquitos? New methods of genome editing" was the framework in which biological, ethical and governmental aspects were brought together. While they were doing this, the facilitator asked exactly the same questions as on the postcards and invited the visitors to answer them with their cell phones. We asked the questions in a context, which was closely linked to gene-drive-systems. Participants voted on the questions as follows.

All participants' answers agree that most of them prefer interventions over other considerations for the different scenarios. However, the profiteers differ considerably (respondents, 59% agree; world community, 51 % agree; social proximity 53 % agree).[3] The "benefits" seem to be most obvious in the answers to the first questions. The other two scenarios, on the other hand, show

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1   For a closer look at the corresponding possibilities please see: Giese, Bernd in this volume. (p. 82)
2   For a discussion see Johannes Frieß and Wolfgang Liebert in this issue. (p. 107)
3   For more information on the concrete evaluations of the results, see: (Diekämper in prep)

stronger tendencies towards balancing. This is because - this is our assumption - here, firstly, people do not recognize themselves so directly as affected and, secondly, because - unlike genome editing in general - a highly charged concept of nature comes into play.

One of the results we won via questioning the visitors after the event was: there were mostly academics (37%), mostly connected with science.

Opinionboxes

The questioning of an audience that is determinedly interested in these questions of genome editing is one thing. The other one? Exploiting the possibilities of the museum and its heterogeneous public. But how can we engage visitors into these debates and animate them to connect single exhibits to larger contexts? We have therefore installed interventions in the permanent exhibition. We call them "opinionboxes".

In a certain sense we consider these boxes as Boundary-Objects. The idea of boundary objects, first introduced by Susan Leigh Star and James Griesemer in 1989, is a useful theoretical tool. It is characterized as any object that is part of multiple social worlds and facilitates communication between them; it has a different identity in each social world that it inhabits (Star and Griesemer 1989, 409). As a result a boundary object must be simultaneously concrete and abstract, simultaneously fluid and well-defined.

The opinion boxes now link exhibits with social debates by asking visitors questions on research practice and applications of research.

Figure 3: Opinion Box in the permanent exhibition

Debates focusing on gene technology are – in Germany – highly structured by assumption which makes an exchange of position not fruitful at all.[1] This is why in a first phase the questions

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1   For a closer look see (Hampel 2008, Gaskell et al. 2010)

posed by the opinonbox do not use any terms concerning genetic engineering. Results will be confronted with a second phase in which specific references are included.[1]

The evaluation of the first phase of the visitor survey shows that most of the respondents had rarely (30%) or never (30%) dealt with the questions asked. That means: chance acquaintance. A good two thirds of respondents stated that the opinion box had encouraged them to think and discuss. Approximately on third of the respondents (30%) indicated that they were primarily guided by their "feeling" / "intuition" when it came to answering the questions. Their personal "relationship to nature" (22%), as well as their "experiences" (15%) also played a role in answering the questions.

Let us confront those findings with those gained at the public event (knowing that they are empirically little comparable). What we see here is that while for the first question the relative share for the second answer is obvious, the other two are different. The assessment that it is right to kill mosquitoes, however, diverges enormously. Even clearer is the difference in the question of the mosquitoes that ZIKA transmits. While the majority of those attending both the opinion box and the evening event voted in favor of the third question, the other two answers differ here.

Such figures are not very reliable due to their lack of comparability. But let us think about them as indicators to better understand how the debate works. What we see on the surface are different assessments of what we should do, measured by the degree of affectedness. From this different conceptions of nature can be derived, in which we intervene. And we notice a clash of meanings of this "nature". Here we see furthermore a relation to nature which is the base to judge political decisions and technical solutions etc. as positive or negative. How to deal with the opening of new play areas here?

Hartmut Rosa recently proposed "nature" as a resonance sphere (Rosa 2016). He argues that through technical possibilities the assumption of modernity, we experience who we are, becomes confused, as if we could increasingly decide for ourselves what our abilities and inclinations are. Nature no longer appears as given, but as made. This is the classic critique of objectification as we know it from Heidegger to critical theory (Heidegger 1967, Honneth 2015). It is the background on which the above-mentioned strong normative concept of nature is woven into the debates about genome editing and gene drives: Nature as the unavailable, as a sphere of self-legality, as the other of our technological access. Rosa, however, does not stop at the front position of nature's control and nature as an end in itself, but assumes a resonance relationship against the background of an idea of successful life. Understanding nature as such a multi-layered sphere of resonance - without neither instrumentalizing nor romanticizing - can complement the discourse on genome editing to the extent that it is no longer a question of asking: What may we do? What are we risking? It is about generating vibrations via the path of everyday experiences, which in turn are in the best sense part of a deliberative process.

Conclusion

Taking up the same question in different formats allows us to think about narrative structures and allows opening the discourse beyond the classical categories (e.g. benefit or risk). We argue that we need to think about bioethics as a broad term that encompasses different levels of

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1   The second phase has now been completed. The results are currently being evaluated.

access and beyond "technical" models of expertise (Moore 2010). Up to a certain extent, this may result from the technologies, it is therefore necessary to focus on their practical dimensions in everyday life.

Additionally, gene drives serve as an example about localaziation/self-efficacy in the word. This location in the world depends on a perception of nature (Birnbacher 2006). And this in turn depends fundamentally on the questions of good life. As a first step, we must make these references visible, take them seriously.

The call for publicity is a call for participation. This can only succeed if places are created and procedures are established in where the motives, attitudes and background convictions can be articulated and are taken seriously. We strongly believe that we need places for mutual learning. To invent and establish these places and procedures is one thing, to listen to and argue about what is being discussed there is another. Only when members from the public as well as political, and scientific areas come together the struggle for sovereignty of interpretation of what science should and may do is opened and eventually becomes a democratic discussion.

Central to this is the concept of "chance acquaintance". If we assume that we live in a society of singularities (Reckwitz 2017), we cannot assume that a public will focus on a universalistic moral question, but that questions of good living which each individual then thinks further for himself. "chance acquaintance" can only succeed if they are thought of as open, participative situations, beyond universalist moral questions, but also beyond one-dimensional scientific communication. Museums are not exclusive places where this can happen. But they can be one of the many places we need.

References

Acatech. 2017. *Innovationspotenziale der Biotechnologie (acatech IMPULS)*. München: Herbert Utz Verlag.

Balmer, Andrew S, Jane Calvert, Claire Marris, Susan Molyneux-Hodgson, Emma Frow, Matthew Kearnes, Kate Bulpin, Pablo Schyfter, Adrian Mackenzie, and Paul Martin. 2015. "Taking Roles in Interdisciplinary Collaborations: Reflections on Working in Post-ELSI Spaces in the UK Synthetic Biology Community." *Science & Technology Studies* no. 28:3-25.

Bandelli, Andrea, and Elly A. Konijn. 2015. "Public Participation and Scientific Citizenship in the Science Museum in London: Visitors' Perceptions of the Museum as a Broker." *Visitor Studies* no. 18 (2):131-149. doi: 10.1080/10645578.2015.1079089.

Birnbacher, Dieter. 2006. *Natürlichkeit*. Berlin: Walter de Gruyter.

Bundesinstitut für Risikobewertung. 2017. Durchführung von Fokusgruppen zur Wahrnehmung des Genome Editings (CRISPR/Cas9). Berlin: Bundesinstitut für Risikobewertung.

Deutscher Ethikrat. 2017. Keimbahneingriffe am menschlichen Embryo. Deutscher Ethikrat fordert globalen politischen Diskurs und internationale Regulierung. Berlin.

Diekämper, Julia et al. in prep. "Involving society: Evaluation of different formats for genome editing in a natural history museum."

Gaskell, George, Sally Stares, Agnes Allansdottir, Nick Allum, Paula Castro, Yilmaz Esmer, Claude Fischler, Jonathan Jackson, Nicole Kronberger, Jürgen Hampel, Niels Mejlgaard, Alex Quintanilha, Andu Rammer, Gemma Revuelta, Paul Stoneman, Helge Torgersen, and Wolfgang Wagner. 2010. Europeans and Biotechnology in 2010. Winds of change? : European Commission.

Habermas, Jürgen, ed. 1990. *Strukturwandel der Öffentlichkeit. Untersuchungen zu einer Kategorie*

der bürgerlichen Gesellschaft. Frankfurt a.M.: Suhrkamp Verlag.

Hampel, Jürgen 2008. *Der Konflikt um die Grüne Gentechnik. Diskursverfahren und öffentliche Meinung* Edited by Roger Busch and Gernot Prütz, *Biotechnologie in gesellschaftlicher Deutung*. München: Herbert Utz Verlag.

Heidegger, Martin. 1967. *Sein und Zeit*. Tübingen: Max Niemeyer Verlag.

Honneth, Axel. 2015. Verdinglichung. Eine anerkennungstheoretische Studie. Frankfurt a.M.: Suhrkamp Verlag.

Jasanoff, Sheila. 2013. "Epistemic subsidiarity–coexistence, cosmopolitanism, constitutionalism." *European Journal of Risk Regulation* no. 4 (2):133-141.

Jasanoff, Sheila, and J. Benjamin Hurlbut. 2018. "A global observatory for gene editing." *Nature* no. 555:435-437. doi: 10.1038/d41586-018-03270-w.

Leopoldina, Nationale Akademie der Wissenschaften, Deutsche Akademie der Technikwissenschaften Acatech, and Union der deutschen Akademien der Wissenschaften. 2015. Akademien nehmen Stellung zu Fortschritten der molekularen Züchtung und zum erwogenen nationalen Anbauverbot gentechnisch veränderter Pflanzen.

Museum für Naturkunde. 2016. Geschäftsbericht 2016. edited by Johannes Vogel and Stephan Junker. Berlin: Museum für Naturkunde.

NASEM. *On human gene editing: International summit statement.* 2015. Available from http://www8.nationalacademies.org/onpinews/newsitem.aspx?RecordID=12032015a. Nuffield Council on Bioethics. 2016. Genome editing. Nuffield Council on Bioethics.

Reckwitz, Andreas. 2017. *Die Gesellschaft der Singularitäten - Zum Strukturwandel der Moderne* Berlin: Suhrkamp Verlag.

Reich, Jens, Heiner Fangerau, Boris Fehse, Jürgen Hampel, Ferdinand Hucho, Kristian Köchy, Martin Korte, Bernd Müller-Röber, Jochen Taupitz, Jörn Walter, and Martin Zenke. 2015. Genomchirurgie beim Menschen. Zur verantwortlichen Bewertung einer neuen Technologie Berlin: Berlin-Brandenburgische Akademie der Wissenschaften.

Rosa, Hartmut. 2016. *Resonanz: Eine Soziologie der Weltbeziehung*. Berlin: Suhrkamp Verlag.

Simon, Nina 2010. *The participatory museum*. Santa Cruz: MUSEUM.

Star, Susan Leigh, and James Griesemer. 1989. "Institutional Ecology, 'Translations' and Boundary Objects. Amateurs and Professionals in Berkeley's Museum of Vertebrate Zoology, 1907-39." *Social Studies of Science* no. 19 (3):387–420. doi: 10.1177/030631289019003001.

Van Mil, Anita, Henriette Hopkins, and Suzannah Kinsella. 2017. Potential uses for genetic technologies: dialogue and engagement research conducted on behalf of the Royal Society. Royal Society.

Vohland, Katrin, Julia Diekämper, Alexandra Moormann, Tobias Nettke, and Wiebke Rössig. 2017. "Vor welchen Herausforderungen steht der Diskurs mit der Öffentlichkeit über neue Ansätze der Genomeditierung? Forschung zu Vermitlung und Partizipation." *Zeitschrift für Medizin-Ethik-Recht (ZfMER)* no. 8 (1):33-42.

Technology Assessment of Gene Drives

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The GeneTip Project

One of the goals in the project GeneTip: "Genetic innovations as triggers of phase transitions in animal and plant population dynamics" is the technology characterization of gene drive techniques. The project is a collaboration between the University of Bremen, TestBiotech in Munich, the University of Vechta in Lower Saxony and the University of Natural Resources and Life Sciences, Vienna. The GeneTip project looks at gene drives and self-propagating artificial genetic elements (SPAGEs) from a prospective risk analysis point of view and tries to identify hazard and exposure potentials in the development. It also analyzes their potential applications in order to give recommendations for a safer design and development path as well as regulations, taking into account the precautionary principle. But at the earliest phase of such innovations stands the prospective technology assessment with a technology characterization as its first step.

Prospective Technology Assessment and Characterization

Technology characterizations examine emerging technologies from a prospective point of view. In the early phases of technology development and innovation the knowledge about possible adverse effects is very low but the potential for maximizing opportunities and minimizing risk is still high [1]. But this will decrease as more and more investments into the technology are made and path dependency increases. Therefore, technology characterization is beneficial in early phases where the design and development paths can effectively be influenced. Analytical investigation in the course of a technology characterization is trying to gain knowledge on potential benefits, reasons for concern, reasons for relief and uncertainties.

In order to characterize and compare technologies there are different criteria which need to be considered. These are: the depth of Intervention, divided into its main effects technological power and range, considering its lasting persistence in a population, as well as the range with which it could spread across populations, and the intensity of intervention, divided into contributions by mass and frequency. Where the mass is determined by the quantity of gene drive organisms (GDOs) per release and the frequency represents the number of releases. Reliability concerns the failure probability by listing vulnerabilities within the technology and tries to estimate the probabilities that they will lead to failure of a drive. Besides the technical reliability it is important to check whether there are options for corrective actions after the release of GDOs in the case that greater problems occur. An investigation of these options should answer the question how far a potential damage could be reversed.

Gene Drives

In genetics, a gene drive is defined as a phenomenon that favorably biases the inheritance of a particular gene or set of genes. It can arise through a variety of mechanisms and results in an

increasing prevalence within a population. Gene drives have been proposed to provide effective means of genetically modifying populations or even whole species (for an introduction read [2]–[4]). Possible applications encompass: The control or even eradication of insects carrying pathogens, like malaria and dengue, or pest species such as the spotted wing drosophila or the diamondback moth. Also gene drives could be used to control invasive species, like rodents or weeds, or finally to eliminate evolved herbicide or pesticide resistances. Thereby a gene drive can be used to either suppress or transform a population or even a whole species by a new trait which is transmitted via the drive.

General Concerns about Gene Drives

The potential of gene drives to wipe out whole species raises some concern. An extinction should never be the set goal of an application but might still happen if the situation gets out of hand. There are three distinguishable groups of concern. First at the genetic level, where a multitude of problems await, depending on the method of gene drive applied, the target organism and the desired genetic modification. Two very general problems of faithful transgene integration are insertion into the wrong locus and faulty integration of the transgene. These are called off-target effects. And these effects are not just an issue when designing the gene drive organism but also post-release, when the modified genes are passed on and are exposed to mutation and selection processes.

Relevant implications may as well occur on the ecological level, where the released genetically modified organism (GMO) is part of a complex interconnected food web. Here it has to compete for food, space and mates. The concerns comprise so called non-target effects on other populations and species beside the target-population, which might foster unforeseen ecological and evolutionary impacts, such as the population eradication or replacement or the spread of a gene drive beyond the intended area and population. Moreover, an additional matter of concern is if and in what way humans or human health might be affected by a gene drive. Besides effects on ecosystem functions a gene drive might also affect ecosystem services and may thus result in a socio-economic impact. Beyond that, there is still a general legislative lack in regulations concerning gene drive technology.

The Spotted Wing Fruit Fly and the Medea-Gene Drive Technique

In the following some potential applications and the gene drive approaches which are considered in this context are presented. One recent target organism is the spotted-wing fruit fly (*Drosophila suzukii*). It is an invasive pest species in California, which lays its eggs into ripening cherries. To be able to do that, the fly possesses an unusually sharp ovipositor with which it punctures the hard skin of the immature fruit. The flies lay one egg per cherry and a female can lay approx. 200 eggs. Therefore, they cause a severe damage of approximately 700 million US Dollars each year. The problem with conventional insecticides is that they kill insects indiscriminately including useful pollinators like bees. Thus, a gene drive using the Medea technique is considered to either eradicate the fly populations by fusing the construct to fertility genes or to alter the flies' ovipositor so they would not be able to puncture the cherries and would have to alter their behavior [5]. It is important to note, that if as envisioned, such a gene drive would be released in about 5 years it would not only be the very first gene drive at all, but also the first to be released for agro-industrial reasons. This could be a precedent to allow the

application of gene drives against agricultural pests in numerous other cases. Followed by not only ethical but also ecological implications.

Medea is named after the sorceress from Greek mythology, the wife of Jason, who is known for his quest for the Golden Fleece. And as Medea found out that Jason was cheating on her, she intended to punish Jason by killing the children that she had with him. The name seems to meet the mode of action of the gene drive, as the technique genetically makes the mother kill their offspring. The genetic construct contains a tightly linked maternal toxin and an embryonic antidote. Therefore, embryos of Medea mothers are killed if they did not inherit the Medea construct. And surviving embryos will continue inheriting the gene drive [6]. In principle, Medea can be characterized as a low threshold gene drive and a modification drive. Which means in its basic form it is not meant to eradicate a population but to invade and take over. And low threshold means that it does not take many Medea-carrying organisms to drive the trait into the population. Therefore migration of those flies is a problem because – at least theoretically – one gene drive might eliminate all spotted-wing fruit flies in California and beyond.

Malaria and Dengue

An example of potential gene drive applications in the field of infectious diseases aims at vector species of pathogens such as for Malaria and Dengue. The malaria pathogens include 5 Plasmodium species. Wherein *Plasmodium falciparum* is the main contributor. The malaria vectors are mainly three species of the Anopheles genus. According to the World Health Organization (WHO) malaria is considered endemic in 91 Countries. The WHO estimates that there have been 216 million new malaria cases in 2016 and almost half a million deaths, most of them children under 5 years of age [7]. Strategies of disease control are hindered by emerging resistances of the vector against insecticides and of the pathogen against drugs [7]. Dengue on the other hand is transmitted by the dengue virus of which 4 different serotypes exist. The main vector species are of the Aedes genus. Dengue is endemic in approximately 100 countries. It is estimated that there are around 93 million clinical cases each year and around 22,000 deaths, also mostly children. The treatments remain supportive and mostly preventive vector control is condoned [8], [9].

Regarding malaria, there is the Target Malaria Project which is funded by the Bill and Melinda Gates Foundation and the Open Philanthropy Project Fund. Target Malaria pursues two gene drive approaches to tackle the malaria vector. One is the supposedly Y-linked X-Shredder approach. The letters X and Y of course stand for the sex chromosomes. In this approach, the male specimen produces mostly Y-bearing sperm and if such a male mates a wild type female, male-biased sex ratios of up to 95% can occur in which all males are also X-Shredder males [10]. After a few generations the increasing imbalance leads to a population crash.

The X-Shredder technique constitutes a suppression drive. There is the danger that such a gene drive may spread to surrounding populations, which seems especially probable in a population with a low ratio of females. The approach might favor alternative vector species. Since wiping out one mosquito population may trigger the next vector species to fill the ecological niche. Also it might trigger a coevolution of the pathogen. As there are fewer females to bite humans, it becomes more important for the pathogen to be even more virulent. But the most harm-bearing vulnerability is that there are no corrective actions to reverse or limit an X-shredder gene drive once released. It is however theoretically possible, although rather unlikely that a resistance will

stop the spread.

The other approach of Target Malaria is a CRISPR/Cas-based gene drive which is used to confer infertility in females. In the CRISPR/Cas-approach, a gene cassette containing the CRISPR/Cas gene and specific gRNAs as well as cargo genes that reduce female fertility are inserted into the mosquito's genome. When mating with a wildtype female then all offspring will be homozygous gene drive carriers. After fertilization, CRISPR/Cas recognizes the complementary locus on the homologous wildtype chromosome and makes a cut. The cell's DNA-repair mechanism recognizes that cut and in the best scenario, uses the gene drive containing chromosome as a repair template, thereby copying the gene drive cassette (as explained in [4] and successfully demonstrated in yeast in [11]). Thus, this technique allows to transform heterozygous carriers into homozygous gene drive carriers.

One major genetic drawback consists in the fact that when a cut by CRISPR is not repaired by homology-directed repair, it not only impedes the copying of the gene drive cassette but also creates a homing resistant allele which will be passed on to offspring generations. Furthermore, there are serious indications of a problem with incomplete or imperfect copying into the target locus, as well as off-target effects due to lacking specificity of the system. Sequence polymorphisms and maternal effects also make organisms resistant to homing. However, the CRISPR/Cas9 system is relatively new and currently one of the most heavily researched technologies in biology, thus further improvements (e.g. regarding specificity) are to be expected and already, there are some viable strategies to overcome the most obvious issues [11], [12].

The ecological implications harbor all the general problems associated with gene drives. For instance, there is the issue of lowered fitness. A population eradication would reduce diversity. Resistance formation is a major problem in the ecosystem as well, as it would confer an inheritable fitness gain that would persist in the population's gene pool and may lead to the failure of the gene drive. Furthermore, the CRISPR/Cas-based gene drives are thought to be highly invasive, wherein a small number of carrier-individuals could potentially cause the spread of the gene drive into neighboring populations [13]. Thus, confinement may be a problematic issue with this technique. This approach just as X-Shredder, may favor alternative vector species and trigger the coevolution of the pathogen [4], [14]. Beyond that, there is probably going to be transgenic contamination of an ecosystem, in so far as non-functioning gene drive components in the genome may persist in wild populations.

Dengue – RIDL

Another vector-transferred disease, which was already targeted by a SPAGE technique is dengue. This technique is called RIDL, which stands for Release of Insects Carrying a Dominant Lethal. This non-gene-drive technique comes in two varieties: the bi-sex RIDL and female specific RIDL. RIDL works using multiple mass releases of male GMO mosquitoes with GMOs to one wild type release ratios as high as 54:1 [15]. The GMOs carry a gene that will kill offspring during early life stages. The bi-sex RIDL kills offspring regardless of sex and is therefore self-limiting because after one generation all GMOs are dead. The female specific fsRIDL on the other hand only kills female offspring. Male offspring is then heterozygous for the lethal gene. In the next generation these males mate again with female wild types and half of their offspring will heterozygously inherit the deadly gene where again females will die. The other half of offspring

are genotypic wild types. This gives the fsRIDL approach both a short-term self-sustaining but ultimately a self-limiting character [2].

The RIDL technique has some vulnerabilities which especially in the case of dengue, are quite numerous. Already there have been test trials on the Cayman Islands, Malaysia and Brazil [16]. These revealed that the mating capabilities of the released GMOs are quite limited – with a competitiveness of 56% in comparison to wild males [17]. Additionally, there is the danger to spread antibiotic resistances because the GMOs need to be fed with this antibiotic in the laboratory in order to suppress the lethal gene. This is also a major culprit. Because tetracycline is widely used in animal feed production it can be found in the environment and sewage so that up to 15% of RIDL-females were viable when fed on cat food [18]. Besides these drawbacks, an eradication of one vector species *Aedes aegyptii* in the case of a successful RIDL application, allows the other vector species *Aedes albopictus* to spread [16]. Furthermore a reduction in the vector species might result in reduced cross- and herd-immunities and thereby favoring a more serious and deadly disease variant including hemorrhagic fevers [19]. Furthermore, there is the problem of spread to other populations, which again is especially probable in a population consisting mainly of male fsRIDL mosquitoes with a dwindling percentage of females. The gene product of the lethal gene was shown to be neurotoxic in mice [20]. Therefore, it might be possible to negatively affect predators. Moreover, there have been some errors in release as the mechanical sex sorting failed in 0,33% which is quite a lot considering that in the Cayman Islands a total of around 10 million mosquitoes were released [21]. Furthermore, the lethal gene does not seem to work in about 3% of cases [18].

Invasive Species in New Zealand

The last example for a possible gene drive application targets the invasive predators in New Zealand which damage the indigenous flora and fauna. Therefore, New Zealand's initiative predator free 2050 is planning to get rid of invasive species until 2050 [22]. Currently, New Zealand is conducting multiple techniques such as the sterile male technique, live trapping, poisoning and maybe in the future the so called Trojan female technique [23]. The most dreaded invasive species are rodents, especially rats, stoats and possums. In this regard, the application of a gene drive (possibly one that is based on CRISPR/Cas) is considered. A major problem in this case is confinement. Since these animals mostly stowed away on ships to get to New Zealand, gene drive organisms might use the same means of transportation to reach the rest of the world. This might result in a global diffusion of a gene drive that ultimately might exterminate all rats and potentially have devastating effects on ecosystems worldwide. A related problem would be the smuggling of a gene drive. Because these rodents are globally considered as pests and although they cause a net damage of about 50 million dollars in New Zealand the damage they cause in the USA of around 19 billion dollars is quite steeper. Therefore, a deliberate confinement breach is conceivable [24].

Comparison of different Gene Drive Technologies

On the basis of these parameters and the aforementioned criteria, the different gene drive techniques can finally be compared. It has to be noted that, gene drives in general fulfill the criterion of high depth of intervention resulting in high technological power and a high range due to persistence. Taking into account the fact that the technology acts on the fundamental basis of

an organism, the degrees of freedom of its genomic information and the potential to bias the inheritance of respective (artificial) traits, the technological power has to be rated as high. The technological range on the other hand scores as high due to the gene drive's capability of self-replication/propagation, the possibility to spread geographically and invasively penetrate populations. A major distinction in the technological range can be made between self-limiting and self-sustaining drives. However, between individual gene drive techniques further distinctions are possible: The intensity of intervention (i.e. mass and frequency) is high for technologies like RIDL and X-Shredder that require mass releases and low for those that do not, as e.g., Medea and CRISPR/Cas-based Drives. The depth of intervention is high for technologies like X-Shredder and CRISPR/Cas that confer a self-sustaining drive, permanently altering wild type populations, and moderate for self-limiting drives like MEDEA and RIDL. With regard to the reliability and failure probability, in particular resistance formation is a major issue that limits the effectivity of CRISPR/Cas-based drives. But evolutionary changes on the level of DNA may in general be a source of unforeseen effects and therefore hamper the intended impacts of SPAGEs.

For corrective actions, wild type releases to outcompete the altered SPAGE organisms are considered for both RIDL techniques. With regard to CRISPR/Cas9-mediated gene drives, there are considerations for a rescue drive to remedy the genetic alterations and currently there are plans for anti-gene drives that utilize a chemical killing-off only the GDOs [12], [24]. So far, only for X-Shredder there is no way to remedy the gene drive. But it has to be noted that most of the discussed options for corrective action are not proven so far and limited to theoretical speculation and models.

Concluding Remarks

The purpose of this article is to raise awareness toward reasons for concern and potential benefits of the emerging gene drive technologies. There is still time to act and influence the design and development paths. We face a great challenge in our responsibility towards our ecosphere and all its residents. Therefore, we need to be careful in the alterations we extract upon the environment and be vigilant of adverse effects that might follow rash interventions into complex systems. The precautionary principle is dependent on reasons for concern. Some of which have been presented here. These reasons for concern should also be considered in the next step concerning the regulation of these newly emerging technologies that possess a new quality beyond anything that is currently practiced in genetic engineering.

Funding

References
[1]   D. Collinridge, *The social control of technology*. London u.a.: Pinter u.a., 1982.

[2]   L. Alphey, "Genetic control of mosquitoes," *Annual review of entomology*, vol. 59, pp. 205–24, 2014.

[3]   A. Burt, "Site-Specific Selfish Genes as Tools for the Control and Genetic Engineering of Natural Populations.," *Proceedings of the Royal Society B: Biological Sciences*, vol. 270, no. 1518, pp. 921–928, May 2003.

[4]	K. M. Esvelt, A. L. Smidler, F. Catteruccia, and G. M. Church, "Concerning RNA-guided gene drives for the alteration of wild populations," *eLife*, vol. 3, Jul. 2014.

[5]	A. Regalado, "Farmers Seek to Deploy Powerful Gene Drive," 12-Dec-2017.

[6]	O. S. Akbari, C.-H. Chen, J. M. Marshall, H. Huang, I. Antoshechkin, and B. A. Hay, "Novel Synthetic Medea Selfish Genetic Elements Drive Population Replacement in Drosophila, and a Theoretical Exploration of Medea-dependent Population Suppression," *ACS Synth Biology*, vol. 3, no. 12, pp. 015–928, Dec. 2014.

[7]	WHO, "World Malaria Report 2016 - Summary."

[8]	R. W. Byard, "Lethal Dengue Virus Infection: A Forensic Overview.," *American Journal of Forensic Medecine and Pathology*, vol. 37, no. 2, pp. 74–78, Jun. 2016.

[9]	WHO, "Dengue Control- What is Dengue? URL: http://www.who.int/denguecontrol/disease/en/," 06-Jun-2018.

[10]	R. Galizi *et al.*, "A Synthetic Sex Ratio Distortion System for the Control of the Human Malaria Mosquito," *Nature Communications*, vol. 5, p. 3977, Jun. 2014.

[11]	J. E. DiCarlo, A. Chavez, S. L. Dietz, K. M. Esvelt, and G. M. Church, "Safeguarding CRISPR-Cas9 gene drives in yeast," *Nature biotechnology*, vol. 33, no. 12, pp. 1250–1255, Dec. 2015.

[12]	K. M. Esvelt, "Precaution: Open gene drive research," *Science Letters*, vol. 355, no. 6325, pp. 589–590, Feb. 2017.

[13]	C. Noble, B. Adlam, G. M. Church, K. M. Esvelt, and M. A. Nowak, "Current CRISPR gene drive systems are likely to be highly invasive in wild populations," *eLife*, vol. 7, no. e33423, pp. 1–30, Nov. 2017.

[14]	L. Alphey, "Can CRISPR-Cas9 gene drives curb malaria?," *Nature biotechnology*, vol. 34, no. 2, pp. 149–50, Feb. 2016.

[15]	Gene Watch UK, "Oxitec's Genetically Modified Mosquitoes: A Credible Approach to Dengue Fever?," 2015.

[16]	Gene Watch UK, "Oxitec's Genetically Modified Mosquitoes: Ongoing Concerns," 2012.

[17]	A. F. Harris *et al.*, "Field Performance of Engineered Male Mosquitoes," *Nature Biotechnology*, vol. 29, no. 11, pp. 1034–1039, Oct. 2011.

[18]	C. Rodriguez-Beltran, "GM Mosquitoes: Survival in the Presence of Tetracycline Contamination," 2012.

[19]	Y. Nagao and K. Koelle, "Decreases in dengue transmission may act to increase the incidence of dengue hemorrhagic fever," *PNAS*, vol. 105, no. 6, pp. 2238–2243, Feb. 2008.

[20]	H. J. Han *et al.*, "Strain Background Influences Neurotoxicity and Behavioral Abnormalities in Mice Expressing the Tetracycline Transactivator," *Journal of Neuroscience*, vol. 32, no. 31, pp. 10574–10586, Aug. 2012.

[21]	R. Lacroix *et al.*, "Open Field Release of Genetically Engineered Sterile Male Aedes aegypti in Malaysia," *PLOS ONE*, vol. 7, no. 8, p. e42771, 2012.

[22]   Department of Conservation, "Homepage Predator Free 2050 - https://www.doc.govt.nz/ nature/pests-and-threats/predator-free-2050/," 06-Jun-2018. .

[23]   N. J. Gemmell, A. Jalilzadeh, R. K. Didham, T. Soboleva, and D. M. Tompkins, "The Trojan female technique: a novel, effective and humane approach for pest population control," *Proceedings of the Royal Society B: Biological Sciences*, vol. 280, no. 1774, pp. 1–8, Oct. 2013.

[24]   K. M. Esvelt and N. J. Gemmell, "Conservation demands safe gene drive," *PLOS Biology*, vol. 15, no. 11, p. e2003850, Nov. 2017.

CRISPR-Cas9 based gene drives for fighting malaria: aspects of prospective technology assessment

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One important example for research and development (R&D) aiming at technically engineered gene drives (or mutagenic chain reactions) are attempts to develop such systems against mosquito species which can transmit malaria. The pathogen causing malaria is mainly *plasmodium falciparum*. The transmitter of that pathogen are mainly **Anopheles** mosquitos and specific sub-species. Typically, around 1% of an infected female mosquito population bears the pathogen and amplify it. After a bite of an infected mosquito a small number of the pathogen could cause the infection of a human. There starts a huge amplification process and finally the erothrocyts in the blood circulation of the human come under sever attack. Very few of the pathogen can transform in a way that a next biting mosquito can be infected again. The whole cycle endures roughly four weeks.

Malaria is still endemic in many regions of the world. The most significant hot spots are located in Africa. The World Health Organisation (WHO) has estimated in 2015 that still about 200 million humans are infected annually and about 400,000 death cases occur. (WHO 2015a) Malaria is regarded as one of the global challenges and was included in the UN Agenda for Sustainable Development in 2015.

One focus of the fight against malaria is "vector control", that means the combat against malaria transmitting mosquito species. Hopes for a new technical tool are associated with gene drives which could effectively attack mosquito populations by circumventing the Mendelian heritage rules.[1] The discovery of new gene scissor CRISPR-Cas9 has triggered a research boom also in this field. Gene drives could become extremely powerful tools for humans to make dramatic intentional or unintentional changes in populations and entire ecosystems – possibly on a global scale. Therefore, it is necessary to engage in appropriate procedures of science and technology assessment in good time before such technologies are mature.

A group of colleagues – including me – have developed the concept of Prospective Technology Assessment (Liebert et al. 2005, Liebert/Schmidt 2010, Liebert/Schmidt 2015), which could guide the assessment in this case. Prospective Technology Assessment (ProTA) which is partly impossible without analysing the scientific-technological core can roughly be described as follows:

- analysis of scientific-technological development at an early stage anticipating what might be relevant for science-based mid-term assessments and for (participatory) discourse inside and outside science
- assessment of intentions, potentials, risks and unintended consequences, realistic potentials versus unrealistic visions and promises, uncertainties (and ignorance)
- analysis/characterization of the type of technology involved

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1   Cf. contributions of B.Giese and J.Frieß to the conference proceedings.

- analysis/assessment of opportunities for shaping science and technology and technical or socio-technical alternatives
- reflection on normative issues, values and interests involved.

In the following, I will address several of these aspects in order to demonstrate the need for such exercises of technology assessment.

Potentials and development risks

We have already seen laboratory experiments with relevant mosquito species based on gene drives constructions using CRISPR-Cas9. Up to now four gene drive constructs have been engineered in the lab: one in the fruit fly *Drosophila melanogaster* (Gantz/Bier 2015), one in yeast (DiCarlo et al. 2015), two in mosquitos (Gantz et al. 2015, Hammond et al. 2016), which transmit malaria (*Anopheles stephensi*, *Anopheles gambiae)*. However, it turned out that after several mosquito generations the chain reaction slowed down in most of the cases, the engineered gene drives became unstable. Thus, a potential, which could be exploited in principle, has been made visible, but not more. What has been achieved scientifically are steps towards a theoretical proof of concept in the laboratory.

In general, two main development paths of gene drives which are relevant for combatting malaria vectors are envisioned:

- *suppression drives* aim at dramatically reduce malaria transmitting mosquito populations regionally or globally – probably eradicate them
- *modification/manipulation* drives strive to manipulate mosquitos (or probably the pathogen) so that malaria infection of humans is reduced or disabled.

The principle potential of gene drives is seen as advantageous by the scientists involved in R&D. They believe that the efficacy of gene drive strategies could be much more target specific with much lower "collateral damages" than for other technological approaches currently in use. However, first of all, it is unclear so far whether gene drives in mosquito wild populations will be feasible:

- The observed slow down of gene drives can be partly explained with the occurrence of resistance against the gene drive construct (Unckless et al. 2017, Champer et al. 2017). The mechanism can be roughly explained as follows. CRISPR-Cas9 finds appropriate locations of the mosquito´s DNA by specifically designed short guide-RNA strains. At these sites a cleavage of the DNA is induced and specifically designed "homing endonuclease genes" are copied into these cleavage sites thereby creating a construct which is inherited at a super Mendelian rate if copied into the germ line. Prerequisite for that result is that a repair mechanism for the DNA is working in a suitable manner. This wanted repair mechanism is called Homology Directed Repair (HDR). But there is a competing repair mechanism called Non Homologous End Joining (NHEJ). If the repair is done by NHEJ the target site cannot be recognized anymore by the gene drive. Therefore, CRISPR-based gene drives have the propensity to generate resistance alleles which cannot be converted anymore to drive alleles. Eventually the mutagenic chain

reaction comes to an end. Strategies to overcome this obvious disadvantage are discussed but could not be demonstrated so far. Furthermore, one could expect that such strategies working with multiple guide-RNAs would increase the complexity and non-linear behaviour of a gene drive construct. In consequence, its instability could be increased again.

- *Anopheles* mosquitos possess a large genetic variety and evolutionary adaptability. Therefore, it is unclear whether genetically modified mosquitos will react efficiently with wild populations. A single gene drive might not be effective so that the development and use of many gene drive constructs might be needed to cover the range of genetic variants of *Anopheles.*
- Trends so far indicate that genetic modifications of wild-type mosquitoes make them less evolutionary fit. Such generated disadvantages could also limit gene drives.
- Cross-fertilization has been reported among various mosquito species. Thus, one insect can overtake the role of transmitting malaria to another. Therefore, eradicating or modifying only one vector species might be futile.

These examples demonstrate that development risks are numerous. But imagine it could be done. Many scientists are eager to overcome the briefly sketched hurdles on the way to efficient gene drives. If they could succeed, will that be the solution for the malaria challenge? In the end, control of *Plasmodium falciparum* and other parasites is the crucial point. It has to be done much more than attacking the genetic code of vectors (mosquitos): the parasite cycle itself has to be interrupted in a sustainable manner. That is much more a question of health care and access to suitable simple measures than a new sophisticated technological tool. Social organisation and behaviour, access to modern healthcare, a functioning health care system in regions concerned, preventive and curative measures and availability and affordability of suitable means are of utmost importance when fighting malaria. The question arises whether the promise of gene drives against malaria is tenable.

Anticipatable risks, consequences, and uncertainties
Imagine it could be demonstrated that gene drives against malaria transmitting mosquitos could work in the wild. What risks would be involved in gene drive usage?
Questions arising related to suppression drives:

- An efficient mutagenic chain reactions could work across many or even all national borders. (The danger – or hope – exists that an extinction programme will work globally.) This will raise very serious and difficult questions concerning decision making and regulation unparalleled so far.
- The specificity of guide RNAs targeting cleavage points of the DNA of a targeted species is below 100%. Unintended gene variants could be generated that way. Thus off-target effects could produce unwanted mutations and unwanted mosquito variants could emerge.
- As mentioned above, the pathogen could possibly find a way to change its currently most favoured host mosquito. Would that require efforts to eradicate more and more mosquito species by more and more gene drives unleashed on nature? We know already about 30

mosquito species transmitting malaria.

- Due to cross-fertilization between different mosquito species it could be possible that an efficient suppression drive jumps over to another non-target mosquito species.
- Ecological consequences (including cascading effects within the food chain) could be the unintended result of the use of gene drives. (David et al 2013) It is scientifically irrefutably clarified that malaria mosquitoes have only a damaging function in nature by infecting humans? Do they have instead also important beneficial and indispensable roles in the food chain or in the pollination business? For mosquitoes, in general, there are examples showing that (Camargue, Nordic Artic, aquatic systems), but mainly we have to admit ignorance about that.

One could believe that manipulation drives finally aiming at the transmitting behaviour of the parasite might be more intelligent and less risky. But again unintended off-target effects are possible. And it could turn out that very quick processes of natural evolution in the parasite-host relation destroy initial successes or make the parasite´s impact for humans even worse. This would probably provoke engineering and use of more and more gene drives trying to resolve renewed emerging problems again and again.

In sum, several risks and unintended consequences of gene drives can be anticipated in all clarity. But, there are also plenty of uncertainties and unknowns due to the dynamic complexity of natural systems.

Fundamental problems and questions

Beyond the risks sketched above several much more fundamental problems and questions emerge:

- If there is a chance that a gene drive can be made evolutionary stable in a natural environment, then already a single release of a modified organism with wrong or detrimental characteristics (even unknown before) could have irreversible consequences. There is not something like a tolerable limited release.
- A dual-use potential seems to be obvious.
- By realizing mutagenic chain reactions the already high depth of intervention by humankind into natural processes would be massively increased. That is per se a risky undertaking, since irreversible unintended changes could be the result. Also intended effects could be problematic.
- The intrinsic logic of gene drives fighting malaria suggests already that after first attempts more and more gene drives have to be engineered and released to correct or improve what wasn´t achievable in the first step? One gene drive will not suffice, the pressure for more will "naturally" be generated to bring about human control – which could turn out as being unachievable in the end? Do we have to expect a chain reaction of mutagenic chain reactions, prone to human error and ignorance?
- Engineering gene drives to fight malaria (and the fight against malaria is definitely justified and indisputable) could turn out as a welcomed door-opener for much more. What is already on the horizon? (NAS 2016) Surely, gene drives against other mosquitoes, in general against other insects or rodents transmitting infectious diseases. Probably gene

drives against so-called pest animals? Are various fruit flies or plague locust not already on the list? Also so-called invasive species (plants as well as animals), neophytes can be attacked, eventually eradicated.

- What starts with the fight against malaria could end in a nature under complete management of humankind. Gene drives would dramatically change the way how humans act within nature. Humans will have a tool, then, to steer evolution deliberately, humans can decide, what species their like or dislike, which one have the right to survive in a given form etc. One of the young shooting-stars in the scientific scene (coming from the group around George B. Church), Kevin Esvelt, named already his new working group at MIT "Sculpting Evolution". Another researcher, Andrea Crisanti, is cited with "we can edit nature". Despite the far-reaching visions we are faced with huge unknowns of the complex, non-linear interactions in genetic transfer, living cells and organisms, populations, ecosystems, sensitive global life connections.

- Gene drives are engineered selfish genetic elements designed to operate autonomously in nature. Other technologies are also underway in R&D to eventually work nature-like in nature (e.g. in the field of synthetic biology or autonomous robots). Jan Schmidt has coined the term *late-modern technology* ("nachmoderne Technik") to identify a remarkable paradigm shift. (Schmidt 2015) This new type of technology is based on the concept of self-organisation and is linked to instabilities which have to be triggered in non-linear dynamical systems. The classic-modern type of technology was, in contrast to that, related to concepts of stability, linearization, predictability and controllability. But now non-linear features and capabilities are exploited and scientists and engineers are striving for self-replicating systems which have the potential of further evolutionary changes. However, this kind of built-in dynamics is provoking limitations with regard to the possibility of a stable construction and subsequent monitoring and control of such technologies.

Alternatives to gene drives?

Gene drives are highly invasive tools which can or should persist in nature. Should we rely on such technologies? If not, alternatives have to be considered. Several approaches are currently discussed, researched, validated and are partly in use (Alphey 2014). One example is the infection of mosquitos with **Wolbachia** bacteria which are maternally inherited and affect reproduction capabilities. That could therefore lead to strategies to suppress or replace mosquito populations. Another example of population suppression is the release of genetically modified mosquitos passing on dominant lethal factors to their offspring (RIDL). Another approach, which has been in use against major agricultural pest insects, is the sterile insect technique (SIT), where large numbers of the target insects are mass-reared, sterilized by radiation, and then released in order to negatively influence the reproduction of insect populations. Multiple releases of sufficient quantities of manipulated mosquitos are necessary in all these cases to obtain the wanted results. Such approaches must also be carefully assessed. To obey the precautionary principle is mandatory also for these technologies. But, in principle, one could say, that unpleasant risks and other ramifications of these technologies might be less severe than in the case of gene drives.

The most important socio-technical alternative might be the UN and WHO strategy to eliminate malaria until 2030. (WHO 2015b) This strategy is merely based on more or less low tech use like

- long lasting insecticidal nets
- indoor residual spraying
- prevention of risk groups (pregnant woman and children under five years) by chemoprophylactic treatment
- increased access to diagnostics and medical treatment in epidemic regions (e.g. artemisinin-based combination therapy).

Crucial is a minimally functional health care system, affordability of diagnostics and medicaments as well as educating and empowering of communities so that their can reduce the malaria risk themselves. Important successes of the global strategy have already been reported: the malaria incidence rate declined by 37% and the mortality rate by 60% since the turn of the century (WHO 2015a). Therefore, the hopes are high that global malaria elimination is possible like in many world regions in the past. But this important task can only be accomplished if sufficient funding can constantly be raised (several billion dollars a year).

One should also remark that in several countries past (successful) elimination campaigns also had harmful side effects on the environment by massive use of DDT. Furthermore, first resistances of mosquitos against insecticides have been developed then. Improper use of malaria drugs, which mostly have to be taken in suitable combinations, has also lead to resistance of the malaria parasite.

A global malaria elimination strategy has to include more than vector control: the interruption of the parasite cycle as a whole has to be considered. Therefore, the UN/WHO strategy cannot be replaced by anything else. However, may be new technological tools could be added to that.

Normative questions, values and interests involved

Values and value judgements are involved in the development of novel technology. That is also the case for gene drive R&D. Often scientists and decision-makers state: "risk has to be balanced against benefit". That sounds good because risk assessment plays an important role then. But this can lead to a purely utilitarian ethical position. Weighing positive and negative consequences is advisable but ethical reflection should heed all ramifications of scientific-technological development and also serious fundamental problematics.

Deduced from Hans Jonas´ *principle of responsibility* (Jonas 1979) high importance is attached to the fundamental *precautionary principle* – at least in the framework of the European Union. This "conservative" positioning calling for the preservation of nature can be combined with an *unfolding principle* calling for a just developmental progression of humankind which depends partly also on novel technology. The latter can be associated with Ernst Bloch´s *principle of hope* if the technology invented is in harmony with nature which Bloch has named "alliance technology" (Bloch 1959). Both principles together could give orientation also when judging about the best acceptable ways to malaria elimination.

The perception of the role of humans in nature is also highly relevant. Is humankind seen as manager of all life on earth, what can be deduced from "modern" statements like that one of

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René Descartes who has apostrophized man as "master of nature". Or do we see humankind embedded into nature and as a partner of all life on earth? Albert Schweitzer´s principle *respect for life* could be cited in this respect: "I am life that wants to live in the middle of life that wants to live". (Schweitzer 1966)

How should WE decide? What seems to be an acceptable and well-founded ethical position? Scientists have to reflect about such questions and not only about their purely scientific tasks and challenges. Even more, the normative debate, argumentation and position finding with respect to gene drive R&D is a challenge for us all as citizens of the planet earth.

The whole fabric of risks, uncertainties and ignorance, possible dramatic consequences of mutagenic chain reactions have to be considered within the normative discourse. Is gene drive research and development directed on practical use a responsible undertaking? Is the malaria challenge a sufficient argument to invest into this kind of research? Who is entitled to change nature in a way that it could irreversibly affect all life on earth? A single researcher, the scientific community, an agency, a nation?

Do we have to anticipate already a race between WHO´s malaria elimination programme 2030 and Bill Gates´ heavily funded dream of releasing anti-mosquito gene drives before 2030? (He believes that already in three to five years gene drives could be used in the wild, neglecting the probably long-lasting regulative procedures? Why the US Defense Advanced Research Projects Agency (DARPA) is investing 100 million US dollars in gene drive technology?

Why early stage assessment

We know all the old formula, which is stubbornly preserved in the scientific community: "First let us research and develop technology, thereafter we will see, thereafter society can decide". The example of gene drive R&D demonstrates (again) that this is not anymore tenable. It would be a breakneck approach to proceed further based on that principle.

When a gene drive technology against malaria transmitting mosquitos seems to be mature – and that could be soon the intuition of several involved researchers and founders – it is too late for serious reflection and discourse. Then it is barely possible anymore to deny its use in a region with serious malaria burden. The hope for some advantages will cover up all concerns over possible or anticipatable negative side effects or long term consequences.

Science and (global) society are at the crossroad. We have to find suitable ways so that the direction of scientific-technological progress is scrutinized before it takes place.

Kevin Esvelt, who is seriously involved in gene drive research, is cited with the following: "We need to recognize that the answer to the question whether we should use a gene drive in a particular instance - `no´ has to be an acceptable answer."(Nature Biotechnology 2015) And: "Scientists must accept the possibility that society could say no, halting gene drive research entirely." (Harvard Magazine, May-June 2016). Yes, that has to be debated – now. Prospective Technology Assessment is necessary to provide input for this important discourse inside and outside science.

Note: more elaborated considerations and also more references can be found in (Liebert and Wölcher 2017) and (Liebert 2018).

References

Alphey, L. 2014. Genetic control of mosquitoes. Annual Review of Entomology 59: 2015-224.

Bloch, E. 1959. Prinzip Hoffnung. Suhrkamp-Verlag, Frankfurt. (Engl. translation: The Principle of Hope. Cambridge, Massachusetts, USA, 1986).

Champer, J., R. Reeves, S. Y. Oh, C. Liu, J. Liu, A. G. Clark, and P. W. Messer. 2017. Novel CRISPR/Cas9 gene drive constructs reveal insights into mechanisms of resistance allele formation and drive efficiency in genetically diverse populations. PLOS Genetics 13 (7): e1006796.

David, A., J. Kaser, A. Morey, A. Roth, and D. Andow. 2013. Release of genetically engineered insects: a framework to identify potential ecological effects. Ecology and Evolution 3: 4000-4015.

DiCarlo, J.; A. Chavez, S. Dietz, K. Esvelt, and G. Church. 2015. Safeguarding CRISPR-Cas9 gene drives in yeast. Nature Biotechnology 33: 1250-1255.

Gantz, V., and E. Bier. 2015. The mutagenic chain reaction: A method for converting heterozygous to homozygous mutations. Science 348: 442–444.

Gantz, V., N. Jasinskiene, O. Tatarenkova, A. Fazekas, V. Macias, E. Bier, and A. James. 2015. Highly efficient Cas9-mediated gene drive for population modification of the malaria vector mosquito *Anopheles stephensi*. Proceedings of the National Academy of Sciences 112: 6736-6743.

Hammond, A., R. Galizi, K. Kyrou, A. Simoni, C. Siniscalchi, D. Katsanos, M. Gribble, D. Baker, E. Marois, S. Russell, A. Burt, N. Windbichler, A. Crisanti, and T. Nolan. 2016. A CRISPR-Cas9 gene drive system targeting female reproduction in the malaria mosquito vector *Anopheles gambiae*. Nature Biotechnology 34: 78-83.

Jonas, H. 1979. Das Prinzip Verantwortung. Suhrkamp-Verlag, Frankfurt (Engl. translation: The Imperative of Responsibility. In Search for an Ethics of the Technological Age. Chicago, USA, 1984).

Liebert, W. 2018. CRISPR-based Gene Drives for Combatting Malaria: Need for an Early Stage Technology Assessment. To be published in: Hendrichs, J.; Pereira, R.; Vreysen, M. (Hrsg.): Area-wide Integrated Management of Insect Pests. Proc. Joined FAO/IAEA Conference

Liebert, W., J. Schmidt, and W. Bender. 2005. Prospektive Gestaltung von Wissenschaft und Technik – Zum Umgang mit Fragilität und Ambivalenz. In: A.Bora, M.Decker, A.Grunwald, O.Renn (Hrsg.): Technik in einer fragilen Welt. Die Rolle der Technikfolgenabschätzung. Berlin: Sigma, pp. 353-362.

Liebert, W., and J. Schmidt. 2010. Towards a prospective technology assessment: challenges and requirements for technology assessment in the age of technoscience. Poiesis & Praxis 7: 99-116.

Liebert, W., and J. Schmidt. 2015. Demands and Challenges of a Prospective Technology Assessment, pp. 331-340. In: C. Scherz, T. Michalek, L. Hennen, L. Hebáková, J. Hahn, and S. Seitz (eds.), The Next Horizon of Technology Assessment. Technology Centre ASCR, Prague, Czech Republic.

Liebert, W., and J. Wölchert. 2017. Gene Drive: auf CRISPR/Cas9 basierende mutagene Kettenreaktion als Ultima Ratio zur Bekämpfung von Malaria? In: M.Decker, R.Lindner, S.Lingner, C.Scherz, M.Soutoudeh (Hrsg.): "Grand Challenges" meistern – Der Beitrag der Technikfolgenabschätzung. Baden-Baden: Nomos/Sigma, pp. 171-181.

(NAS) National Academies of Sciences. 2016. Gene Drives on the Horizon: Advancing Science, Navigating Uncertainty, and Aligning Research with Public Values. The National Academies Press. Washington, DC, USA.

Schmidt, J.C. 2015. Synthetic Biology as Late-Modern Technology, pp. 1-30. In: B. Giese, C. Pade, H. Wigger, and A. von Gleich (eds.), Synthetic Biology. Character and Impact. Springer-Verlag, Cham/ Heidelberg, Switzerland/Germany.

Schweitzer, A. 1966. Die Ehrfurcht vor dem Leben. Grundtexte aus fünf Jahrzehnten. Verlag C.H.Beck, Nördlingen, Germany

Unckless, R., A. Clark, and P. Messer. 2017. Evolution of resistance against CRISPR/Cas9 Gene Drive. Genetics 205: 827-841.

(WHO) World Health Organization. 2015a. World Malaria Report 2015. WHO Press, Geneva.

(WHO) World Health Organization. 2015b. Global Technical Strategy for Malaria 2016-2030. WHO Press, Geneva.

STREAM: Sustainable and Innovative Public Procurement and EcoDesign

Biophilic product design: A bio-inspired approach to user preferences.
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Abstract

The vicious cycle that we have caused to by our consumption patterns and the artificial world breaks the cycle of nature. This distortive cycle can be summarized as the developments in science and technology – new consumption patterns – ecological issues – new technologies to solve the environmental problems – newer consumption patterns – more ecological issues, and so on. We cannot and shouldn't ignore the place of the artificial surroundings and artifacts in our lives. This proposal suggests searching the ways of affecting the consumption patterns by bio-approaches which target more sustainable solutions.

Bio-inspired approaches are rising in the fields of design and engineering. Nature can inspire us in the way we produce and recycle, the material which we use, the form that we give but the most critical part of it may be missing: the user behavior. The products have their life cycle in this artificial world, and the usage phase can be the longest part of some products. A product which was produced through the sustainability concerns may not be sustained because of using it in an unsustainable way. That would be a two-sided issue to be solved. One is raising awareness among the people; the other one is the guidance of products to be used more sensibly. The latter is the focal point of this study. Janine Benyus who is the first biomimic that comes to mind might have implied that kind of approach when she talks about 'mimicking the nature holistically' (Benyus, 1997/2002).

This proposal focuses on the concept of biophilia as a bio-inspired approach to the user preferences. Edward O. Wilson defines biophilia as "the innate tendency to focus on life and lifelike processes" (Wilson, 1984). Based on the savanna hypothesis, biophilia is issued in architectural and urban design as an evolutionary tendency which can affect the people to prefer biophilic places. (Heerwagen, 2011).

The Biophilic design may be employed to lead the user behaviors for being adapted to the natural cycle. What is asserted here is to search biophilic features that direct the users subliminally by appealing to their evolutionary and natural tendencies through the affordance and the signifiers of the products. The biophilic design is suggested as a bio-inspired solution for the missing link of the sustainable cycle of the products.

Stephen Kellert created the chart of 'Elements and Attributes of Biophilic Design' for architectural and urban design (Kellert, 2008). In this study, a set of interviews was held with industrial designers through a product pool to frame this chart into the product design. To propound the biophilic features of products is very significant to understand if they are impressive on the user motivations. Those features can be used to trigger the sustainable

behaviors since the humans appropriate the artifacts as the way they domesticate the animals and plants (Pantzar, 1997). Since nature and culture are co-evolving and interwoven (Wilson, 1998) the user approaches should be evolving accordingly.

Introduction

We are living in an environment which is dominated by artificial units. However, some argue that we are still under the effect of the life in the ancient natural environment. (Heerwagen, 2003; Kellert, 2008; Salingaros, 2015) Hence our behaviors towards the artifacts may resemble the way our ancestors approach the natural beings like domestication. Pantzar asserted that there was a significant analogy between the way of domesticating the technology today and the wild plants and animals 10,000 years ago (Pantzar, 1997). Pantzar referred to Hughes with: *"Hughes emphasizes that technological systems are both socially constructed and society shaping."* (Pantzar, 1997). Edward O. Wilson who has a significant major in biophilia puts forward a similar view with *Consilience*. He employs a compromising position in the nature-culture discussion by defending *gene-culture coevolution* (Wilson, 1998).

Recent technological developments are evolving with high speed, and each change causes new consumption patterns. New consumption patterns create new ecological issues, and to solve those issues; new technologies are developed. This cycle becomes vicious by newer developments, newer consumption patterns, and more ecological issues. Parallel to the technological developments, sustainability studies suggest new approaches. This proposal aims to propose a perspective for sustainability by the perspective of bio-inspiration.

Bio-approaches share the same principle although they are called by different terms like biomimicry, biomimetics, bionic, bio-inspiration, etc. The essence of them in common is modeling themselves on nature. We can confront the types of bio-approach in the phases of design process like research & development, problem definition, idea generation, problem-solving and the technical details, engineering, production, distribution, marketing, waste-recycle-retrieval. However, it is not commonly issued in the phase of use although it is the longest part of some products' life cycle. To 'bio'-approach to the habits of use products may be modeling a new sustainability method which is inspired by nature. This paper puts 'biophilia' forward as the bio-approach to understand the foundation of the user preferences regarding products. That would be consistent with the first biomimic comes to mind Janine Benyus who defends the holistic approach to the nature inspiration (Benyus, 1997/2002).

What is biophilia?

Erich Fromm coined biophilia as "love of life" (Fromm, 1964, loc.396) and Edward O. Wilson defined it: "the innate tendency to focus on life and lifelike processes" (Wilson, 1984). This concept was associated with the Gordon Orians' savanna hypothesis and became a hypothesis through the argument that claims the habits and preferences of savanna era are still effective on today's modern people choices. The fields of architectural and urban design issue and discuss biophilic design, but hitherto, biophilic perspective was not confronted in the literature of product design in the frame of the research. That is why the table Elements and Attributes of Biophilic Design by Stephen R. Kellert is the primary reference and initial point of this study (Kellert, 2008, p.15).

Environmental features	Natural shapes and forms	Natural patterns and processes	Light and space	Place-based relationships	Evolved human-nature relationships
Color	Botanical motifs	Sensory variability	Natural light	Geographic connection to place	Prospect and refuge
Water	Tree and columnar supports	Information richness	Filtered and diffused light	Historic connection to place	Order and complexity
Air	Animals (mainly vertebrate) motifs	Age, change and the patina of time	Light and shadow	Ecological connection to place	Curiosity and enticement
Sunlight	Shells and spirals	Growth and efflorescence	Reflected light	Cultural connection to place	Change and metamorphosis
Plants	Egg, oval and tubular forms	Central focal point	Light pools	Indigenous materials	Security and protection
Animals	Arches, vaults, domes	Patterned wholes	Warm light	Landscape orientation	Mastery and control
Natural materials	Shapes resisting straight lines and right angles	Bounded spaces	Light as shape and from	Landscape features that define building form	Affection and attachment
Views and vistas	Simulation of natural features	Transitional spaces	Spaciousness	Landscape ecology	Attraction and beauty
Façade greening	Biomorphy	Linked series and chains	Spatial variability	Integration of culture and ecology	Exploration and discovery
Geology and landscape	Geomorphology	Integration of parts to wholes	Space as shape and form	Spirit of place	Information and cognition
Habitats and ecosystems	Biomimicry	Complementary contrasts	Spatial harmony	Avoiding placelessness	Fear and awe
Fire		Dynamic balance and tension	Inside-outside spaces		Reverence and spirituality
		Fractals			
		Hierarchically organized ratios and scales			

Table 1: *Elements and Attributes of Biophilic Design* by Stephen R. Kellert (Kellert, 2008, p.15).

Judith Heerwagen who has significant studies on biophilic spatial and urban design claims that innate biophilic tendencies are efficient on modern people's preferences today and the designing by considering this aspect can be manipulative on people's decisions of purchase, use and prefer. She said based on habitat selection theory; ecologist Gordon Orians contended that people are inwardly prone to the scenes that portrayed the African savannah where assumed to be the site of human evolution. Even though people presently live in a wide range of living spaces, our mind ought to be affected by the hunter and gatherer ancestors who had

spent a long time in the African savanna. In case the "savannah theory" was valid, it was fair to expect to see some key elements of the habitats which had helped to the human progenitors to survive and also an innate appeal of people to those kinds of surroundings. These elements included:

• *"A high diversity of plant (especially flowers) and animal life for food and resources.*
• *Clustered trees with spreading canopies for refuge and protection.*
• *Open grassland that provides easy movement and clear views to the distance.*
• *Topographic changes for strategic surveillance to aid long distance movements and to provide early warning of approaching hazards.*
• *Scattered bodies of water for food, drinking, bathing, and pleasure.*
• *A "big sky" with a wide, bright field of view to aid visual access in all directions."*
(Heerwagen, 2003, p.2).

According to the research of design of the retailing, the modern places like shopping malls, golf ranges, retails and parks which reflect the savanna features have a manipulative effect on people through the light, décor, sounds, food, flowers, smells, visual corridors (Heerwagen, 2003).

There are several clinical studies about the positive effects of biophilia on human well-being both physiologically and psychologically. Roger Ulrich who has substantial studies on healthcare facilities design carried out many investigations into the restorative effects of the innate tendency for nature on patients. He suggested that biophilic features like natural vista and light have a substantial positive impact on patients, attendants and facility personnel. He stated that biophilic design evidentially helped out stress reduction, pain mitigation, emotional well-being enhancement, and so on. Exposure to artificial environments and materials like concrete, glass, metal, and plastic did not have that therapeutic effect whereas natural substances like vegetation, water, etc. had (Ulrich, 2008).

There are also some approaches in which biophilia is related to the fractal structure of the living beings. They discuss the biophilia through the assertion of the human eye is programmed to recognize the fractal structure in which all the living beings share essentially. Nikos Salingaros states that "The word biophilia is sometimes misused by architects to buttress the case for "green" aspects of otherwise non-adaptive designs. Yes, the presence of plants is therapeutic — a key property of biophilic architecture — but a building's structure itself must be healing as well if it is not to induce anxiety." (Salingaros, 2015, p.24). He claimed that our visual relationship with the built environment did not need to be through the mimicry of the biological entities; a restorative complex structure had stimuli which humans responded. Also, he adds "Healthy socio-geometric configurations in society rely upon our inherited intuitive response to built forms and natural settings, and generate even more healthy social interactions by encouraging their spontaneous occurrence." (Salingaros, 2015, p.33).

What about biophilia in product design?
There is need to define what the biophilic product is to discuss biophilia in the context of product design. It is not a one-sentence definition for sure. Since the product is a multifaceted creation, it should be evaluated with its all aspects like formal, structural, psychological, cultural

and so on. The method for searching the biophilic features of products has consisted of two phases. First, there was the need for a group of objective judges to set the biophilic product features. The latter one is to crosscheck it with the users.

A product pool was made to use in the research of this study which includes 95 images of various products. The following specifications were the key elements to select the products. The products might have one or more of the features below.

- Formal reference to the natural and living beings
- Natural and/or artificial materials
- Reference to social status and/or prestige
- The images of the same or similar products in front of different backgrounds (natural or artificial backgrounds)
- The importance of the function (if it heads off the other features or not)
- Permission to the user for interaction, intervention, inclusion to active usage process
- Different color and pattern alternatives of the same/similar products

A set of interviews was held with the objective judge group through the product pool. The members of the group were academic and/or professional designers who took education in a degree of industrial design. There were 40 members; 24 of them were women, 16 were men; 31 were academics, nine were professional. Their work experience was in a range of 3 to 45 years; the average was 14 years.

They were asked to create a word pool by free association with the concepts of 'biophilic', 'non-biophilic' and 'biophobic'. First, they were briefly introduced to the concepts and the studies about them in the literature. Then they created a concept pool which included words, abstract notions, adjectives, adverbs, phrases, anything about the concepts come to their mind about each title. Then they evaluated the products as biophilic, non-biophilic, biophobic or none of them.

Highlights from the interviews:
- They frequently said: 'means neutral' for the concept of 'non-biophilic'. It was found hard to understand and place in the frame of the study. It took place with the title of 'biophobia' instead of an independent concept in the user survey study not to cause any vagueness.
- The review showed that there are more common and consistent expressions for 'biophobic' than the 'biophilic'. It can be related to the vital role of the phobia in the evolutionary survival.
- Each participant has considered the products according to their professional specialties, and the effects of this were visible in their responses. For example, if one had profession on materials, then s/he interpreted the biophilia through the concept of 'material' and evaluated the products according to their materials.
- Although they have seen the products through their professional designer identity instead of their user identity, they were apparently under the effect of their tastes and value judgments. Even they noticed the inconsistencies in their expressions; they frequently named their favorites as biophilic.
- Variations in the cross-section of the structural frames (esp. seating units) were mostly

found biophilic. The living beings are also constructed by the amorphous units which have variable sections rather than the perfect geometrical ones.

- They have categorized the products which they regarded kitsch under the title of biophobic. It varied from person to person which product was kitsch, but the state of being kitsch was biophobic for them who mentioned it. That can be related to the approaches of the prevailing education system of the profession.
- Another expression which was defined as biophilic is "being able to follow the flow of water", "to see the spring of the water".
- The participants were tended to choose the wood in a comparison between wood and stone; even they both are considered in the same category of being 'natural'. Wood was found warmer and more biophilic. Since 'bio' indicates the living beings, the stone is not 'bio'; but the wood was once. Thus the participants did not express that kind of difference when they were asked to reason their choice. It may lead to think that if the human mind can unconsciously recognize that material came from a being which had been alive before.
- In some occasions, some of them have labeled a product biophilic while some said biophobic or they could agree to describe a product as biophilic or biophobic but with different arguments. The innate dispositions may be in charge when deciding if it is biophilic or not; however, the differentiation of justifications may come from the differences in cultural and professional backgrounds.

After the review of the interviews with the group of objective judges, both a word pool and a product pool were available. The words which were categorized as 'biophilic', 'non-biophilic' and 'biophobic' have been listed separately and determined the conflicted ones. Those words/ concepts were classified according to the table "Elements and Attributes of Biophilic Design" by Stephen Kellert with considering the explanations under each item. Some words especially the examples of products did not fit under any title and stayed out. Each word that was told by the participants was placed under the titles of Kellert's table and categorized by the concepts of "biophilic", "non-biophilic" and "biophobic". The categorization of Kellert's was remained inadequate because of:

- The word pool was a work of free-association brainstorming. That is why all the words/ concepts are not appropriate for the categories that Kellert put forward.
- Kellert's classification was for the architectural and urban design, so it remained insufficient for the product-specific design in some aspects like scale and specific design elements. Products did not fit the titles like "geomorphy", "filtered diffused light", the ones about the space and light, etc.
- Some of the titles remained empty because there were no words about them in the interviews even though they could be related to the product design (e.g., Central Focal Point, Light as Shape and Form, Complementary Contrasts).

The review showed that there is a need to add categories like "human scale/ human-friendly", "naturality", "liveness/animalism", "energy". Moreover, also it needs to elaborate the category of "Simulation of Natural Features" according to product design.

Kellert has another classification for the biophilia values. Compared with the previous chart, this

one is more inclusive and abstract; that is why it was found more suitable to adapt to the product design.

The words in the pool were sorted according to the frequency of use by participants. The most repeated ones were selected to place in the user survey. The words were: forced(unnatural), interesting, unknown, random, healthy, alive, disproportionate, comfortable, primitive, hygienic, plastic, warm, fear, simple, harmful, balanced, functional, harmonious, dirty/pollution, sympathetic, aesthetic, regular, shiny, safe, complicated, dangerous, aversive, natural, strong and cold.

95 product visuals were shown to the judges. The products were generic and parts of daily life like armatures, cutlery sets, salt-pepper containers, sieves, graters, lemon squeezers, seating units. The participants were expected to evaluate those products if they were biophilic or non-biophilic / biophobic. They had an option to remain silent if they thought the product did not fit any category. 18 product visuals which got the most consistent responses were selected to use in the user survey.
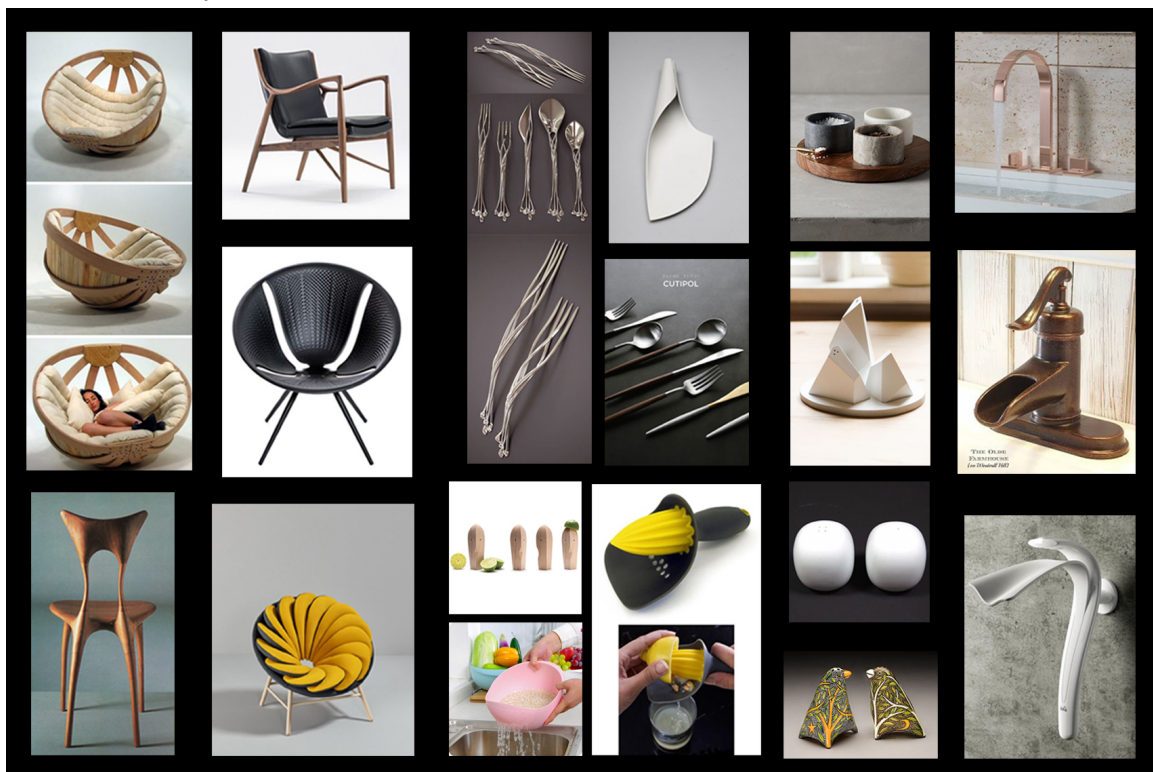
Figure 1: 18 product visuals which were shown to the group of objective judges. (Please refer to Bibliography for the URL sources of the pictures)

The user surveys were held with 29 users. The participants were expected to rate the relationship between the product visual and the words that they found related from 1 to 5. There was one page allocated to each visual and the 30 words below. The words were randomly ordered on each page to prevent participants from being accustomed to the places of the words. The order of the products was arranged by considering the products with same functions do not come sequentially. The participants were asked to select the words that they found

relevant to the product and rate how much relevant it was and finally, would they prefer to use it or not.

Average of the participants' age was 33; 20 of them female, nine were male, and 20 of them were married, nine were single. Their professions included: engineering (software, electronics, mechanical, telecommunication, textile), product design, interior design, graphic design, academic, design student, attorney, banking, housewifery, news reporting, technical service, archive specialist, medicine and public accountancy.

While selecting the products from the generic ones; it was aimed not to cause to the misunderstanding about the utility of them. Nevertheless, during the interviews, the participants asked the material of the product, how to use, how it works, how to hold, etc. That was a limitation of the study. Surely the responses would be more practical if the real products could be used in the survey.

The other limitation of the study was about the dispersion of the results. Since the participants chose the words to rate; the evaluation was not through the same concepts for all the products. Thereby a comparison between the products was not made; instead, the assessment was independent for each product. The acquired data was listed for each product separately. The classification of products was according to:

- the objective judges' analysis of biophilic or non-biophilic / biophobic
- the operational definition made by the researcher before the study
- Kellert's chart of *A Typology of Biophilic Values* (Kellert, 1993, p. 59).

During the interviews with the judges it was foreseen that it would not be possible to label a product as 'fully biophilic' or not; rather it would vary according to different features of the product. That is why user survey had the rating method. The words which have already been specified as biophilic or not by the objective judges. They also were classified under the titles of operational definition and Kellert's chart by matching the highlights of the contents. Thereby a product could be evaluated how biophilic it was according to which aspect. For example, if a product was found 'aesthetic' %85 in the average of the responses of the users; the concept of 'aesthetic' is;

- *biophilic* according to the objective judge group
- under the title of *Aesthetic* in Kellert's table
- indicating the category of *Form* in the operational definition.

It means that product was found %85 biophilic in the context of Aesthetic and Form. This demonstration represents a summary of the method. Indeed, it was not as direct as the concept of *aesthetic* for the other concepts.

Term	Definition	Function
Utilitarian **(functional, primitive, comfortable, safe, healthy, balanced)**	Practical and material exploitation of nature	Physical sustenance/ security
Naturalistic **(natural, alive, interesting)**	Satisfaction from direct experience/ contact with nature	Curiosity, outdoor skills, mental/ physical development

Ecologistic- Scientific **(regular, random, pollution)**	Systematic study of structure, function, and relationship in nature	Knowledge, understanding, observational skills
Aesthetic **(aesthetic, sympathetic, harmonious, aversive, disproportionate, shiny)**	Physical appeal and beauty of nature	Inspiration, harmony, peace, security
Symbolic **(unknown, simple, complicated)**	Use of nature for metaphorical expression, language, expressive thought	Communication, mental development
Humanistic **(cold, warm)**	Strong affection, emotional attachment, "love" for nature	Group bonding, sharing, cooperation, companionship
Moralistic **(plastic, dirty / pollution, hygienic)**	Strong affinity, spiritual reverence, ethical concern for nature	Order and meaning in life, kinship and affiliational ties
Dominionistic **(strong, forced / unnatural)**	Mastery, physical control, dominance of nature	Mechanical skills, physical prowess, ability to subdue
Negativistic **(fear, harmful, dangerous)**	Fear, aversion, alienation from nature	Security, protection, safety

Table 2: The table of A Typology of Biophilia Values by Stephen Kellert and the categorized words. The colored words are from the word pool created by the group of objective judges.

form	attitude	material	function	sensory	meaning	psychological
fractal geometry	honesty / loyalty	natural	productivity	texture	connotations	consistency
rhythm	healthy	artificial	energy saving	scent	iconic value	wellbeing
curve	coherence		ergonomics	color	symbolic value (signs)	feelings
organic /amorphous	ecological		comfort	vibration	historical / story	emotions
asymmetry	familiarity			sound	identifiable	calmness
contrast	active			taste		protection
balance	integrating the user					

Table 3: Operational definition seeks the features of a biophilic product through the seven aspects of a product. The features under the titles are expected specifications for biophilic products.

form	attitude	material	function	sensory	meaning	psychological
disproportionate	balanced	natural	functional	cold	interesting	dangerous
regular	hygienic	shiny	primitive	warm	strong	safe
random	dirty / pollution	plastic	comfortable		alive	healthy
simple	forced (unnatural)				unknown	harmful
aesthetic	harmonious				aversive	fear
complicated					sympathetic	

Table 4: Operational definition with the categorized words

Here are some notable highlights from the user survey through the evaluation above:

%70 biophilic, positive response to prefer to use, biophilic according to the judges

This is an example which shows consistency between the evaluation tools.

*The possible reasons were: fetal position, sleeping figure on the photo, indicating comfort, protection, safety, trust, peace, natural material (wood) and soft cushions.

%66 biophilic - %52 non-biophilic/biophobic, mostly positive response to prefer to use, biophilic according to the judges.

*The possible reasons were: smooth lines and transitions, matt metal, the warmth of wood elegant joints and the variations through the section. Also it was found non-biophilic/biophobic because its sharp form may cause harm and may not be ergonomic.

%73 biophilic, positive response to prefer to use, biophilic according to the judges

This is an example which shows consistency between the evaluation tools.

*The possible reasons were: natural material, clarity, strength, simplicity, directness.

%62 biophobic/non-biophilic, negative response to prefer to use, biophobic/non-biophilic according to the judges

This is an example which shows consistency between the evaluation tools.

*The possible reasons were: reminds scary living beings, texture, plastic as the material.

%64 biophobic/non-biophilic, negative response to prefer to use, biophilic according to the judges

This is an example which shows inconsistency between the evaluation tools. Judges found it biophilic because of the biomimic features but it reminded scary living beings to the users and also it felt fake to them.

%63 biophilic, negative response to prefer to use, biophobic/non-biophilic according to the judges

This is an example which shows inconsistency between the evaluation tools. Judges found it biophobic/non-biophilic because they found it kitsch. However, the users matched it to biophilic concepts, even though not to prefer to use it because of inappropriateness to use as a salt-pepper container.

%65 biophobic/non-biophilic, negative response to prefer to use, biophobic/non-biophilic according to the judges

This is an example which shows consistency between the evaluation tools.

*The possible reasons were: being fake, pretending, reminds scary living beings, not hygienic, not appropriate for use.

 *The possible reasons were collected from the comments of users and the judges during the interviews.

The biomimic products were biophobic to some of the judges because they labeled them as kitsch. For some of them, they were biomorphic and so biophilic they are. From the users' perspective as long as the biomimic forms were consistent with the function, they reacted positively. The ones that were thought to have no proper relation between form and function would not be preferred to use; although they were found decorative and beautiful. The users responded negatively to the products which recall scary living beings.

The products made of the natural materials like wood, stone, ceramic, etc. mostly got positive responses to be preferred. Plastic products were related to the non-biophilic concepts however the functional ones were preferred to use. That would support the view that the products were not valued through only one aspect, but the more complicated mechanism was influential in the decision to prefer.

Different from the architectural design criteria, function and efficiency stepped forward in product preferences. This situation may have occurred because of the differences between two fields in terms of scale and the relationship with the human.

Conclusion

This study was the pilot study of a Ph.D. research. It revealed critical qualitative results in search of biophilic effects on the user preferences. Even it does not seem to be directly related to sustainability; it has a significant value to understand the motivations behind the user decision mechanism. This research is expected to bring a new perspective to the sustainability of user behaviors through new design methods by considering biophilic effects on users.

Orians indicated that loving an object which had helped to the survival of our predecessors was genetically transferred, which means that skill had been natural selected. Similarly, the displeasure of an object that had endangered the survival and proliferation was also coded in our brains (Orians, 2014). In support of Orians' words, this study has shown that there is the need to be aware of the functionality and the productivity of the objects which can dominate the user preferences. That would also be the main issue to be considered in the design process to manipulate the user behaviors by encouraging more sustainable ways of use.

Bibliography

Fromm, Erich (1964), *The Heart of Man*. Electronic Book. New York: Harper & Row.

Benyus, Janine M. (2002), *Biomimicry: Innovation Inspired by Nature.* New York: Harper Perennial. (Original work published in 1997).

Heerwagen, Judith H. (2003), *Bio-inspired Design: What can we learn from nature?* U.S. Green Building Council, http://www.usgbc.org/Docs/Archive/External/Docs8542.pdf [downloaded 13 April 2013]

Heerwagen, Judith H. (2011), 'Biophilia, health and well-being.' in Campbell, Lindsay and Wiesen, Anne (Eds.), *Restorative Commons: Creating Health and Well-being through Urban Landscapes*. Pennsylvania: USDA Forest Service Northern Research Station, 38-57, https://www.nrs.fs.fed.us/pubs/gtr/gtr-nrs-p-39papers/04-heerwagen-p-39.pdf [downloaded 27 April 2018]

Kellert, Stephen. R. (1993), 'The Biological Basis for Human Values of Nature.' In Kellert, Stephen R. and Wilson, Edward O. (Eds.), *The Biophilia Hypothesis*. Electronic Book Washington: Island Press, 42–70.

Kellert, Stephen. R. (2008), 'Dimensions, elements, and attributes of biophilic design.' In Kellert, Stephen R., Heerwagen, Judith H. and Mador, Martin L. (Eds.), *Biophilic design: The theory, science and practice of bringing buildings to life.* New Jersey: John Wiley & Sons Inc., 3-19.

Orians, Gordon H., 2014. *Snakes, Sunrises, and Shakespeare: How Evolution Shapes Our Loves and Fears*. Electronic Book, Chicago: University of Chicago Press.

Pantzar, Mika (1997), 'Domestication of Everyday Life Technology: Dynamic Views on the Social Histories of Artifacts.' *Design Issues* 13 (3): 52-65.

Salingaros, Nikos A. (2015), *Biophilia and Healing Environments: Healthy Principles For Designing the Built World.* New York: Terrapin Bright Green, LLC.

Ulrich, Roger (2008), 'Biophilic Theory and Research for Healthcare Design'. In Kellert, Stephen R., Heerwagen, Judith H. and Mador, Martin L. (Eds.), *Biophilic design: The theory, science and practice of bringing buildings to life.* New Jersey: John Wiley & Sons Inc., 87-106.

Wilson, Edward O. (1984), *Biophilia: The human bond with other species*. Cambridge: Harvard University Press.

Wilson, Edward. O. (1998), C*onsilience: The Unity of Knowledge*. New York: Vintage Books

Url-1, http://skinnyninjamom.com/wp-content/uploads/2016/01/Cradle.jpg
Url-2, https://i.pinimg.com/originals/92/d6/4d/92d64dc02697065f11a2a4064fdb66ce.jpg
Url-3, https://dm4c9mjc2jvtf.cloudfront.net/product-media/1OGF/1200/900/Onecollection-Finn-Juhl-45-Armchair.jpg
Url-4, https://image.architonic.com/imgTre/05_15/Material-Tendencies_Ross-Lovegrove_diatom.jpg
Url-5, https://blog-espritdesign.com/wp-content/uploads/2016/07/quetzal-marc-venot-fauteuil-blog-espritdesign-4.jpg
Url-6, https://loldamn.com/wp-content/uploads/2016/05/creative-silverware-3D-printed.jpg
Url-7, https://i.pinimg.com/564x/94/12/3e/94123e228bd0045787da613cf8baac46.jpg
Url-8, https://i.pinimg.com/564x/f4/d3/8b/f4d38b1a0552243a94d39583a7109143.jpg
Url-9, https://i.pinimg.com/564x/2b/0c/8d/2b0c8dc8bbf500b9b68f518529481d0a.jpg
Url-10, https://mir-s3-cdn-cf.behance.net/project_modules/fs/7a3e6e31069519.56401550890e2.jpg
Url-11, http://picturetherecipe.com/wp-content/uploads/2014/02/Cool-kitchen-ideas-and-gadgets-21.jpg
Url-12, https://i.pinimg.com/564x/04/b8/b0/04b8b01711efc3ab07689733c6dea118.jpg
Url-13, http://industrielldesign.com/wp-content/uploads/2014/02/selfpromo-5liten-copy.jpg
Url-14, https://i.pinimg.com/564x/c8/d1/49/c8d14908b2e43e0ea0122c620dcef935.jpg
Url-15, https://i.pinimg.com/564x/df/78/b5/df78b54bb521bab769d278473ab274fa.jpg
Url-16, https://i.pinimg.com/564x/f1/0a/bc/f10abcda0de522ceda2dfd9310443e19.jpg
Url-17, https://i.pinimg.com/564x/b1/db/a4/b1dba4901280476ba315ad5131e74cc4.jpg
Url-18, http://www.yankodesign.com/images/design_news/2012/03/27/linfa12.jpg

The importance of the positive footprint as mental model for circular design

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Introduction

What makes a design really interesting, ambitious and sustainable? One important reason is the way the designer approaches a project. This article will focus on the importance of the positive footprint as mental model for circular design, the design concept for the new circular economy.

Since 2014 the transition to a new and regenerative circular economy has become a declared objective of the EU, since it has become obvious, that the linear economy with its huge consumption of resources is unsustainable. The "Growth within" report by the Ellen MacArthur Foundation highlights that the European economy's value creation model is surprisingly wasteful. The authors state that most materials are only used once (Ellen MacArthur Foundation, Sun, McKinsey 2015, 12).

Unlike the old German recycling economy concept of the 1980s, the new regenerative circular economy does not limit itself to recycling and disposal of residual and toxic waste, but focuses on designing cycles for biological and technical materials from the beginning. Design plays an important part in this new concept, to make economy regenerative and restorative. Regenerative means to take care that all biological material is used in products in a manner to ensure that after use this material can be easily be brought back into the natural cycle, in form of compost or biochar. To shredder and recycle technical materials used in products usually requires a lot of energy, therefore it is important to design them in a way that restoration of the product performance by repair or remanufacturing can be easily done to maintain value.

Circular design

In the definition of the circular design by the Ellen MacArthur Foundation (Ellen MacArthur Foundation 2012, 9) they stress the importance of changing the way products are designed for the success of the circular economy in Europe. Circular design " i.e. improvements in materials selection and product design (standardization/modularization of components, purer materials flows, and design for easier disassembly), lie at the heart of a circular economy."

This design concept is based on the Cradle to Cradle design concept (Braungart & MacDonough 2002a), which has one focus on benefits for society and environment from safe materials that can return to cycles (biological or technical cycle) and so to eliminate the concept of waste. The Ellen MacArthur Foundation included the consequent reuse, refurbishing and remanufacturing of products and parts as well as new business models for it. Bakker et al. stress in their definition of circular product design especially the system level a design has to take into account, maintenance of product integrity, new experiences and relationships for users with their products and the need for new business models (Bakker et al. 2014).

At the circular design classes at the Fachhochschule Salzburg, focus is laid on the consideration of the impacts of social changes for design, to integrate other useful design concepts to improve the applicability of Cradle to Cradle, and to integrate core ecological concepts in the education to help students to gain that broader systemic perspective (Eser

2017). Social changes include e.g. open source or sharing economy, which are important movements to get circular economy off the ground. Relevant for the work of designers are shared production machines like 3D printer and design templates in the internet, which means that design and production is continuously moved into the hands of the general public. The broader systemic view is especially emphasized, that means to open the focus from the product to material flows, production processes and conditions with an emphasize on consideration of distant effects and impact on the ecosystems, as well as aspects of reuse and recycling. With circular design, one does not only design a product but a whole system with circles, and has to think about where each material comes from and how it can be reused later in the same quality (Feldbacher 2016, 69). It is necessary to think wider than only the product and to integrate topics like business models, marketing, transport or take back systems already into the concept phase. Feldbacher interviewed in her master thesis various designers for changes in design process to fulfill the C2C and circular design requirements. As result she described a complex extended design process, and among other things a system analysis needs to be included (Feldbacher 2016).

The positive footprint as mental model for circular design
It is important to develop a circular, integrated thinking to develop new innovative approaches. This means that a change in mindset is needed first to come up with circular design product innovations. The positive footprint is discussed here as the important different mental model that inspires creativity in student projects. The idea of improving product design in a way that positive sustainability-related effects arise of the product or interlinked business activities, for both human society and the environment, was first formulated in the Cradle to Cradle design concept: to start with the positive in mind, so to "leave a beneficial footprint for human society and the environment" (McDonough Braungart Design Chemistry 2016). In the Cradle to Cradle design process this is part of the vision statement or intension statement. The idea is to have an additional benefit, that does not only address the value a product has to its user – as the primary purpose of a product – but as de Pauw specified, it means that the impact of that product has additional benefits for its environment, especially "contributes to regeneration of that environment towards a sustainable state" (De Pauw 2015, 45). One main goal of the circular economy – to be restorative and regenerative – can be addressed with this concept of the positive footprint. Additional benefits could be that products improve life quality, extend the utilization period of other products, increase sustainability awareness and biodiversity or bring people together.

This concept of being positive was also addressed by Janine Benyus in formulating her biomimicry concept, another design concept inspired by nature. She stresses that one of lives basic rules is to create conditions that are conducive to life (Benyus 2013), and the principles of biomimicry consistently aim at improving conditions for life with design. Nature-inspired design strategies include biomimicry, natural capitalism and Cradle to Cradle. These strategies "offer opportunities to design in a radically different, goal-driven manner", help designers to focus more on the product context and therefore to improve overall sustainability (De Pauw et al. 2010).

This is a different approach than trying to reduce the environmental impact, which is usually the starting point for ecodesign. With just reducing the impact, system level is not abandoned, while a change in system structure is needed to achieve a better sustainable solution. A change in systems structure is for example to include material cycles, that means to change from linear to a cyclical system. The kind of mental model with which a designer approaches his task was observed to make a prominent difference in results (De Pauw et al. 2014). As an important reason it is discussed that with applying these principles, designers address environmental sustainability at a systems level (De Pauw 2015, 200). Students with a design task following biomimicry or Cradle to Cradle design principles considered solutions with a wider systemic perspective and a wider solution space then students following ecodesign rules, and developed more extraordinary designs and included new product functions (De Pauw 2015, 182). Applying biomimicry and C2C principles thus supports to adopt a systems approach and achieve sustainability, as de Pauw found out (De Pauw 2015, 168).

The positive footprint is especially important to bring in social aspects and biodiversity. Especially biodiversity is an aspect which is usually not considered during design, and is also not considered using the LCA, put can be addressed by using the concept of the positive footprint. Biodiversity is also included in the third principle of Cradle to Cradle: "celebrate diversity". It gets into view when the whole system (including material origin, production processes and reuse phase) is considered. It helps to shift attitudes regarding the importance of biological systems. This principle though is hard to translate into design or formulate a design goal from it, as Feldbacher found out in her master thesis (Feldbacher 2016, 71), especially because there are no tools available. It is a special problem that there are not many best-practice examples to show how to include Biodiversity and to translate the principle "celebrate diversity" in product design. For architecture there are several beautiful examples, though, for example the WWF Building in Zeist by Thomas Rau (Hannemann 2010) or the concept of Animal Aided Design (Hauck & Weisser 2015).

Tools for teaching the positive footprint

In the following, several tools and methods to teach the positive footprint are discussed that have been applied in circular design classes as well as results, on the basis of student lectures given to newcomers in sustainable design and students with prior knowledge in ecodesign in comparison.

Special attention deserves the teaching of all three Cradle to Cradle principles (1. Everything is a resource for something else , 2. Use clean and renewable energy, 3. Celebrate diversity). Young designers have to learn to use these principles as equal important and to consider all three in their design projects. It is necessary to insist in the projects that students learn to widen the perspective also on topics of which they have thought so far are out of the responsibility of a designer. Otherwise designers tend to selectively apply the design principles they like or consider useful, and skip those that they think are out of the scope of their influence, which was also observed by de Pauw (De Pauw 2015, 196). Selectively applying of the C2C principles is common practice, but does not lead to high innovative developments or a positive footprint.

Students have to learn about the **core ecological concepts** (Stone & Barlow 2005), to understand what are the basics of ecosystem functioning. To make something beneficial for the environment, one first has to have a minimum understanding what this could be and to teach

these principles provides a basis of understanding for design students. In class an overview of these concepts is presented, followed by a teamwork and discussion of what students know and think are specifics of nature inspired design.

Redesign is another important aspect. In analyzing the Cradle to Cradle design process, Feldbacher describes a passive redesign, which especially replaces harmful substances with healthy ones, following a phase-out-list (Feldbacher 2016). Another tool is to install a positive list of described material with no or positive impact that helps to choose materials in continuous product development. A second step is to actively redesign a product. For this procedure, materials are defined either for the biological or the technical cycle and special care is taken to ensure that the product is designed for these circles. Students practice this in their own material researches within their class projects.

To return biological materials after the use in products as compost means to carefully use it in design and do without harmful substances. This is an important aspect for **design for climate protection,** as along with the storage of humus in soil vast quantities of carbon dioxide can be stored.

According to the Cradle to Cradle design concept to **design for the next cradle** is an important thought-provoking impulse. Every material has to be returned to biological or technical cycles in the same quality then before use or even better. To think of every part of the design as borrowed helps to focus on material flows instead of only thinking about the actual product. This was a design task in a successful project called "Trashless" at the Fachhochschule Salzburg in 2015 (Schranzer 2017). Students were given the task to design a product in such a way that after the first product use a second use in another form was possible.

Some of the project resulted in elaborated circular design concepts with additional positive aspects.

The idea of the **Triple Top Line,** a fractal triangle, is to "*enhance* the well being of nature and culture while generating economic value" (McDonough & Braungart 2002b, 251). It is a tool to help design products and processes with a beneficial ecological footprint. To walk around the fractal triangle and ask different questions according to each field helps to balance economic goals with social and environmental concerns and to think about all relevant topics from equity, fairness, health or resource efficiency. It also helps to draw the focus from reducing negative impact to the question of how one can improve quality. As was discussed by De Pauw (De Pauw 2015) using C2C or biomimicry does not automatically lead to integration of social and economic sustainability. Using the TTT tool gives a broad perspective about that issues and help to include these important aspects into design.

The same is true for a tool called **Use Life Benefits,** from the publication "Nature Inspired Design", a newly developed design concept at the TU Delft to make products more beneficial (Tempelman et al. 2015). Use Life Benefits is a brainstorming tool with twelve questions considering different aspects of the product system like purchasing of material or transport to distributors and how at these stages clean energy can be created or biodiversity be supported. In class, this tool was used for adding benefits to student project sketches. Students need a lot of exercise to manage a more systemic view beyond the product and this tool can help to do this, as it breaks down the vision of being positive in concrete steps that can be examined individually.

Simplycycle is a simulation game developed to teach the principles of an eco-effective design (Eser 2012). In three levels of increasing complexity the participants learn how to set the course for a cyclical metabolism. Serious games provide a special learning experience and make it easy for players to try out new patterns of activities. The aim is to trigger ideas to make products beneficial and to help players to reflect the own mindset concerning sustainability.

This simulation game is used in every class. The game was tested during an Erasmus project with students from four different countries and was considered an innovative teaching instrument, and in another test using it for language training students presented a high degree of involvement and were deeply immersed (Suparam & Sturza 2017). Main benefit of this simulation game from observation in class is that it stimulates discussions and exchange of knowledge as well as out-of-the-box-thinking. It is therefore a good tool to help the students reflect on the concept of the positive footprint and test different sustainable solutions.

Examples from class

In teaching Circular Design, different reception of the concept of the positive footprint by the students were noticeable, depending on their previous knowledge in sustainable design.

During winter semester 2017, two identical courses were held in circular design for a Bachelor third semester, newcomers in sustainable design, and Master first semester class with prior knowledge in ecodesign. Both classes got the same training with same amount of hours. Their task in circular design class was to map beneficial aspects of a project idea. Students of the bachelor class did this with their semester project, modular urban elements made out of recycled plastic.

While the bachelor course completed it with best grades, students of the master class struggled with the concepts of the positive footprint. Main differences could be observed in lacking assessment of circularity of materials and problems to translate the concept of being beneficial in own ideas. These students showed typical ecodesign choices, so e.g. to reduce the content of plastics and replace it with grass, which would mix a technical with a biological material inseparable and is not a good idea for circular design. Aspects like reduced use of energy or reduced amount of waste were named as additional benefits, but these aspects are usually standards in ecodesign. To grasp the concept of the positive footprint was problematic was problematic for those students.

Also de Pauw et al. observed that groups of students dealing with an ecodesign task focused more on analyzing hot spots of current products and reducing the product's environmental impacts, while Cradle to Cradle challenged the groups to think of beneficial effects (De Pauw et al. 2014). The observations suggest that students who have not been taught in ecodesign before can use the mental framework of the positive footprint easier to come up with interesting sustainable design solutions. Impartiality seems to make it easier to adopt the new mental model and theories, while trained students first have to kind of unlearn the strategies of ecodesign to start with thinking about a positive footprint.

References

Bakker, C., Hollander, M., van Hinte, E., & Zijlstra, Y. (2014), 'Products That Last - product design for circular business models'. Delft: TU Delft Library.

Benyus, Janine M. (2013), ' A Biomimicry Primer.' In *Resource Handbook*, edited by D. Baumeister, 33–42. Missoula, MT: Biomimicry 3.8.

De Pauw, I.C., Kandachar, P., Karana, E., Peck, D., Wever, R. (2010), 'Nature inspired design: Strategies towards sustainability'. Knowledge Collaboration & Learning for Sustainable Innovation. *ERSCP-EMSU conference*, Delft, The Netherlands, October 25-29, 2010

De Pauw, I.C., Karana, E., Kandachar, P. Poppelaars. F. (2014), 'Comparing Biomimicry and Cradle to Cradle with Ecodesign: a case study of student design projects'. *Journal of Cleaner Production* 78, 174-183.

De Pauw, I.C. (2015), *Nature-inspired design. Strategies for sustainable product development.* PhD Thesis Delft University of Technology, Delft, The Netherlands.

Ellen MacArthur Foundation (2012), *Towards the Circular Economy Vol. 1: an economic and business rationale for an accelerated transition.*

Ellen MacArthur Foundation, Sun, McKinsey (2015), *Growth within: a circular economy vision for a competitive Europe.*

Eser, S. (2012), 'Simplycycle - a design adventure game.' SinnenWandel, Buch am Erlbach, Germany. www.simplycycle.eu.

Eser, S. (2017), 'Circular Design - Gestaltung für Kreisläufe'. In: Eser, S., Leube, M. (Hrsg.): *Circular Design in der Praxis. Strategie und Konzepte zur Gestaltung der neuen, regenerativen Kreislaufwirtschaft*. Norderstedt, Books on Demand, 2017, 15-19

Feldbacher, D. (2016), 'Implementierung der C2C Prinzipien in den Designprozess. Anwendung des Prozesses bei der Entwicklung eines Kinderhochstuhles'. Masterarbeit an der Fachhochschule Salzburg, Fachbereich Design und Produktmanagement.

Hannemann, M. (2010), ' I have a dream. Was Menschen bewegt. Thomas Rau'. *Brand Eins* 06/10, 131-135.

Hauck, T.E. & Weisser, W.W. (2015), *Animal Aided Design.* Bayerischen Staatsministerium für Umwelt und Verbraucherschutz

McDonough, W. & Braungart, M. (2002a), *Cradle to Cradle: Remaking the Way We Make Things*; North Point Press: New York, NY, USA.

MCDonough, W. & Braungart, M. (2002b), 'Design for the Triple Top Line: New Tools for Sustainable Commerce'. *Corporate Environmental Strategy*, Vol. 9, No. 3, 251-258

McDonough Braungart Design Chemistry (2016): *Cradle to Cradle Certified Product Standard. Version 3.1.*

Schranzer, M. (2017), 'Experimentelles Projekt "Trashless" - Design eines zweiten Produktlebens im ersten'. In: Eser, S., Leube, M. (Hrsg.): *Circular Design in der Praxis. Strategie und Konzepte zur Gestaltung der neuen, regenerativen Kreislaufwirtschaft*. Norderstedt, Books on Demand, 2017, p.140-144.

Stone, M.K. & Barlow, Z. (Eds.) (2005), *Ecological literacy: Educating our children for a sustainable world.* Sierra Club Books, San Franscisco.

Suparam, A. & Sturza, A. (2017), ' The opportunity of introducing serious games in teaching English for specific purposes - a study case on playing "Simplycycle" serious game. *The Journal of teaching English for specific and academic purposes*. Vol. 5, No. 3, 459-466.

Tempelman, E., van der Grinten, B., Mul, E.J., de Pauw, I.C. (2015): *The Nature Inspired Design: A Practical Guide Towards Positive Impact Products*. Technische Universiteit Delft

STREAM: Towards Low-Carbon Energy and Mobility Systems

Local demonstration projects for energy efficient cold supply and their contribution to niche development

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Introduction

The refrigeration sector is predicted to grow substantially worldwide in the upcoming years – with a corresponding rise in energy demand if no countermeasures are implemented. One measure is a fortified dissemination of more energy efficient technologies and systems. In this context, innovative types of absorption chillers are being discussed. The research and demonstration project „Field test absorption chillers for combined heat, power and cold-systems" (FAkS) (2013-2018), funded by the German Ministry for Economics and Energy focuses on implementation and optimisation of innovative, more energy efficient absorption refrigeration systems in real world environments (field tests). These local demonstration projects consist of larger properties (office buildings, consumer market, hospital, server cooling, laboratories, etc.) with centralized cooling facilities. The project also includes socio-technical research which aims at identifying important actors, factors, and especially barriers of an intensified implementation and diffusion of absorption chillers. The empirical research is made up of two levels of investigation: Firstly, socio-technical constellation analysis targeting the system/regime level of refrigeration supply (see Keppler 2016, 2018), and secondly, interviews with actors involved in field tests. In my talk, I presented results of these interviews.

Theoretical approach: multi-level perspective on socio-technical transitions

Analysis was based on the multi-level perspective, an approach from science and technology studies (e.g. Geels 2011). Application of this to the cold sector reveals that current absorption chiller innovations can be considered as radical innovations from a long-established market niche technology. Radical innovations are not compatible with the current regime structures where compression refrigeration is still the dominant technology. Thus, they develop in socio-technical niches. MLP defines such niches as protected spaces were radical innovations and their related societal structures and rules develop (Geels 2002). Here, small networks of actors support such innovations on the basis of expectations and future visions, and learning processes take place on multiple dimensions (ibid.). Field tests within the FAkS project can be understood as local experiments. Local experiments are pilot, demonstration, development or use projects which form the physical base of socio-technical niches. They aim at customising the respective technical innovation to real world conditions and proofing its applicability (Raven 2005, 37–38). Literature also offers success factors for niche development which are used as the main categories for analysis: alignment of expectations, network building, and learning (ibid. 39–53).

Interviews with actors involved in field tests

Semi-structured interviews with actors involved in field test installations should help answer the question of the socio-technical factors influencing the quality of installed cold systems which work as drivers or barriers to the increased dissemination of the innovation. This should also shed light on how these local experiments work as the drivers of change by contributing to alignment of expectations, network building, and learning.

Interviewees included representatives of facility management, planners, energy suppliers, decision-makers, and researchers involved in seven field tests. The interview guide focused on their experiences during the planning, installation and launching process of the absorption refrigeration systems.

Results

Interview results reveal differentiated information, especially about learning processes taking place, but also regarding the development of expectations among participants of field tests and their contribution to network development.

Learning processes and effects concern various aspects: Technology itself, user context and demand, (cooperation during) planning process, knowledge and know-how, economic efficiency and perspectives, and regulative framework conditions. In the following, I present selected main results concerning technology, user context, planning process, and economic aspects.

Learning effects related to technology

Interview results reveal that the innovation fulfills practitioners' expectations regarding lower size, weight and space requirements. Despite current problems or negative experiences, actors believe in the future of absorption refrigeration technology and are ready to invest time and money. Nevertheless, results show that the technology is perceived as demanding. Practice actors had difficulty understanding the functionality of the plant which would have been necessary for some fundamental decisions which had to be taken at an early stage of planning process. Due to a lack of understanding, decisions had to be revised in some cases when the effects of decisions for other parameters became visible.

Learning effects related to user context

Often, new refrigeration systems must be introduced into existing building energy systems. This implies planning based on very little data about the existing technology system and cold demand, as, in many cases, "measuring was always a foreign concept", as one interviewee said. The innovative technology often needs to be integrated into aged, patchwork-like systems, partly with components which are not compatible with the requirements of the new technology. Adaptations and/or exchange of components in the existing building energy system (with respective additional costs) and/or compromises are necessary. These context conditions usually limit possible energy efficiency.

Additionally, a contrast between the "full automation" vision (of researchers) and current practices occurred. Today, many systems are serviced by staff-members who know the existing building energy system and keep it running despite lacking data and information, based on their practical experience and tacit knowledge. The question is not only if these actors are willing to

change their routines; it is also questionable whether such a change is desirable. It would imply a decrease of knowledge about individual plants which is seen as highly relevant for good planning and operational management and might be important, for example, on the occasion of forthcoming rearrangements in the building energy system.

Learning effects related to planning process

Due to a low level of standardisation (no plug-in systems), absorption chiller systems require extensive individual, case-related planning. Concerning actor structures, there is a high degree of division of tasks and responsibilities. Planning must integrate contributions from several fields of competence (facility management, overall planning, electrical and hydraulic implementation planning, energy supplier, company management, building owner), and with actors with different decision-making authority and interests which are not necessarily aligned with the highest possible energy efficiency of the planned system. Additionally, data requirements differ from what practitioners perceive as "normal" (i.e., from data requirements for compression refrigeration machines). Thus, planning is associated with high communication effort and time requirements; communication problems and misunderstanding are foreseeable. Good planning results, in terms of the technological system's optimisation towards energy efficiency, depend very much on factors effecting the quality of communication and collaboration. Good coordination, clear definition of responsibilities and sufficient time for necessary exchanges are essential but cannot be taken for granted. As involved professionals work under cost (= time) pressure and are accustomed to standard technology and procedures (which reduce time and cost), and interview partners reported an increasing practice to plan without a planner responsible for overall integration, it can be concluded that real-world conditions are opposed to optimised planning conditions in several ways.

Learning effects relating to economic efficiency and perspectives

Interviewees reported that pursued economic efficiency was not easy to achieve (but they – realistically – expected improvements, pointing to pending optimisations at the time of interviews). Despite recent cost reductions, investment costs are still too high (but with increasing production, further reduction is expected). Heat costs, which depend very much on local conditions (heat source, regional price structures for district heat), are crucial for economic efficiency. Additionally, in practice actors do not differentiate sharply between costs for cold systems and the costs for necessary modifications in existing technology, as budgets are limited and each expense has to be justified towards decision-makers.

Not least, the estimation of cost efficiency is perceived as difficult, as there are different models and actors were not secure about "best" or appropriate models.

In order to reduce costs, actors demand more standardised products. Following the researchers' statements, this is hardly possible.

Conclusions

Interviews with practice actors show that and how field tests for innovative absorption chiller systems result in comprehensive learning processes, comprising different aspects from user context to legal framework conditions. These results confirm and refine outcomes of the constellation analysis (see Keppler 2018) by more detailed insights on actor constellations,

interests and expectations and other factors influencing optimised planning and installation processes in real-world environments.

As the possibilities and limits of the technology have become clearer in the course of planning, implementation and launching, expectations have also become more specific and need for action beyond technological optimisations became apparent. Some starting points for further considerations and reflections are: professional and communicative know-how, practical experience (capacity building), standardisation and/or optimisation of planning procedures, critical review of researchers' "full-automation"-goals in the light of current routines and practices. Some of the identified barriers also require changes and measures on a higher level of action, for example adequate heat pricing, integration of relevant aspects in educational regulations, fee structures for planners, and – not least – the necessary alignment of dissemination strategies with overall goals of the energy transition.

References

Geels, Frank W. (2002), 'Technological Transitions as Evolutionary Reconfiguration Processes: A Multi-Level Perspective and a Case-Study', *Research Policy* 31, 1257–1274.

Geels, Frank W. (2011), 'The multi-level perspective on sustainability transitions: Responses to seven criticisms', *Environmental Innovation and Societal Transitions* 1 (1), 24–40. https://doi.org/10.1016/j.eist.2011.02.002

Keppler, Dorothee (2016), 'The role of absorption chiller demonstration projects in a climate-friendly, energy-efficient restructuring of the refrigeration sector', proceedings STS Conference Graz, 2016, on Critical Issues in Science, Technology and Society Studies: Graz. https://conference.aau.at/event/46/material/paper/4.pdf.

Keppler, Dorothee (2018), 'Absorption chillers as a contribution to a climate-friendly refrigeration supply regime: Factors of influence on their further diffusion', *Journal of Cleaner Production* (172) 2018, 1535-1544. doi.org/10.1016/j.jclepro.2017.10.276 .

Raven, Rob P.J.M. (2005), *Strategic Niche Management for Biomass. A Comparative Study on the Experimental Introduction of Bioenergy Technologies in the Netherlands and Denmark.* Eindhoven: Eindhoven University Press.

Exploring post-carbon futures

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Introduction

Revealing potential paths to a post-carbon future requires qualified estimates of possible trajectories in particular areas of the socio-economic system, especially regarding available technologies, infrastructures, policies and labour demand. With our approach, we aim to identify implications of the post-carbon transformation (inspired by the European Union's energy roadmap and its goal to cut greenhouse gas emissions by 80–95 % by 2050) for labour demand, in order to gain a better understanding of the system and guide our choices and actions at the present.

We propose a stakeholder-supported, evidence-based decision support system for economic, social, and biophysical impact assessments of the post-carbon transformation. Participatory modelling combined with input-output analysis (IOA) is proposed as a tool to address these requirements. The input-output model provides an analysis of the structural economic impacts of the post-carbon economy in terms of monetary flows between economic sectors and associated changes in labour demand and greenhouse gas (GHG) emissions. We briefly describe the approach and discuss some methodological challenges that have to be addressed.

Post-carbon economy

We approximate the post-carbon economy as an economy fully based on renewable energy sources (RES). Decreasing electricity costs from renewables as a whole, and the low costs from the best solar PV and onshore wind projects in particular, represent an important change. Therefore, wind onshore and solar PV energy is taken as a basis for the post-carbon economy because of their increasing importance in the energy mix and also very promising competitiveness in comparison with conventional energy sources (IEA 2017). Moreover, especially wind and solar energy are often said to have positive effects on employment (Bernardo and D'Alessandro 2016).

The transformation process requires explicit assumptions about possible future developments in sectors crucial for the transformation. As the first step and as an example of the proposed approach, we focus on modelling changes in the sector of electricity production (i.e. replacing fossil fuels with renewable energy sources), based on expert judgements regarding possible future development trajectories. Electricity production is one of the largest sources of GHG emissions from human activities from burning fossil fuels (together with heat and transportation) worldwide as well as in the European Union (EU) (IEA 2018).

Nevertheless, if we approximate the post-carbon economy as a RES based economy, then we also have to replace every input from the refinery sector, providing fossil fuels, fully to electricity or other renewable source of appropriate form of energy. To do so, similar analyses can be replicated for other GHG emissions intensive sectors such as transportation. But as our aim here is just to provide an example of the proposed approach, we focus only on the sector of electricity production.

Participatory modelling as an extended peer-review process

Participatory modelling brings together experts on technology (with qualified estimates of future technological and infrastructural changes intended to support the transformation) and policy experts (identifying possible political and economic accelerators and obstacles) with experience in implementing steps towards the post-carbon economy. Experts (e.g. engineers, researchers, governmental and non-governmental organizations' analysts, lobbyists, policy-makers etc.) are stakeholders with detailed knowledge of possible developments in the sector of wind and solar energy. Participatory modelling of input-output structures has been applied early on, e.g. by Duchin and Lange (1995).

The underlying assumption is that the stakeholders have both (1) knowledge of the topic, and (2) interest in shaping the future towards a post-carbon society. The research approach should assure that not only knowledge of expected developments in particular sectors and its technical details (i.e. electricity production based on renewable energy), but also broader ideas about ways to shape policy and economic developments in order to achieve the post-carbon future, are taken seriously into account.

We propose to develop our research along post-normal science (as applied e.g. by Haag and Kaupenjohann (2001)) as a suitable philosophical grounding. The extended peer-review (i.e. including non-scientific knowledge) as a specific methodological approach under fundamental uncertainty was suggested by Funtowicz and Ravetz (1994), but can be tracked down already to Paul Karl Feyerabend and his "Against method" (Feyerabend 1993). We take this approach in order to overcome several uncertainties arising from future developments, and in order to get more compelling images of desirable future socio-economic structures, trusted by those who endeavour to bring this future.

Input-output representation of the post-carbon economy

The experts' estimations will be translated into the logic of alternative input-output models for 2050, representing structural effects of different transformation pathways and underlying scenarios. IOA allows capturing inter-industry linkages and measuring their direct and also indirect effects of externally imposed changes (Kerschner and Hubacek 2009). The basic input-output transaction table consists of rows showing "Who gives to whom?" and columns showing "Who receives from whom?" in an economy. The input-output models with socioeconomic and environmental accounts allow to track changes e.g. in labour demand or related GHG emissions production.

The World Input-Output Database (WIOD) is taken as a source of data for the current monetary fluxes. Our study works with data from WIOD 2016 release, which contains data for monetary fluxes between the economic sectors for every year since 2000. WIOD 2016 release divides the economy into 53 sectors according to the International Standard Industrial Classification of All Economic Activities (ISIC) classification structure, an international reference classification of all productive activities. We track changes in the sector called *Electricity, gas, steam and air conditioning supply* in the WIOD structure, by modelling monetary fluxes coming to this sector as inputs to generate electricity with a given technology.

To obtain a trustworthy representation of the future post-carbon economy, it is necessary to incorporate technological changes likely to take place in the modelled sector. However, IOA is frequently criticised for its constant production coefficients. Although this can be a virtue in the

context of analysing short-term economic effects, where production technologies cannot be replaced instantaneously and thus fixed coefficients allow the evaluation of short-run effects of supply shocks, in the long-term this creates contradictions as one can assume significant effects of substitutions in supply and technological development in general. This is also the case of replacing fossil fuels with RES in the horizon of 2050. Wind and solar power generation technologies will very likely evolve over this period, and assuming unchanged production coefficients would miss an important aspect in the representation of the post-carbon transformation.

The construction of an input-output model capturing technological change requires focusing on technical coefficients for intermediate inputs. A technical coefficient is a ratio of input to a given sector to its output, measured in monetary terms (Miller and Blair 2009). Determinants of the technical coefficients cover technological progress (Leontief 1983), but also infrastructure policies, substitution due to relative price changes, as well as industrial structure (Peneder 2003). To get an idea about the determinants, we ask the experts about expected developments of inputs necessary for construction, operation and maintenance of the wind and solar energy producing devices up to 2050. We look for answers to questions regarding estimations of:

- Lifespan of renewable (solar and wind) energy producing devices;
- Share between capital costs (costs necessary for construction) and variable costs (costs of operation and maintenance) and its expected developments;
- Developments in shares of inputs;
- Technologies and procedures (institutional changes) that should be applied to lower greenhouse gas (GHG) emissions;
- Likelihood of the proposed changes.

Once technical coefficients and their changes over time are defined, it is possible to build future input-output tables, showing the interacting elements (input-output relations among sectors and associated socioeconomic and environmental accounts) required for a structural representation of the post-carbon economy. Translating the answers into the input-output logic is done via inserting new sub-sectors in the input-output table – wind and solar energy based production of electricity as part of an aggregate *Electricity, gas, steam and air conditioning supply* sector. We split the sector *Electricity, gas, steam and air conditioning supply* of the WIOD structure into the following components:

- Production of electricity by wind
- Production of electricity by solar photovoltaic
- Production of electricity by fossil fuels
- Production of electricity by other sources; Transmission and distribution of electricity; Manufacture of gas, distribution of gaseous fuels through mains; Steam and Air-conditioning supply

The sectoral disaggregation is based on input cost shares (i.e. proportions between inputs necessary to construct, operate and maintain wind and solar energy sources, measured in monetary terms, and coming to the sector from other economic sectors) of wind and solar

energy production, derived from EXIOBASE (a global, detailed Multi-regional Environmentally Extended Supply and Use / Input Output database) and external data sources on wind and solar energy capital and variable costs.

The share of fossil fuels in the sector *Electricity, gas, steam and air conditioning supply* is gradually diminished and replaced by inputs necessary to construct, operate and maintain wind and solar PV energy based electricity generation. The rest is kept constant over the modelled period. The aim of our approach is to see how this change in inputs from other sectors to the sector of electricity generation will affect the rest of the economy in terms of monetary flows, and what the associated impacts would be in terms of employment requirements and GHG emissions. The demand for electricity is kept constant, but can be increased as a part of an economic growth scenario.

The methodology enables comparison between different types of policies and infrastructures (e.g. countries with a different energy mix of fossil fuels based electricity generation). The approach can be used at every respective level of analysis – from regions and countries to larger socioeconomic and geographic units such as the EU. A potential extension could also include material requirements for the construction of renewables or the analysis of land requirements.

Methodological challenges

We propose the research approach described above as an alternative to conventional methods of estimating technological change in economic models dealing with renewable of post-carbon transformation in general, and for input-output modelling in particular. In this section, we compare the proposed method (input-output participatory modelling) with learning curves, a widely used approach in the field. We propose a process determining the technical coefficients that should help to overcome a significant number of methodological challenges, often described as limitations to the other methods.

Learning curves, a popular approach in energy-climate input-output models, internalizing technological progress to replace the conventional assumption of an autonomous energy efficiency improvement, receives plenty of criticism. According to (Pan and Köhler 2007),

> "the learning curve cannot separate the effects of price and technological change, cannot reflect continuous and qualitative change of both conventional and emerging energy technologies, cannot help to determine the time paths of technological investment, and misses the central role of research and development activity in driving technological change".

While participatory modelling per se cannot separate between price and technological changes, the continuous versus qualitative changes, time paths of technological investments as well as the level of expected research and development activity in the field should be possible to address with the proposed research design. It enables to build several scenarios according to clusters of experts' estimations, reflecting both continuous and gradual changes in the RES deployment and/or their production (technical) coefficients. The proposed approach should also ask for expected relations between institutional (political, economic) settings and research and development activity in the field.

Somewhat similar to our approach is backcasting, another method developed to deal with incorporating technological change in economic models. Backcasting starts with defining a desirable future and then tries to identify policies and actions taken in order to achieve the specified future backwards. It answers what actions must be taken to attain a certain (predefined) goal (Robinson 1982). Nevertheless, while backcasting might work perfectly for political, economic and legal (institutional) actions and arrangements and can probably work also for estimating continuous technological change, there are several problematic points with applying backcasting to predict technological change and specifically technological breakthroughs. One step forward could be to use backcasting together with e.g. a participatory workshop identifying possible future technological breakthroughs influencing the post-carbon transformation.

Our proposal is a two-step research design. The first step consists of exploratory in-depth interviews with experts on wind and solar energy. The associated scenario building can be based on each interview separately – outcomes of one interview are translated into one scenario in case of widely differing results, or clustered according to responses with similar estimations. Then, a participatory workshop takes place. This is to assure that uneven events and changes are also taken into account in the following scenario building (such as technological breakthrough and their implications). Assuming that the group work can create a more stimulating environment for the experts, participatory modelling should provide answers to questions such as the likelihood of technological developments that can take place, and can give more rigorous ideas about the range of institutional and policy developments.

The method of experts' selection must be dealt with caution. How do we define who is an expert, and who is not? The selection has to be done in an explicit and self-reflective way. We recommend to ask a question on the experts' self-evaluation, regarding their level of understanding of the technological details of the RES production, operation and maintenance, respectively the policy framework of RES deployment. A snowball method can be used to identify the appropriate "available" experts. However, this method has been also criticised in the field of science and technology studies. According to (Klein and Kleinman 2002), some relevant social groups may be excluded from participation and their absence may go unnoticed. Both the exclusion and the reasons for it would thus remain hidden, with the risk that some major factors influencing technological change are undetected.

The authors conclude that the snowball method is inadequate for identifying unrecognized and missing participants, while its emphasis on groups overlooks social structures that might account for such absences. While this criticism is certainly relevant for several fields of research, with highly specific a technology-oriented questions about renewable energy developments this should not be a serious problem. The group of technology experts is well defined, based on their knowledge of technical details concerning RES production, operation and maintenance.

On the other hand, this might not be true about the second group of policy experts. The group's definition is broader and more dependent on interpretation of what it means to be a "policy expert" (on renewable energy transformation). Bijker (1997), following Latour (1987), suggests that researchers must "follow the actors." The idea is that the only categories and lines of social demarcation of importance are those consciously recognized by the actors. In our case, this would mean asking the (first contacted according to the researchers' judgement) policy experts about whom they would classify as other experts in the field (and why). The burden of identifying

the first circle of experts thus lies on the researcher's shoulders and the choice has to be as explicit and reflective as possible.

Conclusion

The post-carbon future might not to be forecasted, but instead to be carefully constructed: the point is to try to shed light on different possible futures in order to gain a better understanding of the system and guide our choices and actions at the present. Revealing potential paths to a post-carbon future requires detailed and qualified estimates of possible future development pathways in particular areas of the socio-economic systems, as well as more general proposals, ideas and visions regarding future economic structures, available technologies, infrastructure and policies.

The transformation requires understanding interconnections between developments in various economic sectors. We propose to base the related scenario building on a participatory process bringing together experts with knowledge of possible future developments in particular economic sectors (organizational and technological changes that are supposed to be leading to a post-carbon economy) with experts on policies for the post-carbon transformation, identifying the likely obstacles and accelerators of the transformation process. The expert judgements are translated into the information about technical coefficients expected developments, incorporated into the logic of an input-output model of 2050.

References

Bernardo, Giovanni and Simone D'Alessandro (2016), 'Systems-Dynamic Analysis of Employment and Inequality Impacts of Low-Carbon Investments', *Environmental Innovation and Societal Transitions* 21: 123–144.

Bijker, Wiebe E. (1997), 'Of Bicycles, Bakelites, and Bulbs: Toward a Theory of Sociotechnical Change.' Cambridge: The MIT Press.

Duchin, Faye and Glenn-Marie Lange (1995), 'The Future of the Environment: Ecological Economics and Technological Change.' New York: Oxford University Press.

IEA (2018), *Energy and CO2 emissions in the OECD*, https://www.iea.org/media/statistics/ Energy_and_CO2_Emissions_in_the_OECD.pdf [downloaded 25 June 2018]

Feyerabend, Paul (1993), 'Against Method.' London: Verso.

Funtowicz, Silvio O. and Jerome R. Ravetz (1994), 'The Worth of a Songbird: Ecological Economics as a Post-Normal Science', *Ecological Economics* 10 (3): 197–207.

Haag, Daniel and Martin Kaupenjohann (2001), 'Parameters, Prediction, Post-Normal Science and the Precautionary Principle – a Roadmap for Modelling for Decision-Making', *Ecological Modelling* 144 (1): 45–60.

Kerschner, Christian and Klaus Hubacek (2009), 'Assessing the Suitability of Input–Output Analysis for Enhancing Our Understanding of Potential Economic Effects of Peak Oil', Energy 34 (10): 284–290.

Klein, Hans K. and Daniel Lee Kleinman (2002), 'The Social Construction of Technology: Structural Considerations', *Science, Technology, & Human Values* 27 (1): 28–52.

Latour, Bruno (1987), 'Science in Action: How to Follow Scientists and Engineers Through Society.'

Cambridge Massachusetts: Harvard University Press.

Leontief, Wassily (1983), 'Technological Advance, Economic Growth, and the Distribution of Income', *Population and Development Review* 9 (3): 403–410.

Miller, Ronald E. and Peter D. Blair (2009), 'Input-Output Analysis: Foundations and Extensions', Cambridge UK: Cambridge University Press.

Pan, Haoran and Jonathan Köhler (2007), 'Technological Change in Energy Systems: Learning Curves, Logistic Curves and Input–output Coefficients', *Ecological Economics* 63 (4): 749–758.

Peneder, Michael (2003), 'Industrial Structure and Aggregate Growth', *Structural Change and Economic Dynamics* 14 (4): 427–448.

IEA (2017), *Renewables 2017*, https://www.iea.org/publications/renewables2017/ [downloaded 25 June 2018]

Robinson, John Bridger (1982), 'Energy Backcasting A Proposed Method of Policy Analysis', *Energy Policy* 10 (4): 337–344.

Car sharing – a feasible way to a low-carbon mobility system?

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1. Introduction

This paper examines car sharing as an emerging innovation that has the potential to contribute to a more energy efficient and low-carbon mobility system. Although it does not represent a radically new technology, car sharing challenges the foundations of the current mobility system, which is based on private ownership. By combining approaches from the study of socio-technical transitions and social practice theories, it seeks to provide new insights into how innovative technologies and practices are used and their potential impacts. The paper discusses the following research question: *"How can car sharing contribute to a decarbonisation of the road transport system and to a low-carbon mobility system?"*

Moving towards a more resource-efficient and carbon-neutral mobility system is a key challenge in the years ahead, especially in urban areas. Systemic mobility challenges are often perceived as being technical in nature. Accordingly, technological innovations, such as hybrid and battery electric vehicles, are often regarded as the best means to achieve efficiency and sustainability. It is likely, however, that the deep structural changes associated with a systemic transition would also involve social or organisational innovations. Although spurred by new mobile technologies and applications, car sharing is primarily related to non-technological innovations focusing on changing *mobility practices*, new *markets* and new forms of *cooperation* and *business models*.

The paper utilises desktop studies and in-depth interviews with car sharing operators, users and potential users from ongoing projects. It draws on both socio-technical and practice theory to derive theoretical and practical insights regarding car sharing as a potential pathway, or component thereof, to a more sustainable mobility system. Preliminary results indicate that car sharing can influence changes in established (private car-dependent) mobility practices at the household level.

2. Car sharing

Carsharing refers to multiple users having access to individual cars on a short-term rental basis through a formal service provider or intermediary (Truffer, 2003, Shared Use Mobility Center [SUMC], 2016). Users can pay for the use based on time, distance or both. Car sharing is particularly attractive to people who make only occasional use of a car or wants access to different types of cars.

Car sharing can take a variety of forms in terms of operational and business model. Some service providers are for-profit while others are non-profit entities. Car sharing may be their core business or a part of a larger business portfolio. Car sharing can also be separated in different operational models such as round-trip, wherein users return the car to the same place it was accessed, and point-to-point or free-floating systems, wherein users to begin and end a trip at different locations within a specified geographical zone (Martin and Shaheen 2016). Carsharing can also be divided by market segments, such as: business-to- consumer (B2C), business-to-business (B2B) and peer-to-peer (P2P).

3. Analytical framework

3.1 The socio-technical approach and MLP

In the study of socio-technical transition, the multi-level perspective (MLP) is a common tool used to describe the processes involved with broad structural changes in the way society uses technology. The MLP was originally developed by Rip and Kemp (1998) and has since been elaborated by others (Rotmans et al. 2001, Geels, 2002, Geels, 2005, Geels & Schot, 2007, Geels et al. 2016, Hodson, et al. 2017) to incorporate more variables and complex interdependencies between systemic components. The MLP describes socio-technical transition using a nested hierarchy of interacting levels (landscape, regime and niche) that constitute the system and its environment. The regime can be thought of as the semi-coherent set of rules and practices that guide actors along particular behavioral trajectories within a socio-technical system. The landscape is the exogenous environment that influences the regime. Niches are spaces in which new, experimental and potentially radical innovations can develop outside of the regime selection environment. Car sharing is the niche innovation that is the central focus of this paper.

3.2 Theories of social practice

The MLP and practice theories have different approaches to innovation. If the MLP has a tendency to focus on technological innovations and follow them from inception to application, practice theory approaches innovation from the other end – that of its end use and the structures that support its use" (Southerton & Watson, 2015). Practice theory is a social theory that eschews the tendency to view human behavior through the lenses of *homo economicus* and *homo sociologicus*, which view human actions, respectively, as the result of either (1) individual actions, intentions and interests that are deliberate choices; or (2) collective values and rules that shape human behavior and lead to a normative consensus (Reckwitz, 2002, p. 244). Practice theory shifts focus away from the human and towards the practice itself, which is conceptualized as being constituted of interconnected elements, namely, materials, skills and meanings. Practices change when there is a change in either the material elements), the practitioner, or the relationship between practices (Pantzar & Shove, 2010; Watson, 2012).

4. Car sharing in Norway

4.1 Supply-side perspective

Although car sharing is still very much a niche mobility practice in Norway, as it is in most other countries, it has undergone rapid growth in recent years. The first car sharing companies in Norway were established as collectives in the 1990s in three largest cities of Oslo, Bergen and Trondheim. Over the last decade, established mobility companies like Hertz, Avis and Møller have entered the market. The most dramatic change has been that of the rise of P2P platforms, which have led to a rapid rise in the size of the car sharing market as measured by membership and number of available cars. P2P platforms, however, have not had a major impact on actual use as compared with the other providers. It is expected that in late 2018, Norway will have ten car sharing service providers. As incumbent regime actors become more involved in the market, smaller entrepreneurial start-ups and cooperatives may be gradually displaced or absorbed.

Interviews with car sharing operators in Norway indicate a variety of business and operational models. Following Andrew et al. (2007), car sharing companies can take the role of an integrator or an orchestrator to govern their business model. An integrator takes full responsibility for the delivery of a value proposition and can be regarded as "the sole owner and executor of the innovation – and the primary, if not the only, participant in the rewards". In contrast, orchestrators adopt a more collaborative approach by leveraging the skills and capabilities of partners. The role of orchestrator is similar to that of a broker, who brings together different actors via a multi-sided business model 'platform' (Osterwalder and Pigneur, 2010). The shift in business models from B2C to P2P also implies a shift from an integrator role to an orchestrator role for the car sharing companies.

Integrators and orchestrator car sharing providers have distinct roles in terms of value proposition, customer segment, revenue, geographic areas served, and environmental goals/ impact (Sarasini & Langeland 2017). Companies that operate a centralised car fleet are dependent on a relatively high frequency of users in order to be profitable. P2P companies, on the other hand, organise car sharing on behalf of private car owners and can operate relatively independent of user frequency. The role as integrator or orchestrator may have both geographical and sustainability implications. Integrators (B2C and B2B) with a centralised fleet need to be situated in larger cities with a critical mass of customers and a high level of vehicle utilisation. Orchestrators (P2P), on the other hand can, in principle, also be located in less urbanised areas. The differences between integrators and orchestrators also have implications for the technological renewal of the vehicle fleet. Integrators typically strive for a modern fleet based on rapid renewal and increased use of zero-emission cars (EVs), whereas orchestrators have less discretion over the types of vehicles which are shared between peers.

As mentioned earlier, niche innovations are often 'immature' in that they are not technologically or economically viable, and must, therefore, rely on protection, in the form of subsidies or other supportive measures, in order to compete in the regime selection environment. The emergence of car sharing in Norway has taken place despite the lack of a formal niche protection strategy on the part of the authorities or incumbent firms. A national policy for promoting car sharing would possibly increase use but local policy measures (e.g. parking) are probably even more important.

4.2 Demand-side perspective

Several dozen in-depth interviews were held with a diverse pool of households living in and around the Oslo area. The informants were either active users of car sharing or had recently considered use. From the interviews it appears that the main differences between the car sharing schemes, seen from a household perspective, are the following: the fixed and variable cost of rental, level of self-service vs. supporting service, personal or non-personal encounter upon rental and delivery, car pick-up locations, parking arrangements, types and vintage of cars offered, availability of equipment, and other aspects. The practice theory framework has allowed for the analysis of these differences as they relate to the constituent elements, namely the materiality, skills and meanings, of car sharing as a practice. The following table shows prominent elements of car sharing based on the household interviews.

Elements	Important themes discussed within each element
Material	The car itself: types of equipment, hedonistic factors
	Cargo: temporary storage, car seat installation.
	Material environment: local geography, spatial proximities and weather
	The digital interface for booking and communication
Skills	The ability to use the digital interface
	Planning of activities and finances
	Vehicle operation
Meaning	Freedom and flexibility
	Environmental protection and/or sustainability
	Maintaining and developing social relations
	Alternative lifestyles and business models
	Being financially smart

Table 1. Elements of car sharing

The manner in which these elements are interlinked are almost never straightforward. For example, the digital interface required to use car sharing is, at once, a technological innovation that is part of car sharing's materiality, the use of which requires specific skills and caries meanings in terms of how and why one uses it. In another example, the majority of households viewed car sharing as beneficial for the environment, but considered this to be an added, secondary benefit, rather than a decisive element. In some instances, the importance of the environmental meaning of car sharing changed over time in such a way that it served as a poor recruitment tool to the practice of car sharing but a strong retention mechanism that kept the practice going. In terms of business model, many users stated that they prefer to deal with a professional rental company (i.e. integrator) that offers a professional level of service. Within this category, however, there were some who preferred collective arrangements because it helped foster a sense of connection with other users, whereas other informants were more sceptical of member owned enterprises. There were also some informants who preferred P2P providers (i.e. orchestrators) precisely because they did not want to support B2C schemes. Importantly, despite the multiple meanings associated with car sharing, for almost all users, car sharing had little or no value, in and of itself; it was almost always a tool with which they could carry out another activity.

5. Discussion and conclusions

Car sharing has, until now, mainly been niche urban phenomenon dominated by integrator service providers. The rise of orchestrator service providers, such as P2P car sharing platforms, opens windows of opportunity for such services to expand beyond traditional markets and contribute to car sharing becoming part of the mobility regime. With the development of new markets and business models, car sharing is a good example of a non-technological innovation that may contribute to a more sustainable mobility system.

The increased involvement of incumbent regime actors in the car sharing market is an indication that the market has viability and potential for growth. Although niche technologies are conceptually distinct from the regime, this is not to say they are exogenous in the way that the landscape is. Although regime actors are prone to behave in ways that promote stable trajectories, this is not to say that they are static. The rules and practices within the regime reinforce stable trajectories whereby regime actors pursue gradual as opposed to radical innovation and change. Car sharing may represent a gradual change, but only if the incumbent actors are active in its provision.

The material and skills elements of car sharing highlight that success often hinges on the ability to replicate, to the extent possible, the practice of owning and driving a private vehicle, while eliminating its negative aspects. Vehicle operation, parking, transport and storage of cargo, use of the digital interface and planning of activities all represent hurdles and opportunities with respect to initiating and reproducing the practice of car sharing. Policy makers in particular are in the position to support car sharing. The concerted efforts from various levels of government in Norway to promote battery electric vehicles provide important lessons on how to successfully promote a niche technology/practice such that it becomes more mainstream part of the regime.

The tendency of service providers and public officials to frame car sharing using the language of sustainability is not the most effective means of attracting new users. It may, however, be a good method for maintaining existing users. Marketing and promotion must reflect the prominent meanings associated with car sharing. Although the utilitarian aspects of cost and convenience are always important, matters of lifestyle, freedom and self-image would also provide good material with which to frame effective discourses on car sharing.

Analysing the micro-phenomena that take place on the user side provides rich information that can be used to inform promotion strategies as well as policy formulation. If we are to truly consider car sharing to be a meaningful innovation that can lead to a more carbon neutral and sustainable form of mobility, users must adopt it. Whereas as invention is the first instance of an improved product or process, an innovation is the attempt to carry it out into practice (Fagerberg, 2005, p. 5). Users have diverse needs, desires, capabilities and worldviews, and as car sharing expands, the set of offerings must reflect this diversity such that a greater extent of the market can be reached.

References

Andrew, J.P., Sirkin, H.L., Butman, J., 2007. Payback: Reaping the Rewards of Innovation. Boston, MA: Harvard Business School Press.

Fagerberg, J. (2004). Chapter 1: Innovation: a guide to the literature, pp1-26. In Fagerberg, J., Mowery, D. C. & Nelson, R. R. (Eds), *The Oxford Handbook of Innovation*. Oxford, UK: Oxford University Press.

Geels, F. W. (2002). Technological transitions as evolutionary reconfiguration processes: a multi-level perspective and a case-study. *Research Policy, 31*, 1257-1274. doi: 10.1016 S0048-7333(02)00062-8

Geels, F. W. (2005). Processes and patterns in transitions and system innovations: Refining the co-evolutionary multi-level perspective. *Technological Forecasting & Social Change, 72,* 681-696. doi: 10.1016/j.techfore.2004.08.014

Geels, F. W. & Schot, J. (2007). Typology of sociotechnical transition pathways. *Research policy, 36,* 399-417. doi: 10.1016/j.respol.2007.01.003

Geels, F. W., Kern, F., Fuchs, G., Hinderer, N., Kungl, G., Mylan, J., Neukirch, M., Wassermann, S. (2016). The enactment of socio-technical transition pathways: A reformulated typology and a comparative multi-level analysis of the German and UK low-carbon electricity transitions (1990-2004)*. Research Policy, 45,* 896-913. doi: 10.1016/j.respol.2016.01.2015

Hodson, M., Geels, F. W. & McMeekin, A. (2017). Reconfiguring Urban Sustainability Transitions, Analysing Multiplicity. *Sustainability, 9*(2), 299. doi: 10.3390/su9020299

Osterwalder, A., Pigneur, Y., 2010. Business Model Generation: A handbook for 27 visionaries, game changers and challengers. John Wiley and Sons, Inc., Hoboken, New Jersey.

Pantzar, M. & Shove, E. (2010). Understanding innovation in practice: a discussion of the production and re-production of Nordic Walking. *Technology Analysis & Strategic Management, 22*, 4, 447-461. doi: 10.1080/09537321003714402

Reckwitz, A. (2002). Toward a Theory of Social Practices: A Development in Culturalist Theorizing. *European Journal of Social Theory, 5,* 243-263. doi: 10.1177/13684310222225432

Rotmans, J., Kemp, R. & van Asselt, M. (2001). More evolution than revolution: transition management in public policy. *Foresight, 3*, 1*,* 15-31. doi: 10.1108/14636680110803003

Steven Sarasini, S. and Langeland, O. "Providing alternatives to the private car: the dynamics of business model innovation". Paper presented at 1st International Conference on Mobility as a Service (ICOMaaS), Tampere, Finland, November 28-29, 2017.

Shared Use Mobility Center (2017). What is Shared-Use Mobility? Retrieved on 23 May 2017 from http://sharedusemobilitycenter.org/what-is-shared-mobility/

Southerton, D. & Watson, M. (2015, 25th of November). Multi-Level Perspective and Theories of Practice: a mistaken controversy? *Mobile Lives Forum*. Retrieved from http:/ /en.forumviesmobiles.org/arguing/2015/11/25/multi-level-perspective-and- theories-practice-mistaken-controversy-2972

Truffer, B. (2003). User-led Innovation Processes: The development of Professional Car Sharing by Environmentally Concerned Citizens. *Innovation: The European Journal of Social Science Research, 16*(2), 139-154. doi: 10.1080/13511610304517

Watson, M. (2012). How theories of practice can inform transition to a decarbonized transport system. *Journal of Transport Geography, 24,* 488-496. doi: 10.1016/j.jtrangeo.2012.04.002

Is energy efficiency the panacea for energy poverty? – Evidence from Austria and Macedonia

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Introduction

In the light of EU's decarbonization endeavors, the key instruments to enforce these low-carbon policies are renewable energy and energy efficiency. Undoubtedly this grand transition requires changes in many aspects, such as at socio-economic, technological, and societal level. Households are one of the key actors to play part in this transition; however there is a general concern that the energy transition will leave out energy poor households, the latter defined as being unable to satisfy their energy needs (Scarpellini *et al.* 2015).

Energy efficiency has been generally considered as the ultimate measure to address energy poverty (Boardman 2010; Thomson and Snell 2013; Tirado Herrero and Ürge-Vorsatz 2012). The logic is that households affected by energy poverty should be able to have financial savings after installing energy efficiency measures since these measures will reduce the energy demand. However, investment in energy efficiency is considered expensive (Healy and Clinch 2004; Tirado Herrero and Ürge-Vorsatz 2012) and often out of reach for affected households (Boardman 2010; Bouzarovski *et al.* 2012; Fahmy *et al.* 2011), especially that the economizing strategies of energy poor are under-researched.

The literature on energy poverty in Macedonia and Austria is limited. In Macedonia half of the households suffers from energy deprivation (Buzar 2007). Energy poverty is not a problem of lower-class, but of middle-class as well (Buzar 2007). The coping strategies of households which are energy poor and/or poor/ at risk of poverty in Vienna were analyzed showing that these households use different strategies to cope with the restriction to satisfying their basic needs (Brunner *et al.* 2012).

The paper includes a comparative case study with focus on Macedonia and Austria and combines both qualitative and quantitative methods. The empirical data consists of 54 interviews with stakeholders from both countries, 219 interviews with households from both countries mostly collected via an online platform, 300 phone surveys in Vienna and Skopje, 150 1per city from both countries. For both types of interviews, purposive sampling was used, while the surveys were collected by randomly selecting households in the capital cities. Important is to note that when collecting data from households, not only energy poor, but also non-energy poor households were surveyed or interviewed.

Macedonia, a Western Balkan country, and Austria, a Central European country, have different historic legacies, whereas Macedonia belongs to the list of former socialist countries. Macedonia is still a developing country, unlike Austria which is a developed one. The aim of this paper is test whether energy efficiency is the most effective measure to address energy poverty in Austria and Macedonia, countries with different levels of living standard and social and energy systems.

Results

Energy poverty definition and indicators

Some of the main findings regarding energy poverty definitions and indicators from the conducted interviews are:

- Energy poverty is expressed in choosing whether to heat or satisfy other basic needs, such as food
- Heating is the most problematic energy service in Austria, while all energy services are relevant for Macedonia
- Income poverty and energy poverty are very much connected in Austria, while in Macedonia not only income poor, but also not income poor are affected by energy poverty
- Related to the previous finding, in Austria affordability is the most relevant aspect of energy poverty, while in Macedonia not only affordability, but access and comfort too
- Not heating the whole dwelling is an indicator of energy poverty, and it is very common in Macedonia
- Most important indicators of energy poverty are: dwellings with bad quality which often have cheap rent in Austria; households living in houses in Macedonia; households using electricity, fuelwood or unconventional materials for heating; those with low incomes and high energy costs

Policies and projects with relevance to energy poverty

In regard to policies and projects in both countries with relevance to energy poverty, the most important findings from the interviews are:

- There is no national definition of energy poverty in both countries
- The initiatives in Austria have a good target group, but poor choice of measures
- Best measures in Austria include the passive house project, and the obligations of energy suppliers to invest in energy efficiency in households
- The measures in Macedonia are well chosen, but the target group is poor
- Best measures in Macedonia are: loans for low-income households, subsidized loans for good quality of energy efficient products and services, project on how to change the heating of most vulnerable households, and a municipality's rulebook on energy efficiency standards in new dwellings

Households' strategies to satisfy their energy needs

The main findings about how households affected by energy poverty satisfy their energy needs from the interviews are:

- Households reduce their comfort in order to reduce their energy costs
- Strategies to reduce their energy costs include: not heating all rooms, lower indoor temperature, small energy efficiency investments, wearing warmer clothes, minimal electricity use
- Households prioritize their energy bills over other needs -Households find comfort to be more important than other needs
- Desired result of energy efficiency is financial savings to be used for other needs other than increasing comfort

- Two households living in a passive house in Vienna contrary to some findings do not have high income

Energy efficiency as a measure to reduce energy poverty

The findings on the use of energy efficiency as a measure to reduce energy poverty from the interviews and surveys are:

- Most stakeholders find energy efficiency to be the best measure to alleviate energy poverty
- Best way to prevent energy poverty is by adopting legislation requiring energy efficiency standards in new dwellings
- Households data based on cross-tabulation between having or not energy efficiency measures and a set of different indicators of aspects of energy poverty shows mostly no relationship
- Reasons for energy efficiency measures not being successful to address energy poverty in the household data include: partial installation of energy efficiency measures, incorrect application of energy efficiency, the type of energy efficiency measure used
- Not every household can afford investment in energy efficiency
- Energy efficiency does not result in energy savings due to households already reducing their energy needs
- Energy efficiency increases the rent which chases away vulnerable households
- Affordability issues prevent Macedonia's households from accessing heat infrastructure; while low electricity price and under-heated dwellings make heat infrastructure projects unrealizable in Macedonia

Conclusion

It seems that energy efficiency is not a panacea for energy poverty in Macedonia and Austria due to barriers to energy efficiency, lack of quality of implementing energy efficiency measures, poor targeting, not tailor-made measures, priorities of households and legal framework which does not take into consideration the issue of energy poverty. It means that energy poverty per se is not the solution to energy poverty; it has to take all these challenges into consideration in order to be effective measure against energy poverty. It means energy efficiency measures need to be suitably chosen, wholesome and implemented with support of social measures, in order to achieve their goal of alleviating energy poverty. However, one persuasive argument is the use of energy efficiency to prevent energy poverty in the future.

If there is energy poverty present in a household, energy efficiency measures need to complemented with social measures in order to be effective and sustainable in the long-term. Legislation and infrastructure projects which envisage high energy standards prevent future consumers from energy poverty. If in a need of immediate short-term action against energy poverty, allowing households to have control over their situation is a good approach even if it means they would continue to face energy poverty. In order to help make the EU energy transition inclusive and successful for all consumers, it needs to consider that energy efficiency on its own does not alleviate energy poverty, and there is need of targeted social measures to help households access adequate measure to improve their energy efficiency.

List of datasets

Survey Vienna dataset (150) Interview Austria dataset (100) Survey Skopje dataset (150) Interview Macedonia dataset (119) Interviews with stakeholders (54)

Bibliography

Boardman, B. 2010. *Fixing fuel poverty : challenges and solutions*. London ; Sterling, VA: Earthscan.

Bouzarovski, S., Petrova, S. and Sarlamanov, R. 2012. Energy poverty policies in the EU: A critical perspective. *Energy Policy* 49 76-82.

Brunner, K.-M., Spitzer, M. and Christanell, A. 2012. Experiencing fuel poverty. Coping strategies of low-income households in Vienna/Austria. *Energy Policy* 49 53-59.

Buzar, S. 2007. The 'hidden' geographies of energy poverty in post-socialism: Between institutions and households. *Geoforum* 38 (2): 224-240.

Fahmy, E., Gordon, D. and Patsios, D. 2011. Predicting fuel poverty at a small-area level in England. *Energy Policy* 39 (7): 4370-4377.

Healy, J.D. and Clinch, J.P. 2004. Quantifying the severity of fuel poverty, its relationship with poor housing and reasons for non-investment in energy-saving measures in Ireland. *Energy Policy* 32 (2): 207-220.

Scarpellini, S., Rivera-Torres, P., Suárez-Perales, I. and Aranda-Usón, A. 2015. Analysis of energy poverty intensity from the perspective of the regional administration: Empirical evidence from households in southern Europe. *Energy Policy* 86 729-738.

Thomson, H. and Snell, C. 2013. Quantifying the prevalence of fuel poverty across the European Union. *Energy Policy* 52 563-572.

Tirado Herrero, S. and Ürge-Vorsatz, D. 2012. Trapped in the heat: A post-communist type of fuel poverty. *Energy Policy* 49 60-68.

STREAM: Sustainable Food Systems

Students' knowledge and attitude towards plastic fruit packaging
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1. Purpose of the Research

The aim of this research is to get to know the attitude towards plastic fruit packaging and the environmental attitude of younger consumers. Furthermore, the knowledge regarding plastic fruit packaging and its waste is taken into account. Students were selected as the target group because they have, worldwide but especially in Europe, a positive environmental attitude (Aminrad et al. 2011; Beba & Eibl 2011; Strack et al. 2017). They are also likely to have a more environmental-friendly attitude towards plastic fruit packaging. To answer these questions an online survey was conducted to explore students' knowledge of, and attitude towards, plastic fruit packaging.

2. Background/Motivation

Plastic packaging waste has doubled from 1.5 million tons to 3.0 million tons in the last 20 years in Germany causing marine debris and environmental littering (Umweltbundesamt 2017). Plastic fruit packaging is a known driver for this problem. Reasons for this increase of plastic fruit packaging waste are among others smaller packaging sizes and the consumer demand of a thick and rigid packaging (Istel et al. 2015). Furthermore, it often substitutes cardboard packaging because it has a cheaper price and better material properties. Fruit packaging has many different functions like e.g. labelling and protection (Pfohl 2004; Jünemann & Schmidt 2000). However, it is only in some cases (e.g. protection of raspberries or labelling of organic fruit) necessary, when the use of the packaging to portion the food is not considered (Istel 2016). Besides that, many consumers, especially the younger generation, claim that they don´t like plastic fruit packaging (Bovensiepen et al. 2018). Still, supermarkets and other contributors sell their fruit in plastic packaging (e.g. a box with a lid, foil, bags).

3. Methodology

The questionnaire of the quantitative online survey composed of six sections and is based on relevant literature (Dunlap et al. 2000; Foscht & Swoboda 2011; Harraway et al. 2012; Jeżewska-Zychowicz & Jeznach 2015; Plumb et al. 2013). The questionnaire consisted of questions regarding students'

1) fruit buying behaviour,
2) knowledge of plastic fruit packaging,
3) preferences for plastic fruit packaging alternatives,
4) willingness to pay for plastic fruit packaging alternatives,

5) environmental attitude and attitude towards plastic fruit packaging, as well as,
6) sociodemographic characteristics (e.g. age, sex).

Sections 2 and 5 are necessary to answer the research questions, whereby sections 1 and 6 are used to describe the results in more detail. The final version of the questionnaire was tested in a pre-test and consisted of 43 questions. The sample size of the online survey contains 999 respondents, who study at a Bavarian university and are 18 years or older. Furthermore, only attendees who answered the whole questionnaire were taken into account.

One main part of the study is to better understand the knowledge regarding plastic fruit packaging. Therefore, the respondents were asked to estimate the functions of plastic fruit packaging, such as protection, transportability and hygiene (Jünemann & Schmidt 2000; Pfohl 2004). A five-point Likert-scale was used to assess the students' estimations. The other main part of the study is to analyse the students' environmental attitudes and attitudes towards plastic fruit packaging. The environmental attitude was recorded using the revised New Ecological Paradigm (NEP) Scale by Dunlap et al. (2000) in the German language. The revised NEP-Scale is a multiple-item scale which is commonly used as a method to assess environmental attitude and has already been applied to several studies (Atav et al. 2015; Sudbury-Riley et al. 2014; Xue et al. 2016). Further, the attitude towards plastic fruit packaging was measured using a self-developed multiple-item scale. For the development process of this scale, relevant literature was consulted (Bovensiepen et al. 2015, 2018; Jeżewska-Zychowicz & Jeznach 2015; Naturschutzbund Deutschland e.V. 2015). The statements used were verified by experts (local grocery shop owners and food retailers), were tested with 24 respondents in a pre-test and were used to generate a multiple-item scale consisting of 10 items. A five-point Likert-scale was used to measure both, the NEP-Scale and the attitude towards plastic fruit packaging scale. Furthermore, a semantic differential was applied to measure the connotative meaning of plastics and bioplastics for fruit packaging. The connotations measured with a seven-level-rating scale were used to derive the attitude towards plastic fruit packaging. The polar adjectives were based on relevant literature (Foscht & Swoboda 2011; Plumb et al. 2013). Thus, the results of the self-developed multiple-item scale could be described in more detail using the semantic differential. Within this study, bioplastics have been defined as plastics made from renewable resources (Fachagentur Nachwachsende Rohstoffe e.V. 2016).

4. Results

The socio-demographic sample characteristics as well as the main grocery store for buying fruit of the respondents is shown in Table 1. The distribution of age resembles the structure of German students (Middendorff et al. 2017), while females are over-represented in the survey with 62,2 % because in Germany 48.2 % of students are female. (Statistisches Bundesamt 2016). Furthermore, the average age of the respondents (23.15 years) nearly equals the average age of German students which is 23.5 years (Statistisches Bundesamt 2017). Additionally, almost all respondents (80 %) purchase their fruit mainly in discounters and supermarkets. Only 6.3 % of the participants are not responsible for grocery shopping.

Sample characteristics		Respondents (n=999)	Frequency (%)
Gender			
	Female	621	62.2
	Male	371	37.1
	No answer	7	0.7
Main grocery store for buying fruit			
	Supermarket	464	46.5
	Discounter	334	33.5
	Wholefood shop	71	7.1
	Online-Shop	1	0.1
	Directly from farmers	100	10.0
	Others (e.g. home-grown)	28	2.8
Responsibility for grocery shopping			
	Yes	529	53.0
	Occasionally	407	40.7
	No	63	6.3

Table 1: Socio-demographic sample characteristics and purchasing habits (n=999)

In a second step, a descriptive analysis of the questionnaire was done to get to know the knowledge regarding plastic fruit packaging. Figure 1 shows the consumer perception of plastic fruit packaging functions, while all items are packaging functions except the job creation scheme (Jünemann & Schmidt 2000; Pfohl 2004). Among the most important results regarding this question is, that the majority of respondents do not percept every plastic fruit packaging function (see figure 1). A large part of the participants percept packaging functions like protection and transportability. 90.7 % of the respondents (strongly) agree that protection is a packaging function, while 89.4 % of the respondents (strongly) agree on the transportability as a packaging function. Against that, 55.9 % of the respondents (strongly) disagree on marketing and 52.5 % of the respondents (strongly) disagree on the differentiation of products as a packaging function. According to that, consumers do not percept every plastic fruit packaging function, only the main functions.
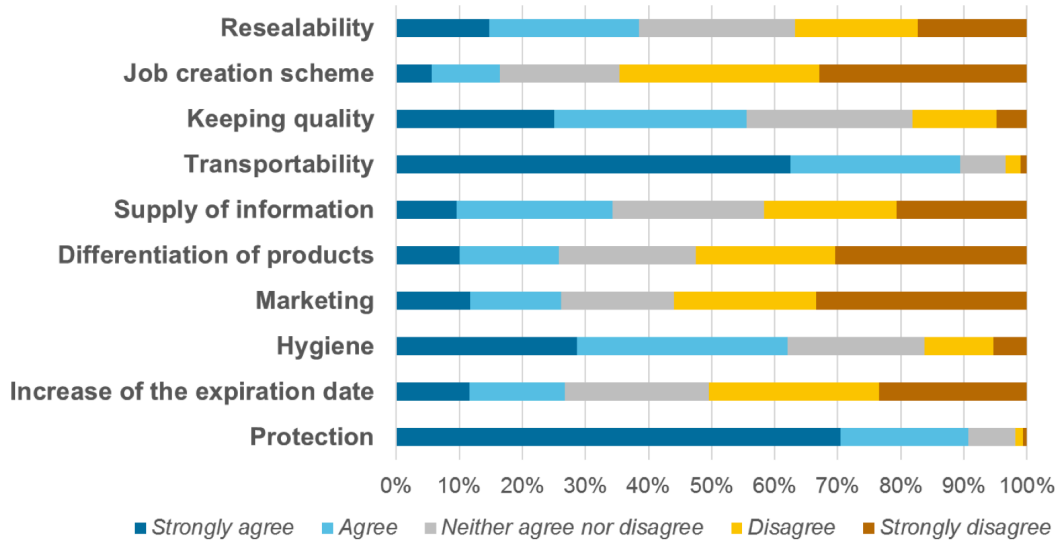
Figure 1: Consumer perception of plastic fruit packaging functions (n=999)

Furthermore, the environmental attitude and attitude towards plastic fruit packaging of the 999 respondents was analysed using a descriptive analysis. The mean value, standard deviation as well as the minimum and maximum value of the two attitude scales were calculated. The mean value of the environmental attitude was 4.05 with a standard deviation of 0.45649. The maximum value was 5.00, while the minimum value was 1.53. Thus, the majority of respondents have a positive environmental attitude in average. Compared with NEP values of comparable studies (Erdogan 2009; Thomson 2013; Weber 2011), the participants of this study scored higher values on average. In addition, the mean value of the attitude towards plastic fruit packaging was 4.30 with a standard deviation of 0.40569, while the maximum value was 5.00 and the minimum value was 2.20. Hence, the majority of respondents have a positive attitude regarding the avoidance of plastic fruit packaging. Their attitude towards the avoidance of plastic fruit packaging is even higher than their environmental attitude.

Besides that, the connotative meaning of plastics and bioplastics for fruit packaging was analysed with a semantic differential as shown in figure 2. Overall plastic as packaging material is seen more negative than bioplastics. For the majority of respondents, for example, bioplastics tends to be seen as attractive, natural and ecological. In contrast, plastics is seen comparatively unattractive, synthetic and not ecological.
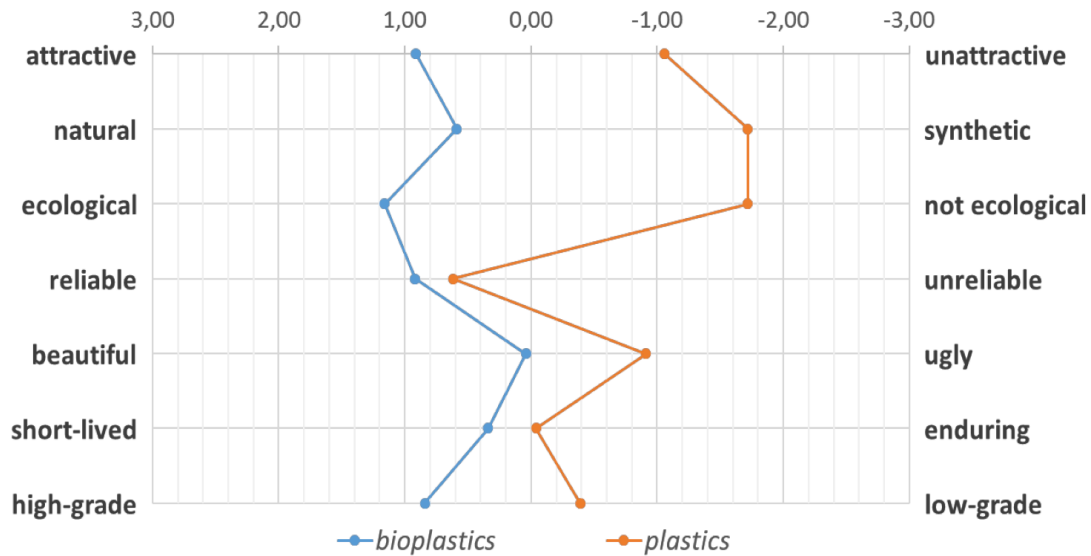
Figure 2: Semantic differential of plastics and bioplastic (n=999)

Bioplastics are associated with more positive properties than plastics because plastics have a bad image as packaging material (Plumb et al. 2013; Thompson et al. 2009). Furthermore, the term "bio" is perceived positively or suggests more positive properties, which can be seen for example on various organic products .(Avensleben & Bruhn 2010; Roosen et al. 2013). The term "bio" and "organic" have the same meaning in the German language. Besides, bioplastic as packaging material can also have some negative properties compared to plastics (negative for the environment) in some cases (Detzel et al. 2012).

This study has also some limitations. The data collected is not a representative sample for Bavarian or German students, since the socio-demographic sample characteristics, such as gender, do not follow the structure of Bavarian or German students (Middendorff et al. 2017; Statistisches Bundesamt 2016, 2017). Furthermore, students as target group do not represent the whole population of Germany. In addition, the participants' course of study was not recorded.

5. Conclusions

Students of Bavarian universities have a positive environmental attitude and a positive attitude towards the avoidance of plastic fruit packaging, but they do not percept every packaging function nor can consider packaging material properties differentiated. Food retailers and the government could use the results of this contribution to tackle the lack of knowledge using educational programs. Furthermore, the insights of this study show that food retailers should try to minimize their plastic packaging consumption along their supply chain.

The German population as target group for a representative study could give further insights into the knowledge of, and attitude towards, plastic fruit packaging. Additionally, plastic packaging waste should be considered as a whole. That´s why future studies should investigate plastic packaging waste in general and not only a part of it (plastic fruit packaging).

References

Aminrad, Zarrintaj; Zakaria, Sharifah Zarina Bint and Hadi, Abdul Samad (2011), *Influence of Age and Level of Education on Environmental Awareness and Attitude. Case Study on Iranian Students in Malaysian Universities, The Social Sciences* 6 (1): 15–19.

Atav, Esin; Altunoğlu, Bahattin Deniz and Sönmez, Suzan (2015), *The Determination of the Environmental Attitudes of Secondary Education Students, Procedia - Social and Behavioral Sciences* 174: 1391–1396.

Avensleben, Reimar von and Bruhn, Maike (2010), *Verbrauchereinstellungen zu Bioprodukten. - Ergebnisse einer neuen Langfriststudie-*. Edited by Institut für Agrarökonomie, Lehrstuhl für Agrarmarketing. Institut für Agrarökonomie, Lehrstuhl für Agrarmarketing. Kiel. http://orgprints.org/1652/1/maikebiohoch.pdf [25 June 2018]

Beba, Werner and Eibl, Janine (2011), *Green Capital of Tomorrow - Next Generation´s Perspectives*. Kompetenzzentrum für Erneuerbare Energien und Energieeffizienz; Siemens AG. Hamburg. https://www.haw-hamburg.de/cc4e/forschung/akzeptanz- nachhaltigkeit/green-capital.html [25 June 2018]

Bovensiepen, Gerd; Fink, Hendrik; Schnück, Pia; Rumpff, Stephanie and Raimund, Stefanie (2015), *Verpackungsfreie Lebensmittel - Nische oder Trend. Verbraucherbefragung*. Edited by PricewaterhouseCoopers AG Wirtschaftsprüfungsgesellschaft. Düsseldorf. https://www.pwc.de/de/handel-und-konsumguter/assets/pwc-verpackungsfreie- lebensmittel.pdf [25 June 2018]

Bovensiepen, Gerd; Fink, Hendrik; Schnück, Pia; Rumpff, Stephanie and Raimund, Stefanie (2018), *Verpackungen im Fokus. Die Rolle von Circular Economy auf dem Weg zu mehr Nachhaltigkeit*. Edited by PricewaterhouseCoopers GmbH Wirtschaftsprüfungsgesellschaft. Düsseldorf. https://www.pwc.de/de/handel-und- konsumguter/pwc-studie-verpackungen-im-fokus-februar-2018-final.pdf [25 June 2018]

Detzel, Andreas; Kauertz, Benedikt and Derreza-Greeven, Cassandra (2012), *Untersuchung der Umweltwirkungen von Verpackungen aus biologisch abbaubaren Kunststoffen*. With assistance of Joachim Reinhardt, Sybille Kunze, Martina Krüger, Horst Fehrenbach

Susanne Volz. Edited by Umweltbundesamt. Umweltbundesamt. Dessau-Roßlau. https://www.umweltbundesamt.de/sites/default/files/medien/461/publikationen/3986.pdf [25 June 2018]

Dunlap, Riley E.; van Liere, Kent D.; Mertig, Angela G. and Jones, Robert Emmet (2000), *New Trends in Measuring Environmental Attitudes. Measuring Endorsement of the New Ecological Paradigm: A Revised NEP Scale, J Social Isssues* 56 (3): 425–442.

Erdogan, Nazmiye (2009), *Testing the new ecological paradigm scale: Turkish case, African Journal of Agricultural Research* 4 (10): 1023–1031.

Fachagentur Nachwachsende Rohstoffe e.V. (2016), *Biokunststoffe*. 3rd ed. Edited by Fachagentur Nachwachsende Rohstoffe e.V. Fachagentur Nachwachsende Rohstoffe e.V. Gülzow-Prüzen (224). http://www.fnr.de/fileadmin/allgemein/ pdf/broschueren/Brosch_Biokunststoffe_Nachdruck_2016_web.pdf [25 June 2018]

Foscht, Thomas and Swoboda, Bernhard (2011), *Käuferverhalten*. Wiesbaden: Gabler Verlag.

Harraway, John; Broughton-Ansin, Freya; Deaker, Lynley; Jowett, Tim and Shephard, Kerry (2012), *Exploring the Use of the Revised New Ecological Paradigm Scale (NEP) to Monitor the Development of Students' Ecological Worldviews, The Journal of Environmental Education* 43 (3): 177–191.

Jeżewska-Zychowicz, Marzena and Jeznach, Maria (2015), *Consumers' behaviours related to packaging and their attitudes towards environment, JARD* 9 (3).

Jünemann, Reinhardt and Schmidt, Thorsten (2000), *Materialflußsysteme. Systemtechnische Grundlagen*; mit 36 Tabellen. 2. Aufl. Berlin: Springer (Logistik in Industrie, Handel und Dienstleistungen).

Middendorff, Elke; Apolinarski, Beate; Bornkessel, Philipp; Brandt, Tasso; Heißenberg, Sonja and Naumann, Heike et al. (2017), *Die wirtschaftliche und soziale Lage der Studierenden in Deutschland 2016. Randauszählung zur 21. Sozialerhebung für deutsche und bildungsinländische Studierende für Bayern*. Edited by Deutsches Zentrum für Hochschul- und Wissenschaftsforschung GmbH. Hannover (Sozialerhebung des Deutschen Studentenwerks, 21). http://www.sozialerhebung.de/download/21/Soz21_ra_bayern.pdf [25 June 2018]

Naturschutzbund Deutschland e.V. (2015), *Nachhaltigkeit beim Kauf von Obst und Gemüse*. With assistance of Forsa Gesellschaft für Sozialforschung und statistische Analysen mbH. Edited by Naturschutzbund Deutschland e.V. Naturschutzbund Deutschland e.V.

Berlin. https://www.nabu.de/imperia/md/content/nabude/konsumressourcenmuell/1512-nabu_umfrage_forsa_unverpackt.pdf [25 June 2018]

Pfohl, Hans-Christian (2004), *Logistiksysteme. Betriebswirtschaftliche Grundlagen*. 7., korrigierte und aktualisierte Auflage. Berlin, Heidelberg, s.l.: Springer Berlin Heidelberg. http://dx.doi.org/10.1007/978-3-662-08413-7 [25 June 2018]

Plumb, Alex; Downing, Phil; Icaro Consulting and Parry, Andrew (2013), *Consumer Attitudes to Food Waste and Food Packaging*. With assistance of Steering Group partners. Edited by WRAP. WRAP. Banbury. http://www.wrap.org.uk/sites/files/wrap/Report%20-%20Consumer%20attitudes%20to%20food%20waste%20and%20packaging_0.pdf [25 June 2018]

Roosen, Jutta; Köttl, Barbara and Hasselbach, Johanna (2013), *Regional und Bio: Kaufmotive und Kaufverhalten bei bayerischen Ökoprodukten*. Edited by Bayerisches Staatsministerium für Ernährung, Landwirtschaft und Forsten (StMELF). Technische Universität München Lehrstuhl für Marketing und Konsumforschung. Freising- Weihenstephan. https://www.mcr.wi.tum.de/fileadmin/w00bet/www/Pictures/pdf/Projekt e/Bericht_Regional_und_Bio_2016.pdf [25 June 2018]
Statistisches Bundesamt (2016), *Studierende insgesamt. Statistisches Bundesamt. Wiesbaden*. https://www.destatis.de/DE/ZahlenFakten/Indikatoren/LangeReihen/Bildun g/lrbil01.html;jsessionid=B68466E9EA88EA2A78F3B0EB520F470F.InternetLive2 [25 June 2018]

Statistisches Bundesamt (2017), *Studierende. Insgesamt nach Bundesländern und tiefer gegliederten Angaben. Statistisches Bundesamt*. Wiesbaden. https://www.destatis.de/DE/ZahlenFakten/GesellschaftStaat/BildungForschungKultur/Hochschulen/Tabellen/StudierendeInsgesamtBundeslaender.html;jsessionid=B68466E9 EA88EA2A78F3B0EB520F470F.InternetLive2 [25 June 2018]

Strack, Mick; Shephard, Kerry; Jowett, Tim; Mogford, Samantha; Skeaff, Sheila and Mirosa, Miranda (2017), *Monitoring surveying students' environmental attitudes as they experience higher education in New Zealand, Survey Review 998*: 1–8.

Sudbury-Riley, Lynn; Hofmeister-Toth, Agnes and Kohlbacher, Florian (2014), *A cross- national study of the ecological worldview of senior consumers International Journal of Consumer Studies* 38 (5): 500–509.

Thompson, Richard C.; Moore, Charles J.; Vom Saal, Frederick S. and Swan, Shanna H. (2009), *Plastics, the environment and human health. Current consensus and future*

trends, Philosophical transactions of the Royal Society of London. Series B, Biological sciences 364 (1526): 2153–2166.

Thomson, Jill (2013), *New Ecological Paradigm Survey 2008: Analysis of the NEP results*. Edited by Waikato Regional Council. Hamilton-Waikato (Technical Report Series, 2013/11). https://www.waikatoregion.govt.nz/assets/PageFiles/26060/TR201311.pdf [25 June 2018]

Weber, Katharina (2011), *Vertrauen in Effizienz-Technologien und dessen Einfluss auf das Gefühl, einem suffizienten Lebensstil verpflichtet zu sein*. Diplomarbeit. Universität Wien, Wien. https://core.ac.uk/download/pdf/11596639.pdf [25 June 2018]

Xue, Wen; Marks, Anthony D.G.; Hine, Donald W.; Phillips, Wendy J. and Zhao, Shouying (2016), *The new ecological paradigm and responses to climate change in China, Journal of Risk Research* 21 (3): 323–339.

STREAM: General STS Topics

Interdisciplinary Research in Law and Forensic Science: From 'silos' to systems.
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Current approaches to the interdisciplinary co-production of forensic-scientific knowledge claims tend to found on the belief that a shared understanding of the respective capabilities, and needs, of both forensic science and criminal justice, may enhance the co-production of knowledge and lead to improved communication. However, the results of empirical research into the Streamlined Forensic Reporting (SFR) scheme, in England and Wales, appear to confound this 'contest and communication' narrative. SFR signals an almost complete co-option of scientific processes by the criminal justice system, the concomitant loss of interpretative forensic expertise, and the avoidance of the allocation of epistemic responsibility. Such instrumental approaches to forensic reporting may be traced to the disruption, and restructuring, of the forensic profession. Nonetheless, it is argued that the application of legal norms and rationality to forensic science may be better understood through the lens of legal autopoiesis, and should be viewed as an instance of the structural coupling of competing sub-systems.

Introduction: the 'contest and communication' narrative

Previous commentators have tended to view law and forensic science as operating in isolated silos. This popular explanation for the interdisciplinary co-production of forensic-scientific knowledge claims is predicated upon a belief that institutional agents from the legal and scientific fields are 'siloed' within their respective domains. 'Siloed' refers to the phenomenon whereby particular centres of organization and activity become isolated in terms of their constituent processes and systems. These centres of organization become self-referential in terms of their conceptualisations, leading to a lack of communication with other centres, and a lack of understanding of the needs of other systems. It occurs when domains, departments, or management groups, do not share information, goals, tools, priorities and processes with other departments. Or it may occur when those networks, which facilitate the sharing of goals, are attenuated or unavailable. The phenomenon may therefore refer to either an intra-disciplinary, or a homologous, process, occurring across disciplinary boundaries.

The subsisting view, as regards the silo-ed nature of law and forensic science, aligns with a narrative in which it is posited that improved communication, and an understanding of each other's needs, may lead to positive creative tension and the co-production of knowledge. Indeed, the majority of accounts of the production of forensic-scientific knowledge claims rest on just such a narrative, which highlights the lack of meaningful communication between forensic scientists and legal professionals. The corollary of this 'contest and communication' narrative is that many of the difficulties encountered by these two discrete fields may be overcome through

improved communication, and a mutual appreciation of both context and milieu. Solutions have therefore tended to be practical, and pragmatic, rather than theoretical, and epistemological.

Thus the 'contest and communication' narrative is generally associated with the view that the forensic, and legal, fields operate from within discrete 'silos', and that the degree to which professionals become 'silo-ed' is exacerbated in an adversarial context.[1] Such views - routinely expressed in the forensic-scientific field - are echoed by members of the judiciary, and the legal profession. Lord Thomas, the Lord Chief Justice of England and Wales, perceives just such a communication problem, and likens it to the challenge facing comparative lawyers, whom he commends for their success in unearthing common legal concepts.

> 'It is now accepted that the work of comparative lawyers, whose discipline was based on finding differences, and the globalization of many legal concepts, particularly the rule of law as applicable to all governmental action and the right to a fair and open trial, have brought about a considerable narrowing of the differences.' [2]

It may be argued, in counterpoint, that the desire to mobilise commonly held concepts is based on an idealised conception of the underlying similarities between two heterogeneous disciplines, whose normative bases may be dissimilar, if not completely divergent. Indeed, data from an empirical study into the marketisation of forensic science in England and Wales[3] provides only partial support for the contest and communication narrative, as advanced by Lawless, Kelty, and members of the Judiciary.[4]

The data (discussed below) reveals that scientific informants speak predominantly of processes of intra-disciplinary fragmentation and stratification, and external control, which do not necessarily equate to autonomy and isolation, or lend support to the assertion that enhanced communication would lead to greater interdisciplinary understanding. Further, the process of 'siloing' has both a descriptive, and a normatively prescriptive, dimension. Therefore, even if it does accurately describe the co-production of forensic-scientific knowledge claims, the degree of divergence may be so deep as to thwart mutual understanding and enhanced interdisciplinarity. Further, the presence of acute power assymetries and the instrumental uses of forensic science. – as evidenced by the research data – may render any such attempts impossible.

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1   See Kelty, SF; Julian, R; and Ross, A. *Dismantling the Justice Silos: avoiding the pitfalls and reaping the benefits of information-sharing between forensic science, medicine and law.* Forensic Science International ; Jul 10;230(1-3): pp.8-15.

2   Thomas, LCJ. 2015 *The legal framework for more robust forensic science evidence.* Philosophical Transactions of the Royal Society B 370: 20140258 at page 1.

3   Richmond, K (2018) *Marketised Forensic DNA Profiling in England and Wales* Doctoral Thesis (Law), University of Strathclyde

4   Lawless, C. (2010). *A Curious Reconstruction? The Shaping of 'Marketized' Forensic Science.* CARR Discussion Paper 63; Lawless, C. *Policing Markets; the Contested Shaping of Neo-Liberal Forensic Science.* British Journal of Criminology (2011) 51, 671-689; Kelty, SF; Julian, R; and Ross, A. *Dismantling the Justice Silos: avoiding the pitfalls and reaping the benefits of information-sharing between forensic science, medicine and law.* Forensic Science International ; Jul 10;230(1-3): pp.8-15; Thomas, LCJ. 2015 *The legal framework for more robust forensic science evidence.* Philosophical Transactions of the Royal Society B 370: 20140258 at page 1.

These disparities are facilitated by the lack of a shared conceptual framework, terminological fluidity, and a lack of expert understanding of other agencies needs. As a forensic expert, and QC, indicated:

> 'I think there's a lot of language used where people assume that they understand what they're saying and meaning but in fact they don't understand what each…actually means by it... It's simply that there are a number of walls, if you like, not just silos, but walls, that stop people from thinking laterally about what the market actually is.'

This view would tend to contradict the typical view of Lawless and Williams, for example, who view the legal and forensic fields, as '[combining] in a mutually constitutive relationship to form a mode of production of scientific commodities, purchased by the police in support of criminal justice objectives.'. Further, the limitations of this current perspective have been thrown into deeper relief by the introduction of non-expert forms of forensic reporting, in particular the innovative Streamlined Forensic Reporting programme.

Streamlined Forensic Reporting

Streamlined Forensic Reporting is an innovative evidential procedure, which was introduced across England and Wales from 2012, for the purposes of criminal case management, and the construction of forensic evidence. Its stated aim is to minimise bureaucracy, and to reduce unnecessary costs and delays in the criminal justice system. Indeed, the scheme operates 'by taking a more proportionate approach to forensic evidence through the early preparation of a short report that details the key forensic evidence the prosecution intends to rely upon.'[1] The objective is thus to avoid the costs associated with thorough forensic analysis by encouraging an early guilty plea. In circumstances where such a plea cannot be elicited, the scheme aims to secure agreement on forensic issues with the defence counsel at the earliest stage. Should such agreement be unattainable, SFR places an obligation on the defence to identify the problematic issues.

The SFR scheme was established throughout England and Wales as part of the Ministry of Justice's 'Criminal Justice System Efficiency Program', which aims 'to [modernise] the CJS by reducing or removing the movement of paper, and people, around the system.'[2]

The Government White Paper, *Swift and Sure Justice*,[3] sets out the objectives of the program:

> 'From a so-called 'system' which operated in silos, we are moving to a criminal justice service where police, prosecution and courts work more effectively together. None of these reforms will compromise historic legal rights or important principles of justice. Rather the reverse: justice must be swift, sure and seen to be done, or it is not done at all.'[4]

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1   ACPO, *Communication Strategy – Streamlined Forensic Reporting* (2012)
2   Ministry of Justice *Defence Practitioner FAQ,* Version 3.92 (14th May 2012)
3   Ministry of Justice. (2012) *Swift and Sure Justice: The Government's Plans for Reform of the Criminal Justice System.* (Cm 8388). London: TSO.
4   *Ibid.* at p.4

The targets of the reforms are criminal cases, which the Ministry of Justice categorises as 'low-level, straightforward and uncontested…where a quick response is appropriate'.[1] Such cases are to be dealt with 'promptly and efficiently' and, in order to better dispense 'swift justice', the CJS Efficiency program seeks to 'transform criminal justice from a fragmented, paper-based system to a seamless, digital service.'[2] In pursuance of these objectives, the program embraces technological innovations, such as the introduction of digital case files, increased use of video technology in proceedings, and the harnessing of social media to communicate with the general public.

However, the use of these non-expert reports, which are frequently compiled by untrained police administrators, has led to serious concerns. Interviews with DNA profiling experts expressed just such concerns, focussing on the loss of expert evaluation and interpretation within the SFR process, and the concomitant loss of contextual information. The responses below, taken from semi-structured interviews with a cohort of DNA profiling experts in 2015-16, were typical:

> '…there's a very strong cohort of individual scientists usually, who feel that [SFRs] are misleading because (a) they don't allow a scientist to talk about the context because they're very formulaic and (b) they don't provide any sort of context to the findings.' (DR)

> 'With SFRs they've taken the expert out of the process. Previously, the expert had an overview. Now, its only when the defence gets it that we have the necessary overview.' (FE)

> 'They are relying on the reputation of DNA but with none of the science underpinning it.' (DI)

> 'Because there is not technical note and so little information, it's very hard to challenge. A lawyer wouldn't know what to challenge and a defendant couldn't get the funds to challenge it.' (MB)

Subsisting theories do not account for the instrumental use of non-expert forms of forensic reporting. For example, Edmond[3] has posited that rational representations of law and science do not merely serve the originating discipline - they also serve to structure the interdisciplinary co-production of forensic-scientific claims. Such ideal cross-representations may be unproblematic when applied within the context of a rigorous legal interrogation of an exhaustive and contextual expert evaluation, which conforms to agreed scientific standards. However, it is debatable to what degree these representations continue to apply when law, and science, departs from these exhaustive standards, particularly through innovative forms of reporting which are characterised by power asymmetries, and the instrumental uses of forensic scientific knowledge claims?

Indeed, any perceived similarities may be limited in scope, superficial, and may mask differences in conceptual frameworks and usages. A more detailed discussion of the incommensurable normative bases of law and science will take place within the theoretical

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1   *Ibid.* at p.5
2   *Ibid.* at p.43
3   Edmond, G (2001); *The Law Set ; The legal-scientific production of medical propriety* Science, Technology and Human Values, 26(2), 191-226; see also Mercer, *Op. Cit.* at note 12 ; Lynch, *et. al.* at p.45; Lawless, C (2016) *Forensic Science: A Sociological introduction* (Routledge: New York) at page 3;

discussion of legal autopoiesis. However, for present purposes, it should be noted that this incommensurability also afflicts those Neo-Weberian perspectives, which focus on the ways in which professional groups further their collective interests, through processes of inclusion and exclusion. Such theories view scientific controversy, and consensus-building, as activities central to the shaping of group cohesion.[1] A further version of this demarcation theory revolves around the proposition *that disciplines and professions themselves define their borders, through 'boundary work'.* Thus, the practice of inclusion and exclusion comes to determine what is science, and what is non-science. Such accounts, it is argued, are more adequately explained from an autopoietic perspective.

It may be pertinent, at this point, to discuss the ways in which forensic expertise travels across legal, and scientific, disciplinary boundaries by returning to Wynne's seminal Science and Technology Studies (STS) research into the tacit knowledge of Cumbrian hill farmers, exhibited in the wake of the Chernobyl reactor incident.[2] Wynne was able to demonstrate that the hill-farmers possessed a significant body of tacit knowledge, and expertise (by Collins' definition), which complemented the certified expertise of nuclear experts. However, they lacked the interactional expertise necessary to enter into a dialogue with the certified experts. As Jasanoff states,

> 'the farmers and radiation experts possessed different, complementary knowledges about local soils, grazing conditions, and radioactive cesium uptake into vegetation…but more significant is the fact that these discrepancies were rooted in different life worlds, entailing altogether different perceptions of uncertainty, predictability and control. The knowledges stemming from these divergent experiential contexts were not simply additive; they represented radically 'other' ways of understanding the world.'[3]

Jasanoff's account of Wynne's study highlights the incommensurability of heterogeneous disciplinary, and non-disciplinary, perspectives, which share no common context – whether perceptual, cognitive, or epistemological – and of the inability of non-experts to account for, and overcome, such limitations. Wynne's experience resonates with Kruse' ethnographic account of the co-production of legal and forensic narratives:

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1   See Collins, H. & Evans, R. 2007, *Rethinking Expertise* (University of Chicago Press: Chicago); Lawless, C (2016) *Forensic Science: A Sociological introduction* (Routledge: New York) at page 3;

2   Wynne, B. (1989). *Sheepfarming after Chernobyl: A case study in communicating scientific information. Environment*: Science and Policy for Sustainable Development, 31(2), 10-39.

3   Jasanoff, S. (2003) *'Breaking the Waves in Science Studies: Comment on H.M. Collins and Robert Evans, 'The Third Wave of Science'*: Social Studies of Science 33/3(June 2003) pp. 389–400 at p.390; it is argued below that, in accordance with autopoietic theory, the hill-farmers knowledge failed to overcome the binary coding (scientific/unscientific) of the science sub-system.

'[Legal and forensic] worlds are quite different…On closer inspection it becomes apparent that we…share a language only on a superficial level.'[1]

Evidence from empirical studies of legal, and forensic-scientific, interactions would tend to support these views.

Autopoietic theories of interdisciplinary communication

A focus on the problematic semantic relations of competing legal and scientific discourses (above) resonates with communicative accounts of social organization, particularly Luhmann and Teubner's theory of autopoiesis. Autopoietic theory is predicated on a definition of society as being composed of communications, rather than individuals (and their social groups). Thus, the concept of the 'expert', as an autarchic agent, is dispensed with from the outset (further, the concept of enculturation is relegated to the first order social sub-system).

Nonetheless, communications may be grouped together in self-propogating societal sub-systems. The interactions between these different spheres of knowledge – particularly the scientific, and governmental – has been the subject of renewed attention amongst systems theorists and, in particular, proponents of autopoiesis. Luhmann[2], Teubner[3], and King[4], together argue that modern society has become so complex that rationality itself has fragmented. They view society as a complex system containing a group of sub-systems and argue that these sub-systems – such as law, or science – are completely self-contained, and completely self-referential. However, they may attempt to translate and absorb knowledge from each other in order to resolve internal conflicts. They propose that each of these discrete sub-systems is cognitively open to its environment but normatively (or operationally) closed. Thus, data can enter the sub-system from outside but such data will be devoid of any meaningful normative content, the normative content being applied by the sub-system itself. In other words, science and law may handle the same elements but will understand them in completely different ways which accord with the internal logic of their respective subsystems.

Luhmann and his followers go into some detail on the ways in which information (such as an expert opinion) may be transposed from one sub-system to another. The legal sub-system filters communications and reconstructs them according to its own norms. Some non-legal discourses are considered capable of reproduction within the sub-system, while others are disqualified, since each sub-system filters data according to a process of binary coding. For example, the legal system filters data according to the coding lawful/unlawful. The science sub-system filters data according to the encoding true/false. This filtering process allows the legal sub-system to make use of scientific information ('resonant stimuli', in autopoietic terms) without ever being

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1   Kruse, C. (2013) *The Bayesian approach to forensic evidence: Evaluating, communicating and distributing responsibility.* Social Studies of Science 2013 43: 887

2   See Luhmann, N. *Operational Closure and Structural Coupling* (1992) Cardozo Law Review 13/5 (1992), 1434 and Luisi, LP. *Autopoiesis: a review and a reappraisal* Naturwissenschaften (2003) 90:49–59

3   See Teubner, G. ed. (1988) *Autopoietic Law: A New Approach to Law and Society* (Berlin, New York: Walter de Gruyter) and *Law as an Autopoietic System,* (1993), Oxford: Basil Blackwell

4   See King, M. and F. Kaganas, *The Risks and Dangers of Experts in Court* (1998)1Current Legal Issues 221–42; *An Autopoietic Approach to the Problems Presented by Parental Alienation Syndrome* (2002)13 Journal of Forensic Psychiatry 609–35, *The 'Truth' About Autopoiesis* 20 Journal of Law & Society 218 1993 and *The Construction and Demolition of the Luhmann Heresy* Law and Critique 12: 1–32, 2001.

truly aware of the *nature* (the epistemological context) of the information that exists within the scientific sub-system.

A more detailed account reveals that these autopoietic discourses are marked by 'semantic closure', such that the sub-systems to which they correspond share no substantial, or teleological, rationality: a discourse emanating from a competing subsystem must function as a text congruent with the semantics of the legal sub-system in order to register as a perturbation. Only then will it register as a stimulus capable of triggering a response. These perturbations are perceived as 'noise' within the system environment, which, if too intense, may lead to dysfunctionalities. The criterion for successful translation is therefore to create resonance. Once resonant events in the external environment 'enter' the domain of legal communications (by means of simulacra created within the system environment) they are inevitably transformed, or reconstructed, by the legal sub-system in ways that allow for conversion into events recognizable as legal communications. Further, the recursive application of these 'internally constructed externalities' allows for the creation or confirmation of rules to govern further reconstructions of similar events.[1]

As soon as the relationship has been established between law, and events in other systems, the way is open for the relationship to continue and for future events in the social world of a similar nature to automatically give rise to shadowing within the legal system. In the language of autopoietic theory a *perturbation* in the social environment, which enters the meaning-system of law, creates a *structural coupling* at the point of perturbation between law and any other systems, both social and psychic, involved in generating the perturbation. From this moment, developments within non-legal systems are coupled to parallel but independent developments in the legal system through linkage institutions that bind law to diverse social discourses.

Structural coupling is but one example of a variety of processes that bind law to diverse social discourses. Alternative outcomes are possible, dependant on the interaction of elements and system processes (emergence, interference and interpenetration). These outcomes have been explored in a diverse body of legal research papers dealing with normative subjects such as the identification of 'syndromes' and 'best interests', the identification of 'risk', 'toxic tort' litigation, and the concept of 'reasonableness'. The diverse studies are united in their conclusions: when dealing with expert opinion, the law reconstructs its own (legal) image of the external system within itself, and disagreements between experts must therefore be settled in compliance with law's conception of expertise.

Therefore, in practical terms, any attempt to investigate law's interactions with expert truth claims from an autopoietic perspective will concern itself with the way in which the legal sub-system filters forensic scientific communications and reconstructs them according to its own logical imperatives. The production of forensic-scientific knowledge claims provides an opportunity to

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1   The binary coding true/false, which regulates inputs to the scientific subsystem, is homologous to the scientific/unscientific criterion employed by the US Supreme Court in *Daubert v Merrel Dow Pharmaceuticals*. It may be seen, in autopoietic terms, as an attempt by the legal sub-system, to resolve internal perturbations through the translation of information from a competing sub-system. While the courts recognise that scientific opinion can be useful in resolving law's internal problems, nonetheless, it is the 'system rationality' of the latter system which defines the normative elements that apply to scientific inputs. The connection, thus made, establishes a 'structural coupling' between the legal and scientific sub-systems which is then used control the input of information from the scientific sub-system and to allow for parallel development.

explore an instantiation of legal autopoiesis, particularly the ways in which certain non-legal discourses are deemed capable of reproduction within the legal sub-system, whilst others are disqualified. Thus, autopoietic theory may shed light on the nature of the relations between the filtering processes and the epistemic authority of competing legal and scientific discourses.

In conducting such an analysis, the focus of inquiry must converge on the structures and processes that govern interactions between law and the discourses of the scientific sub-system (of which forensic science is a part).

Autopoiesis and Forensic Science

The Streamlined Forensic Reporting scheme provides an opportunity to explore an instantiation of legal autopoiesis, particularly the ways in which certain non-legal discourses are deemed capable of reproduction within the legal sub-system, whilst others are disqualified. Thus, autopoietic theory may shed light on the nature of the relations between the filtering processes and the epistemic authority of competing discourses.

The objectives of Streamlined Forensic Reporting, as stated by the Ministry of Justice, refer to the need to move beyond a 'so-called system which operates in silos' towards an effective multi-agency partnership. This impulse to reconcile the truth claims of agents from competing disciplines, each grounded in its own epistemological traditions, resonates with the autopoietic theoretical perspective. In order to better understand the ways in which distinctive discursive outcomes may be attributable to the unique features of Streamlined Reporting, it is necessary to discuss the role of meaning and power in autopoietic theory.

However, prior to any attempt to apply autopoietic theory to the production of interdisciplinary forensic-scientific communications, it is first necessary to address the fundamental question of whether the forensic-scientific field can be said to constitute a discrete sub-system in its own right. This may only be possible if the semantic artefacts produced by the forensic-scientific field are incapable of reproduction by other fields. It is posited that such semantic artefacts are capable of reproduction within the larger scientific field. It is questionable to what extent the forensic-scientific field can be said to be capable of autopoiesis insofar as it does not apply its own norms, and is not operationally enclosed by a specific binary encoding. Therefore, it may be concluded that forensic science should be treated as constituting a body of communications within a greater 'scientific' subsystem.

This body of communications interpenetrates the legal sub-system as the result of a process of structural coupling.[1] This is but one example of a variety of processes that bind law to diverse social discourses. Alternative outcomes are possible, dependent on the interaction of elements and system processes (emergence, interference and interpenetration). However, the 'transformational grammar' of the interaction between the legal and forensic-scientific sub-systems, is best understood as structural coupling, which provides the best macro-theoretical explanation of the way in which the process governs the creation of legal-scientific truth claims. In order to better understand the ways in which distinctive discursive outcomes may be attributable to the structural coupling process, it is first necessary to discuss the role of meaning and power in autopoietic theory.

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1   It may be argued that Mercer's hybrid-set is, in reality, an example of structural coupling between law and science.

As noted above, the legal sub-system is cognitively open but normatively closed. Thus, it is for the legal sub-system to impart meaning onto those messages that resonate with the binary coding lawful/unlawful. Crucially, the meaning of a message depends on the context of the message i.e. the set of possible messages from which it is selected. Since the context of a message cannot be communicated, or directly observed, the meaning of a message is always inferred by the (legal) observer. Inferences with regard to the meaning and context of forensic knowledge imparted by forensic reports are shaped through a reductive process, which constrains the set of possible contextual messages, from which the content of the report is selected, to a further binary: match/non-match. As King states,

> 'The normative communications of other systems cannot simply be reproduced by law as legal communication. They first have to be reconstructed as law if they are to become accepted as law, and this reconstruction process may well give rise to unforeseen distortions and reductions to the meaning of the original communications as they were formulated in [other] systems.'[1]

Thus, certain forensic-scientific mechanisms (DNA/Bayes, and streamlined reporting) may provide the means for the reformulation and reconstruction of forensic discourse, at the point at which that discourse threatens to import a penumbra of 'unhelpful' meanings and contextual choices. Such a view is predicated on the existence of a differential power arrangement between competing sub-systems.

Although autopoiesis does not address hierarchical or hegemonic issues as directly as other theoretical perspectives, it nevertheless takes account of inequalities of power, and domination of one sub-system by another. As King states,

> 'the relationship between social meaning systems is not necessarily one of equality. Although it is theoretically possible for each social system to reconstruct every other system according to its own procedures and to attribute its own meaning to that system, those systems which are widely accepted as defining meanings for the whole of society are in a much more powerful position than others.'[2]

Such is the possible degree of refraction across discrete sub-systems that it is possible to speak of 'the enslavement' of the knowledge of one meaning system by another.' This is particularly true of interactions involving economics, politics, science, and law and may account for the reformation of scientific discourses through procedural means, in particular the CAI and SFR processes. This need not imply that the scientific sub-system is prevented from asserting an alternative meaning to forensic information, since alternative contextual options are available:

> 'It is always possible for the less prevalent systems to insist on their own self-constructions and indeed to reconstruct successful meaning systems according to their particular procedures and reality versions. The problem these weaker systems face, however, is to convince society, the world

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1   King, M. *The Truth About Autopoiesis* (1993) Journal of Law and Society Vol. 20 No.2 at page 466
2   *Ibid. at p.467*

of social communications, to accept their versions of reality in preference to those of the more prevalent.'[1]

Thus, central to law's reconstruction of the social world is the way in which law (re)constructs people – including 'expert' forensic scientists – 'as semantic artifacts of the legal system', in ways which reflect existing power relationships and enhance the self-reproductive potential of the legal sub-system. The reconstruction of forensic expertise is central to this process, and is achieved through shaping of the processes, and contextual factors, which govern the production of forensic-scientific knowledge. These aspects of forensic knowledge production will form the subject of the final chapter in this section.

Conclusions

Those discourses which explore the boundaries of the legal system tend to focus on the potential for interdisciplinary communication to diminish barriers and to enhance the mutual understanding of unrelated disciplines. Such approaches are frequently encountered in discussions relating to the consumption of scientific truth claims by the criminal justice system. The UK Ministry of Justice, for example, speaks of the need to move beyond a 'so-called system which operates in silos' towards an effective multi-agency partnership. Similar statements can be found in jurisdictions across the globe. However, from an autopoietic perspective, these impulses to reconcile the truth claims of agents from competing disciplines – each grounded in its own epistemological traditions – may be misplaced and deserve closer analysis.

This study uses Teubner's theory of legal autopoiesis to explore cross-boundary relations between the legal and scientific sub-systems. It derives from research into the introduction of Streamlined Forensic Reporting in England and Wales (a non-expert form of forensic reporting which restricts DNA reports to a 'match' or 'non-match'). This new form of inter-disciplinary communication provides opportunities to explore the ways in which certain non-legal discourses are deemed capable of reproduction within the legal sub-system, whilst others are disqualified.

The study disseminates research results, which demonstrate that, in accordance with autopoietic theory, it is for the legal sub-system to impart normative meanings onto those messages. Further, that meaning depends on context. And that context is drawn from the set of possible messages from which the resonant input is selected. Thus, inferences with regard to the meaning and context of forensic knowledge imparted by Streamlined Reports must be shaped through a reductive process, which constrains the set of possible messages from which the content of the report is selected. The study thereby demonstrates that the SFR scheme provides the legal system with a means to reformulate and reconstruct forensic discourse, at the point at which that discourse threatened to import a penumbra of 'unhelpful' meanings and difficult contextual choices.

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1   *Ibid.*

"Genderism is junk science!" Gender studies as object of academic criticism and hate speech

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In Germany, the academic subject of gender studies has been attacked recently not only by right-wing movements, parties, and masculinists, but also by fellow-members of the scientific community. In the following, I will analyse this group of critics, their argumentation and their networks. My paper presents findings of my ongoing research, which is part of the interdisciplinary project "Crisis of gender relations? Antifeminism as a threat to social integration" (REVERSE), funded by the German Ministry of Education and Research (BMBF) conducted at the Centre for Gender Studies of Philipps-University, Marburg.

I have researched the antifeminist discourses within the scientific community on the basis of a discourse analysis (following Jaeger 2009) of statements by scientists who criticize Gender Studies, as well as an analysis of their reception in online and offline media, theme-centred interviews (based on Witzel 2000, and Schorn 2000) with some of the critics themselves, with gender researchers who have been attacked, with representatives of scientific associations, and participant observations (see Schmidt-Lauber 2007) at events of conservative/right wing groups and movements.

Name	field	papers	citations	h_index	g_index
Prof. Dr. Gerhard Amendt	Sociology	71	401	10	16
Prof. Dr. Günter Buchholz	Economics and Consulting	137	1349	17	35
Dr. habil. Heike Diefenbach	Sociology, Ethnology	94	2438	23	48
Prof. Dr. Hanna-Barbara Gerl-Falkovitz	Philosophy, political science	74	101	5	7
Prof. Dr. Ulrich Kutschera	Plants physiology and evolution biology	135	2278	28	45
Prof. Dr. Axel Meyer	Zoology, evolution biology	More than one result -> manual check[1]			
Prof. Dr. Harald Seubert	Philosophy, Theology	167	80	4	4
Prof. Dr. Manfred Spieker	Christian social sciences	153	431	9	15
Prof. Dr. Manfred Spreng	Neurosciences	40	310	10	16
Dr. Alexander Ulfig	Philosophy, Sociology	33	330	7	18

Table 1: Scientists who criticize Gender Studies: Impact analysis

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[1] Since the name "Axel Meyer" refers to more than one scientists within google scholar search, an impact analysis via "publish or perish" was not possible. Thus, I´ve taken into account the number of publications and the fact that Axel Meyer has received national and international awards to justify the decision of selecting him as scientist with possible power of interpretation (see his CV at the website of the University of Konstanz, https://www.evolutionsbiologie-uni-konstanz.com/prof-dr-axel-meyer.html [30 April 2018]).

The academics criticizing gender studies were identified by an analysis of internet platforms, journals, and scientific publications. Then, through an impact analysis using the software "publish and perish" ten scientists were selected who had the highest potential power of interpretation for an in-depth discourse analysis of their texts.

Those critics of Gender Studies are or have been active inside the scientific community, many of them are university professors. The selected scientists can because of their academic titles and their impact be assumed to have a high amount of symbolic capital.[1] They come from various fields, not only sciences, but also economics and humanities. So, as we will see, the reason for the critique of gender studies is not merely a misunderstanding stemming from different science cultures.

Argumentation figures and rhetoric strategies

The overall objective of the texts of the mentioned academics is to defame gender studies. For this goal, a variety of argumentation figures are used. First of all, most of the critics frame gender studies as being not scientific. This assessment is often based on faulty representations of gender studies. For example, Ulrich Kutschera, professor of evolutionary biology, states that the main thesis of gender studies is that "people are supposedly born as sex-neutral mammals and then are shaped by society either feminine or masculine"[2], (Kutschera 2016: 55). This leitmotiv of criticism directed against radical deconstructivism can be found in the texts of all of the critics. Gender studies according to them assume that only through socialization and cultural influences, sex and/or gender emerge. As references, often Simone de Beauvoir and Judith Butler are cited – and misunderstood, for example when Kutschera interprets Butler´s notion of the performativity and normativity of the appeal of a baby as "boy" or "girl" as evidence that Butler assumes babies are sex-neutral (Kutschera 2016: 238). In general, the critics state that gender studies ignore the body and biology. They base of their argumentations on the two-sex-concept. Bodies which transcend this dichotomic scheme are seen as exceptions and as abnormal; Kutschera (2016: 187) names them design errors.

Also, some critics, like economics professor Günther Buchholz, suggest that gender studies reject academic standards such as evaluation and only serve as lobbying strategy for feminists (Buchholz 2014).

In addition, the critics argue that gender studies are useless because from their perspective, gender equality already has been acquired. For example, Heike Diefenbach states that there is no patriarchy (Diefenbach 2012). Sometimes this argument of redundancy of gender studies is connected with men´s rights discourse: The retired professor for sociology Gerhard Amendt accuses gender studies of promoting the notion of men as aggressive and violent and women as victims and that gender studies serve to supress men (Amendt 2016).

This leads to the next argumentation figure: gender studies as dangerous for society, an assertion made by most of the critics (Amendt 2016, Buchholz 2014, Gerl-Falkovitz 2011, Kutschera 2016, Seubert 2014, Spreng 2015a, 2015b). First of all, some trace the constructivist

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1   Pierre Bourdieu (1984) has described symbolical capital as a form of prestige which is the outcome of a combination of the other forms of capital: economic, cultural and social capital. For the context of this paper, especially the implications of symbolical capital for power of interpretation are relevant: Bourdieu´s notion that "symbolic power is the power to make things with words" (Bourdieu 1989: 23).

2   All citations are taken from German texts and translated by the author.

gender theory back to a fictive founding father, psychologist John Money, who tried to prove that gender identity only depends on culture: he advised people whose son had been accidentally castrated during surgery to raise the boy as a girl. The experiment failed: the boy rejected the female gender identity imposed on him. Some of the critics use this monstrous story to defame gender studies (e.g., Kutschera 2016: 277-289). Apart from Money, scientists often named as promoters of constructivism are Simone de Beauvoir, and Judith Butler (e.g. see Gerl-Falkovitz 2011, Meyer 2015).

Also, most of the gender studies critic scientists construct a conspiracy theory that feminists somehow aim to brainwash and subvert society. Ulrich Kutschera (2016) and Günter Buchholz (2016) state that at the world women conference of Beijing, feminists conspired to promote homosexuality and to fight Cristian values and the heterosexual family, and that out of this conference, a worldwide plan was formulated to abolish the sexes and to morph mankind into, as Kutschera puts it, "unisex-persons", and that gender mainstreaming was one of the steps to implement a totalitarian society (Kutschera 2016: 44-47). By the way, all of the critics define gender mainstreaming wrongly as some measure for re-education to support their argumentation, while in fact it is only the implementation of gender perspectives regarding decisions in organizations and in politics (see the UN-definition, United Nations 1997).

In this plan of world domination, Gender scientists have the function to infiltrate the universities and to impose sex-education programmes for schools which destabilize the gender identity of children and lead to a premature sexualization (Kutschera 2016: 5, 27, 399; Meyer 2015: pos. 5484).

Gender studies thus are a danger for children, but also for women and men because they set new behaviour norms which are opposed to the nature of the sexes and which do not take into account gender differences. Neuroscientist professor Manfred Spreng points out that regarding women, psychological inner conflicts would be the consequences, and regarding men, a diminishing bonding capacity (Spreng 2015a: 72), and biologist Kutschera states that it is wrong to force women and men to act against their nature, for example to pressure women to study engineering, and men to become active fathers, when they can´t help reacting aggressively to toddlers crying because of their higher testosterone levels (Kutschera 2016: 48, 307).

Often the devaluation of gender studies is supported by a homophobic positioning: for example, professor Buchholz argues that gender studies intend to normalize homosexuality and to abolish what he calls heteronormality (Buchholz 2016). Some of the critics even resort to pathologizing gender scientists as childless, butch lesbians – as Kutschera (2016: 52) does – or as irrational women ridden by envy, like Gerhard Amendt (2016b). Those of the critics who are not themselves religious compare gender studies with a devaluating aim to religion (Kutschera 2016: 7, 55), and some compare them to ideologies like Marxism (Amendt 2016, Buchholz 2014, Kutschera 2016: 15f., Seubert 2014).

Often the critics confound "gender" as such, gender mainstreaming, and gender studies, subsuming it under the pejorative terms "gender ideology" or "genderism" (Kutschera 2016: 26; Meyer 2015: pos. 5519; Seubert 2014: 260). In this context some criticize difference feminism, which they interpret as notion that women think themselves better and of putting women against men who are seen as adversaries (Gerl-Falkovitz 2009: pos. 994; Seubert 2014: 278). However, most gender critic scientists assume postmodernism especially constructivism as epistemological basis of the gender studies and reject it, for example philosopher Alexander

Ulfig (2016: 6-11), christian philosopher Hanna-Barbara Gerl-Falkovitz (2009: pos. 2009-2020; 2011) economist Günter Buchholz (2016) and biology professor Axel Meyer (2015: 4394-4400).

As Buchholz states who equals postmodernism with irrationalism, the effect of everything being construction is that only arbitrariness remains (Buchholz 2016). Postmodern thinking is rejected as being relativist. In this context it is worthwhile to note that sociologist Gerhard Amendt accuses gender studies of being essentialist because according to him, Gender Studies only take the category of gender into account for the analysis of society and not class, education, ethnicity and history and because gender studies made essential differences between men and women configurating men as aggressive evildoers (Amendt 2016). So, it seems that gender studies and their theoretical foundation are interpreted quite controversially by the academics who criticize them.

The critics mainly speak from two epistemological standpoints: Religious vs. positivist-biological. The critics with a Cristian foundation like religious philosophers professors Barbara Hanna Gerl-Falkovitz (2009, 2011) and Harald Seubert (2014) base their argumentation on a belief in divine creation and conclude that there are unchangeable, god-given complementary bodies, gender characteristics and gender roles.

Both employ an argumentation figure which can be described as "myth equals thruth": because in mythical and religious texts of all times and cultures, certain descriptions of gender characteristics and relations prevail, they point to the truth of gender differences. For example Gerl-Falkovitz mentions myths about female goddesses and their ambivalence of spending and taking life as reference to a mother´s womb and its frightening and soothing qualities (Gerl-Falkovitz 2009: 250-290). The background for this argumentation is C.G. Jungs theory of archetypes: in myths and narrations the psychological differences between the sexes manifest themselves, as Seubert states (Seubert 2014: 275).

In contrast, Amendt, Buchholz, Kutschera and Meyer, who are arguing on the basis of a positivist standpoint, are convinced that most of human gender behaviour can be explained by evolved sex differences (Amendt 2017; Buchholz 2016; Kutschera 2016: 21-23; Meyer 2015: pos. 87) which are thus essentialized and naturalized. Only biology and other natural sciences are considered to be real sciences by them, their methods being the only acceptable ones, while the humanities according to Buchholz can never acquire the same validity (Buchholz 2016).

The gender-critical scientists don´t accept that knowledge is situated, they do not seem to have received theories of knowledge production which stress that there is such a thing like paradigms (cf. Kuhn 1962), or Actor Network Theory which has shed light on the construction of knowledge through social interactions (e.g. Latour 2005). For example Kutschera rejects the notion that also in publications of biology, terms and wordings are also influenced by gender concepts (Kutschera 2016: 116-120).

Reactions of the Field

Among the German gender researchers, in the texts of the mentioned gender critic scientists, some are especially highlighted and deprecated as representatives of gender studies: among others, linguistics professor Lann Hornscheidt (who identifies as gender-neutral), professor Elisabeth Tuider, who together with Stefan Timmermanns has written a guidance for sexual education at schools and other institutions (Tuider & Timmermanns 2008), and sociology

professors and renowned gender studies textbook authors Nina Degele, Sabine Hark and Paula Irene Villa (Kutschera, 2016: 52-55).

The German gender studies have started to react to these developments. There were some lecture series, conferences and workshops about the topic, for example in October 2017 at Frankfurt a conference titled „Feminism and the public sphere"[1]. While some gender studies researchers avoid confrontation arguing that they, as scientists, are not rhetorically trained for talk shows or other non-scientific contexts, and thus, participation at such events would be counterproductive, others, like professors Sabine Hark, Paula Irene Villa, and head of the administrative office of the German government´s report on equality Regina Frey, promote interventions also on the media and public level[2].

At the 18th December 2017, some members of the German society for gender studies decided to launch a concerted media action called #4gender studies: different institutes and centres for gender research twittered about their work or why they thought gender studies are valuable, also of course provoking reactions from antifeminist actors like the AfD (Alternative für Deutschland), Germany´s new populist extreme right-wing party.

The outcome of this action was discussed at the Workshop #4gender studies taking place in April 2018 at Berlin. It was debated how to pursue a media strategy and it was agreed on proactive actions instead of merely re-acting to populist attacks. It was decided to repeat the #4genderstudies media action also in 2018.

Background and Networks

As far as my current findings show, inside of academia the gender critics scientists have little power of interpretation regarding the topic of gender studies – as interviews with spokespersons of several scientific associations (e.g. the German associations of theology, sociology, mathematics and economics) show.

However, the criticism on the part of academics have to be considered in the broader context of the political and societal backlash which is experienced not only in Germany, but also in Austria, other European countries and the US. Therefore, gender studies were at the same time also assaulted by right-wing populists, for example authors like Birgit Kelle (2015) or Akif Pirinçci (2015), by journalists of conservative newspapers like the editor of the influential conservative newspaper Frankfurter Allgemeine Zeitung (FAZ) Volker Zastrow (2006), by the "Alternative für Deutschland" (AfD), who in their program demand the abolition of gender studies (Alternative für Deutschland 2017: 22), and by conservative movements like the "Demo für Alle" which fights against the "sexualization of kids" and against gay-marriage[3].

It can be noted that the gender critic argumentations of scientists have an impact on these public discourses. Academics are ascribed high authority and the scientific discourse level works as a "superstructure", as philosopher Arnold Gehlen (1957) has stated, which means as an instance of final justification. To have an impact outside the scientific community also seems to be a central aim of the gender-critic scientists: most of their texts address a non-scientific target audience. They are mostly not published in scientific journals, but as popular scientific

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1   See the homepage of the conference https://feminismusundoffentlichkeit2017.wordpress.com/.
2   Source: informal conversations and interviews.
3   See their homepage, https://demofueralle.wordpress.com/.

volumes or in newspapers and on internet platforms.

The mentioned gender studies critics are valued by members of the New Right, as an interview of AfD politician Beatrix von Storch with Ulrich Kutschera shows (Freie Welt TV 2018). Kutschera also has been interviewed by radio stations (Kutschera 2016: 33-37), his views have been cited by influential magazines (e.g., Spiegel Online 2015, Handelsblatt 2016), and he is cited affirmatively by a psychiatrist at a "Demo für alle" conference[1]. Hanna-Barbara Gerl-Falkovitz and Manfred Spieker have spoken at another "Demo für alle" conference[2]. Gerl-Falkovitz has also been invited as speaker at a conference organized by the influential conservative Konrad Adenauer foundation whose program flyer cited Kutschera as having proven that gender studies are not scientific[3].

Name	field	freiewelt.net		ef-magazin.de		Pi.news.net	
		author	citations	author	citations	author	citations
Prof. Dr. Gerhard Amendt	Sociology	3	19	1	12	0	2
Prof. Dr. Günter Buchholz	Economics and Consulting	0	30	0	2	0	1
Dr. habil. Heike Diefenbach	Sociology, Ethnology	1	8	3	4	0	0
Prof. Dr. Hanna-Barbara Gerl-Falkovitz	Philosophy, political science	1	5	0	1	0	1
Prof. Dr. Ulrich Kutschera	Plants physiology and evolution biology	3	8	0	1	1	0
Prof. Dr. Axel Meyer	Zoology and evolution biology	0	5	0	0	1	1
Prof. Dr. Harald Seubert	Philosophy, Theology	0	2	0	0	0	2
Prof. Dr. Manfred Spieker	Christian social sciences.	3	9	0	0	0	2
Prof. Dr. Manfred Spreng	Neurosciences	0	1	0	2	0	0
Dr. Alexander Ulfig	Philosophy, Sociology	156	11	19	4	0	0

Table 2: interconnections of gender studies critics with right-wing blogs and platforms

Populist writer Akif Pirincci uses the same biologist argumentation figures like professor Meyer and repeats his accordant text passage nearly verbally (Pirincci 2015: 25f.). As table 2 shows, some of the gender studies critic scientists actively build networks with populist and right-wing milieus: they have published articles on right-wing online blogs and platforms. Others are crosslinked passively: they are mentioned quite often in populist media.

Some of the critics also have their own right-wing circles, influential platforms or blogs, like Heike Diefenbach, who is founder, and frequent author, of Sciencefiles.org, Alexander Ulfig, who is

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1   See the video of the talk, https://www.youtube.com/watch?time_continue=1&v=ZHc85nXZWjw.
2   See the program of the conference, https://demofueralle.wordpress.com/symposium/symposium-2016/.
3   See the flyer of the conference, http://www.kas.de/wf/doc/kas_24565-1442-1-30.pdf?171213101703.

editor of the blog cuncti, and Günter Buchholz, who is responsible coordinator for the platform gender-diskurs.de.[1] Gerhard Amendt is a key figure of the male right movement which often uses his scientific authority for their goals (e.g. see an interview with him on the male right-platform MANNdat 2014). Amend is founding member of agens.e.v. which is an association promoting heteronormative and essentialist views on gender and gender roles[2].

This shows that, as also a number of studies (Kováts/Põim 2015, Kemper 2014, Lang 2015, Gehrmann et al. 2015) have pointed out, antifeminist positions like those of the gender critic scientists serve as a link between different groups of actors of the new conservative right. Antifeminism covers ideological differences and thus allows coalitions between conservative, traditional, religious-fundamentalist and radical right-wing groups and movements, a network which is composed of the AfD, PEGIDA which is the radical right movement against the islamization of the Christian occident, the neo-nazi Identitarian movement and their think tanks like the journal "Junge Freiheit", the so-called Institut für Staatspolitik (institute for state policy), the publisher antaios, the Zivile Koalition (civil coalition) and the Demo für alle movement.

All of these groups state a societal crisis and perceive the modernization of gender relationships as a threat to society, to children and to traditional values and life forms like marriage. A part of the middle class tries to mobilize the precarious or those who are threatened by precariousness, and who fear to lose their privileges. Apart from the liberalization of gender relationships, thus also for example migration is problematized.

Some of the scientists criticizing gender studies are also involved in such discourses; Gerhard Amendt depicts muslim male migrants on agens.ev in a culturalist way as savages who molest women because of their tribal origins and who can only be handled by a brutal police force (Amendt 2016a). Also, Ulrich Kutschera warns of "young, testosterone-driven men" and speaks of an "religious motivated African war against german women" (Kutschera 2016: 402; 2018).

Historical Parallels

Historical parallels can be seen regarding antifeminist movements at the beginning of the 20st century: as Ute Planert (1998) points out, during the German Empire, antifeminist activities emerged in reaction to the liberalization of gender relations. In addition, back then, antifeminism was connected to antisemitism (Volkov 2000), which is also today the case, as the popular conspiracy theory that feminism had been invented by Rockefeller and Rothschild shows[3].

Even at the beginning of the 20th century, science was used as final justification. For example in 1900, a neurological essay on the physiological imbecility of women was published (Möbius 1901). philosophers of the time like Schopenhauer have held misogynist views – a worthwhile reading on this is Annegret Stopczik´s collection of philosophers statements on women (Stopczyk 1997).

Back then and today, specific naturalized gender characteristics were assumed. However, in contrast to those historical antifeminist argumentations, a discoursive shift has taken place: at the beginning of the 20th century and beyond, women were denied the same rights as men,

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1   See https://sciencefiles.org/tag/dr-habil-heike-diefenbach/, http://www.cuncti.net/autoren/2-autor/?uid=ulfig-alexander, and http://www.gender-diskurs.de/kontakt/.
2   See their homepage https://agensev.de/.
3   See for example an accordant thread on the blog "Alles Schall und Rauch", http://alles-schallundrauch.blogspot.de/2006/12/der-ursprung-des-feminismus.html.

whereas today, gender critics often stage themselves as being promoters of equal rights but arguing against the deconstruction of heteronormativity and gender dualism.

References

Alternative für Deutschland (2017), *Programm für Deutschland. Kurzfassung des Wahlprogramms der Alternative für Deutschland für die Wahl zum Deutschen Bundestag am 24.09.2017*, https://www.afd.de/wp-content/uploads/sites/111/2017/08/AfD_kurzprogramm_a4-quer_210717.pdf [1 May 2018].

Amendt, Gerhard (2017), *Biologie und rituelle Empörung: Die Zukunft der Geschlechterbeziehungen*, https://agensev.de/die-zukunft-der-geschlechterbeziehungen/ [2 May 2018].

Amendt, Gerhard (2016a), *Köln: Neufeministische Opferverhöhnung*, http://www.freiewelt.net/blog/koeln-neufeministische-opferverhoehnung-10065183/ [3 May 2018].

Amendt, Gerhard (2016b), *Neid und Missgunst – der schwankende Unterbau der Gender Studies*, https://www.cuncti.net/geschlechterdebatte/936-neid-und-missgunst-der-schwankende-unterbau-der-gender-studies [28 April 2018].

Bourdieu, Pierre (1984), *Distinction: A social critique of the judgement of taste*, Cambridge, MA: Harvard University Press.

Bourdieu, Pierre (1989), 'Social Space and Symbolic Power', *Sociological Theory* 7 (1), 14–25.

Buchholz, Günter (2014), *Gender Studies – Die Niedersächsische Forschungsevaluation und ihre offenen Fragen*, https://serwiss.bib.hs-hannover.de/files/405/Gender_Studies_-_Die_Nieders%C3%A4chsische_Forschungsevaluation_und_ihre_offenen_Fragen.pdf [28 April 2018].

Buchholz, Günter (2016), *Sind „Gender Studies" Wissenschaft?*, https://www.cuncti.net/geschlechterdebatte/947-sind-gender-studies-wissenschaft [30 April 2018].

Diefenbach, Heike (2012): Das Patriarchat – Bedeutung, empirischer Gehalt, politische Verwendung, https://sciencefiles.org/wp-content/uploads/2012/06/heike-diefenbach_2012_das-patricharchat_sciencefiles-org.pdf [15 January 2019].

Freie Welt TV (2018), *Das ganze Bild: Beatrix von Storch trifft Prof. Ulrich Kutschera 1/2*, https://www.youtube.com/watch?v=BebukDVgNAM [1 May 2018].

Gehlen, Arnold (1957), *Die Seele im technischen Zeitalter. Sozialpsychologische Probleme in der industriellen Gesellschaft*, Hamburg: Rowohlt.

Gerl-Falkovitz, Hanna-Barbara (2011), 'Fließende Identität? Ein Blick auf Gender', *Theologische Beiträge* 42 (6), 342–352.

Gerl-Falkovitz, Hanna-Barbara (2009), *Frau - Männin – Menschin. Zwischen Feminismus und Gender*, Kevelaer: Butzon & Bercker.

Handelsblatt (2016), *„Was haben wir armen Männer noch für Chancen im Leben?"*, http://www.handelsblatt.com/my/panorama/kultur-kunstmarkt/biologe-ulrich-kutschera-was-haben-wir-armen-maenner-noch-fuer-chancen-im-leben/13616832.html?ticket=ST-1481647-WsoglkUI3X1xle9KEDiI-ap1 [1 May 2018]

Jäger, Siegfried (2009), *Kritische Diskursanalyse. Eine Einführung*, 5. Auflage, Münster: Unrast-Verlag.

Kelle, Birgit (2015), *GenderGaga: Wie eine absurde Ideologie unseren Alltag erobern will*, Aßlar: Adeo-Verlag.

Kemper, Andreas (2014), *Keimzelle der Nation? Familien- und geschlechterpolitische Positionen der AfD – eine Expertise*, Bonn: Friedrich-Ebert-Stiftung.

Kováts, Eszter/ Põim, Maari (eds.) (2015), *Gender as symbolic glue. The position and role of conservative and far right parties in the anti-gender mobilizations in Europe*. Budapest: Foundation for European Progressive Studies/Friedrich-Ebert-Stiftung, http://library.fes.de/pdf-files/bueros/budapest/11382.pdf, [3 May 2018]

Kuhn, Thomas S. (1962), *The Structure of Scientific Revolutions*, University of Chicago Press, Chicago.

Kutschera, Ulrich (2016), *Das Gender-Paradoxon. Mann und Frau als evolvierte Menschentypen*, Berlin: LIT.

Kutschera, Ulrich (2017), 'Ehe für alle? 'Diese widersinnige Entscheidung überrascht mich nicht'', http://www.kath.net/news/60177 [3 May 2018].

Kutschera, Ulrich (2018), *Frankfurter Geschlechter-Allerlei und natürliche Männlichkeit*, http://www.freiewelt.net/nachricht/frankfurter-geschlechter-allerlei-und-natuerliche-maennlichkeit-10073219/ [28 April 2018].

Lang, Julia (2015), 'Familie und Vaterland in der Krise. Der extrem rechte Diskurs um Gender', in Hark, Sabine and Paula-Irene Villa (Eds.), *Anti-Genderismus: Sexualität und Geschlecht als Schauplätze aktueller politischer Auseinandersetzungen*. Bielefeld: transcript, 167–181.

Latour, Bruno (2005), *Reassembling the Social. An Introduction to Actor-Network-Theory*, Oxford: Oxford University Press.

MANNdat (2017), *Gerhard Amendt im Interview mit MANNdat*, https://manndat.de/feministische-mythen/gerhard-amendt-im-interview-mit-manndat.html [3 May 2018].

Meyer, Axel (2015), *Adams Apfel und Evas Erbe: Wie die Gene unser Leben bestimmen und warum Frauen anders sind als Männer*, München: Bertelsmann.

Möbius, Paul Julius (1901), *Über den physiologischen Schwachsinn des Weibes*, 2. Auflage, Halle a.d. Saale: Marhold.

Pirinçci, Akif (2015), *Die große Verschwulung. Wenn aus Männern Frauen werden und aus Frauen keine Männer*, Waltrop/Leipzig: Manuscriptum.

Planert, Ute (1998), *Antifeminismus im Kaiserreich: Diskurs, soziale Formation und politische Mentalität*, Göttingen: Vandenhoeck&Ruprecht.

Schmidt-Lauber, Brigitta (2007), 'Feldforschung. Kulturanalyse durch teilnehmende Beobachtung', in Göttsch, Silke and Lehmann, Albrecht (Eds.), *Methoden der Volkskunde. Positionen, Quellen, Arbeitsweisen der Europäischen Ethnologie*, Berlin: Reimer Verlag, 219–248.

Schorn, Ariane (2000), 'Das „themenzentrierte Interview". Ein Verfahren zur Entschlüsselung manifester und latenter Aspekte subjektiver Wirklichkeit', *Forum Qualitative Sozialforschung, 1 (2)*, http://nbn-resolving.de/urn:nbn:de:0114-fqs0002236 [5 February 2011].

Seubert, Harald (2014), 'Zuhause sein im Leib? Überlegungen zu Gender und Sexualität', in Klose, Joachim (Ed.) *Heimatschichten*, Wiesbaden: Springer VS, 257-289.

Spiegel Online (2015), *"Jung, attraktiv, muss gut kochen können"*, http://www.spiegel.de/

lebenundlernen/uni/universitaet-kassel-professor-ulrich-kutschera-zieht-ueber-genderforschung-her-a-1050888.html [1 May 2018]

Spreng, Manfred (2015a), 'Adam und Eva – Die unüberbrückbaren neurophysiologischen Unterschiede', in Späth, Andreas and Manfred Spreng (Eds.), *Vergewaltigung der menschlichen Identität: Über die Irrtümer der Gender-Ideologie*, Ansbach: Verlag Logos Editions, 35–74.

Spreng, Manfred (2015b), 'Kinder – die Gefährdung ihrer normalen (Gehirn-) Entwicklung durch Gender Mainstreaming', in Späth, Andreas and Manfred Spreng (Eds.), *Vergewaltigung der menschlichen Identität: Über die Irrtümer der Gender-Ideologie*, Ansbach: Verlag Logos Editions, 99–122.

Stopczyk, Annegret (1997), *Muse, Mutter, Megäre. Was Philosophen über Frauen denken*, Berlin: Aufbau-Taschenbuch-Verlag.

Tuider, Elisabeth & Timmermanns, Stefan (2008), *Sexualpädagogik der Vielfalt: Praxismethoden zu Identitäten, Beziehungen, Körper und Prävention für Schule und Jugendarbeit*, Weinheim und München: Juventa-Verlag.

Ulfig, Alexander (2016), *Wege aus der Beliebigkeit: Alternativen zu Nihilismus, Postmodere und Gender-Mainstreaming*, Baden-Baden: Deutscher Wissenschaftsverlag.

United Nations (1997), *Gender Mainstreaming. Extract from Report of the Economic and Social Council for 1997 (A/52/3, 18 September 1997)*, http://www.un.org/womenwatch/daw/csw/GMS.PDF [30 April 2018].

Volkov, Shulamit (2000), 'Antisemitismus als kultureller Code', in: Volkov, Shulamit, *Antisemitismus als kultureller Code. Zehn Essays*, München: Beck, 13-36.

Witzel, Andreas (2000), 'Das Problemzentrierte Interview', *Forum Qualitative Sozialforschung,* 1 (1), http://www.qualitative-research.net/fqs-texte/1-00/1-00witzel-d.htm [6 February 2011].

Zastrow, Volker (2006), *Gender. Politische Geschlechtsumwandlung. Mit Illustrationen von Anke Feuchtenberger*, Waltrop/Leipzig: Manuscriptum.

Decision-making in Repository Siting Procedures – Democratic and Societal Challenges for Nuclear Waste Governance

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Abstract

A prerequisite for siting procedures of contested infrastructures is that they meet the requirements of democracies of the 21st century. Meanwhile, societies that are plural and fragmented hamper interest aggregation and challenge decision-making in increasingly complex problem structures. Therefore, classical top-down approaches of decision-making are criticized and often fail in that either no site can be identified or site identification leads to major conflicts. Democracies in general seem to be less able to take robust decisions that reach acceptability and legitimacy. Participation then becomes a "bestseller". The utilization of participatory elements in decision-making procedures is continuously expanding, in order to represent various views and interests to recreate legitimacy. As a result, new challenges evolve with regard to participation and democratic standards and principles. This article systematizes the literature on participation and decision-making focusing on nuclear waste governance in Germany as an example for a siting procedure of a contested infrastructure. It shows that participation is demanded from different actors with opposing views on what participation means and why and how it should be implemented. On the other hand, democratic principles of equality and legitimacy are put into question when informal participation is intensified. A solution for this is to institutionalize participatory elements, which also means new working modes of institutions and authorities and a change of democratic structures. Nuclear waste governance in Germany is a good example for current efforts undertaken towards this direction.

1. Introduction

Recent developments in decision-making on contested infrastructure projects indicate a participatory turn for example in nuclear waste governance (Bergmans et al. 2015; Seidl et al. 2013), but also in other fields such as renewable energy or transport infrastructure (Renn & Schweizer 2009; Römmele & Schober 2013). The reason for that is that traditional government approaches lost their steering capacity in solving complex and wicked problems[1] (Brunnengräber et al. 2014).

Some authors therefore diagnose a current crisis of representative democracy (e.g. Kriesi 2013). This crisis is also known as post democracy (Crouch 2004). The background of this diagnosis is the growing number of protests, citizens' groups and social movements that demand for more transparency, participation and democratization (Dalton 2014; Geißel 2012) and also the restructuring of nationalism, for instance in Germany in the form of Pegida[2] or the AfD[3]. That is

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[1] Wicked problems are somehow unsolvable or unstructured. This indicates the need to organize learning processes which include a pluralism of perspectives (Brunnengräber et al. 2014; Hoppe 2010, 228-229).

[2] PEGIDA means Patriotic Europeans Against the Islamification of the Western World and is right nationalistic movement.

[3] AfD is the name of a new political party in Germany, called Alternative for Germany which represents right

why new concepts of governance (e.g. Grande 2012; Hoppe 2010) put emphasis on the process and institutional structure as well as design of decision-making.

In nuclear waste governance, which is a complex social and technological problem (Hocke & Grunwald 2009), participation[1] is needed to implement a robust decision-making process with the probable outcome of a decision which might reach acceptability[2]. The complexity of the problem rests upon technical and social issues that are strongly intertwined. Not only security and safety standards are important, but also fairness – distributive, procedural and outcome (Krütli et al. 2012).

In this paper I will analyze how participation is currently understood in nuclear waste governance and what kind of challenges develop due to the implementation of more participatory elements in democratic decision-making.

2. Participation in Nuclear Waste Governance in Germany

In the past, repository siting procedures in representative democracies often failed because decision-making processes were too focused on technical issues and decisions were made top-down without considering concerns of the interested public (Hocke & Kallenbach-Herbert 2015; Krütli et al. 2010; Mackerron & Berkhout 2011). In the long run, this led to conflict and consolidated contest from various citizens' groups and the broader public against government activities regarding all issues of nuclear energy (Hocke & Kallenbach-Herbert 2015; Hocke & Renn 2011). After the severe Fukushima accident (in March 2011), protests against nuclear energy revitalized and forced government action which resulted in the German resolution to phase-out nuclear energy in June 2011. This led to a window of opportunity in nuclear waste governance (Brunnengräber et al. 2014) which culminated in the StandAG[3] (2014 and revised version 2017) and the Commission for the Disposal of High-Level-Waste[4] (2014-2016). The repository site selection procedure for a nuclear waste disposal is in so far an outstanding participation process in Germany as there has not been any such in the past which reached so far into the future and is so challenging regarding the socio-technical complexity and wickedness. Participation is then often understood as a tool to fulfill predetermined sectional objectives. In other words, the aim is already clear, for instance to build a specific infrastructure in one location, and participation is only a mean to reach this aim without openness for alternative proposals. Here, participation becomes an instrument of a new mode of decision-making.

This instrumentalisation of participatory elements is often criticized by participation advocates (e.g. Dalton 2014; Di Nucci et al. 2017; Lehtonen 2010). They argue for the recognition of

nationalistic opinions.

1   There is no common understanding of participation in the literature, therefore I base my argumentation on an understanding of participation as an active involvement of people concerned and those potentially concerned as well as the interested public. Their interests are included into decision-making processes through participatory formats (see also Schaal and Ritzi 2012; van Deth 2009).

2   Acceptability means that legitimate democratic decisions are being accepted, although not all preferences and interests are fulfilled or satisfied (Grunwald 2005).

3   StandAG (Standortauswahlgesetz – Gesetz zur Suche und Auswahl eines Standortes für ein Endlager für hochradioaktive Abfälle) is the German Site Selection Act for a High-Level-Waste repository.

4   The Commission for the Disposal of High-Level-Waste developed criteria and recommendations for the site selection process and reviewed the Site Selection Act.

different understandings of participation and critical differentiation of different functions. Lehtonen (2010, 179–181) developed a very useful and comprehensive classification of different functions of participation, namely the normative, the instrumental and the substantive function. The normative function focuses on the process of participation and deliberation to guarantee legitimacy, for instance in terms of equality of resources, openness for arguments and an equal representation of interests. Then the instrumental function focuses on goals of different interest groups and their motivations to build legitimacy and trust in government, authorities and public decisions. The substantive function focuses on the outcome of participatory and deliberative processes which means an integration of a wide range of values, knowledge and discourses to open up for new perspectives and to achieve better solutions.

Furthermore, criteria of participation are needed to evaluate and categorize different standards of participation. For this purpose, Renn (2013) distills the fulfillment of a good standard of participation down to four basic criteria of participation processes in infrastructure projects: First, fairness must be guaranteed. That means participants have equal rights and duties. Second, there must be a common ground of competence which should be guaranteed through the accessibility of information and knowledge. Third, rules of conversation techniques and scopes of action of participants should be introduced and maintained to gain legitimacy. And last but not least, efficiency should be met through the incorporation of participation outcomes in decision-making (Renn 2013, 80). Such processes require willingness of individuals within public authorities to give-up or share privileges, for instance in terms of knowledge, information, and power. At the same time, individuals need to be open to new perspectives and arguments. Due to this dynamic, the knowledge and information gap is not easily reduced or even closed. Power relations are also not simply balanced, because they are not only preserved by status and official positioning, but also through rhetorical abilities, pre-existing knowledge and the individual ability of information processing (see also Geißel 2009). Accordingly, comprehensiveness of information is equally important as accessibility of knowledge and information. The interested public and NGO members as well as individuals who are directly or indirectly affected will have to be prepared to work together with stakeholders and public authorities in participatory processes. This requires – beside resources[1] – commitment and openness for other perspectives to be able to reconsider and enhance one's own arguments. In particular the fourth criterion suggested by Renn (2013) – efficiency – is difficult to meet in Germany, because of missing legal regulations at the national level to incorporate participation outcomes in decision-making. Deliberation in informal and formal participatory processes might be one option to take participation outcomes into consideration (see also Geißel 2012). This means that the decisions are still made by the legitimate decision-makers and not by the people as it would be the case in a national referendum. Dryzek (2010, 11–12) characterizes such deliberative spaces as „accountable spaces" where individuals of authorities come together with individuals of the interested public to deliberate in symmetric inter-open spaces in order to achieve legitimacy of collective decision-making.

For too long nuclear waste governance focused on the instrumental function which means that

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1   In order to guarantee equality it is also important to give actors a chance to debate on an equal footing. Here financial and time resources come into play, but cannot be discussed in detail. For further reading see Hoppe (2010) and Geißel (2008; 2012).

participation was, and sometimes still is, understood as a tool to gain trust and legitimacy (e.g. Andersson et al. 2003; Bergmans et al. 2015; Blowers & Sundqvist 2010). International recommendations, e.g. those of the IAEA (2017), still focus on the instrumental function of participation in recommending communication and consultation. This is criticized by for instance Blowers and Sundquist (2010, 153) as "technocratic framing". Trust in a fair process which considers all interests equally is not easily gained and information and communication might not be the only or the right tools. As a result, a change in perspective for the benefit of normative and substantive functions of participation would be one step forward to reduce the instrumental character of participation in nuclear waste governance. Recent literature in nuclear waste governance concerning the role of participation for finding a solution of this sociotechnical problem give the process of decision-making priority, which means that the normative function of participation increases in importance (Krütli et al. 2012; e.g. Visschers & Siegrist 2012).

The realization that the process matters a lot is also reflected in the new steps undertaken towards participatory decision-making in radioactive waste governance in Germany, for instance with the Commission on the Disposal of High-Level-Waste and the Repository Site Selection Act (StandAG). The StandAG (BMJV 2017) forms the statutory framework of the whole site selection process. In respect of participation, part two of the StandAG describes the framework and elements of participation: give statements and take part in discussions, the National Support Body (NBG), a symposium on regional sections, regional conferences and the symposium "council of regions". The Federal Office for the Safety of Nuclear Waste Management (BfE) is the supervisory and approval agency and responsible for the participatory processes in the siting procedure. The BfE is a newly established authority and claims to establish a modern organizational culture in which continuously learning processes, self-criticism and a positive error culture should be part of daily work and leadership (BfE 2017). This should guarantee a siting procedure of highest quality. A very important participatory element of the StandAG and therefore also for the BfE is the NBG (StandAG, §8) whose main task is to monitor the site selection process with specific attention to participation in order to guarantee an open and participatory dialogue between all actors on the basis of transparency. The overall aim is to gain trust in the process itself. Participatory elements like the NBG of the new site selection process and the regional conferences have their role in becoming informed by the government in order to inform the interested public and to formulate its own statements in terms of a consultation process (StandAG 2017). The focus of participation in the new German site selection procedure in general still lies on information and consultation as well as transparency. This indicates that the StandAG focuses on formal correctness, and participation is only possible within a tight frame (Hocke & Smeddinck 2017). In reference to the activities of the NBG so far, efforts for a transparent and participatory process are made. However, it has not been clarified yet, how results of participatory elements are being implemented in the decision- making process. Suggestions have been made to communicate findings not only towards the annual reports of the NBG, but as well directly to the government, in case particular findings are regarded as very important or urgent (empirical findings of participant observation by Mbah 2018).

In summary, the plea for a shift of the interpretation of participation functions towards normative and substantive functions is already recognized in politics and across the interested public, due to the fact that in nuclear waste governance in Germany, but also in other policy fields, a transparent and participatory process which means more than information is absolutely new.

There is a political will to take participation seriously. A set of criteria for a good standard of participation processes has been defined, but the implementation of those criteria is difficult in practice, because it is influenced to a great extent by authorities and individual actions and their abilities and readiness to learn. Furthermore, questions of compatibility of participatory elements and the underlying claim of participation as codetermination in decision-making with the representative democratic model are still open and have to be solved.

3. New Challenges through Participation

The traditional role of participation in representative democracy is quite small. Mainly it is based on participation in elections and memberships in political parties or interest groups. In Germany, other forms of small scale participation are possible on local and federal government levels, e.g. hearings, town hall meetings and referenda. Several principles are counted among the basic characteristics of representative democracy (Biegelbauer & Hansen 2011). These include equality, representation and accountability. Equality and representation are intertwined which means that representation of all interests is the overall aim, irrespective of professional career or social status. Subsequently, decision-makers should form a representative portrayal of society and decision-making processes should not be contingent on minority interests (Biegelbauer & Hansen 2011; Saward 2016).

According to the representative democracy model the main challenge in implementing participatory elements is to guarantee equality and representativity in decision-making processes (see Hoppe 2010; Michels 2011). Decker and Fleischer (2012) analysed citizen dialogues introduced by the Federal Ministry of Education and Research in 2010 and 2011 on future technologies and discussed problems of equality and representativity in participatory processes as well as the consideration of the outcome of theses dialogues in decision-making. They concluded that expectations on representation were not fulfilled although more than 1,000 citizens per dialogue were involved based on random sampling. In practice the dialogues showed a bias towards older, highly-educated male participants due to voluntary self-selection processes (Alcantara et al. 2016; Benighaus et al. 2016). Nevertheless, Decker and Fleischer (2012, 97) came to the conclusion that if quality of deliberation could be fulfilled (1,000 representative citizens in table rounds of 8 to 10 people) "the outcomes could be considered as representative" and put "pressure on the Government to actually implement the recommendations [...] and not just to consider it as 'another form of advice'" (Decker & Fleischer 2012, 97).

Apart from that the societal challenge is not only to guarantee efficiency of participatory elements in decision-making, which means that participation is expected to be more than information and should tend towards codetermination. Regarding equality and therefore legitimacy of participatory processes political authorities and decision-makers should keep in mind that power can be applied to a greater extent in participatory processes than in representative decision-making processes (Geißel 2009). Moreover, it is difficult to identify all preferences of people concerned, because informational costs are extremely high (Feindt & Newig 2005). As a consequence, not all affected individuals can be informed and participate in the process, individuals' own interests predominate and participants might be overloaded by the complexity of the issues. This can lead to selectivity which in turn challenges equality (see Craig 2014; Swyngedouw 2011, 2005; Thaa 2016).

In summary, participation exists in several forms and the literature reveals controversies according to what participation means and when participation is in contradiction to the existing representative democracy model in Germany. In reference to German law the implementation of elements of direct democracy is, especially at national level, critical. For example, referenda at national level are not compatible with the parliamentary system, because the federal assembly would be leveraged out (Decker 2014; Linden 2016). Moreover, elements of direct democracy can be problematic in terms of legitimacy, because of the selectivity of participants, which might have a negative effect on the equality of all interests. This argument is based on findings that participation in referenda is more unequal than in elections (Decker 2014; Schäfer & Schoen 2013). Concerning deliberative elements, it is easier to meet the criteria of legitimacy within the scope of representative decision-making. In other words, if a decision is still made in parliament, which means that deliberation outcomes are only recommendations, then deliberation can be evaluated as not in competition with representative standards. Still, this form of participation is criticized as no real participation, as participants are only allowed to have a say but not to decide. Participation in the StandAG is still within the representative democracy model (see also Hocke & Smeddinck 2017). However, it is a trial to embed the participatory informal procedures envisioned in the StandAG in a formal normative frame which means that the StandAG gives the possibility to implement informal participatory formats that are at the same time not essential if the minimum requirements of formal participation are fulfilled (Haug & Zeccola 2018, 79-80). In Germany, different ideas prevail on the type of participation wanted. Actors highlight different challenges in the debate such as who is responsible, how legitimacy can be ensured or how to prevent decision-making behind closed doors.

4. Conclusion

With regard to radioactive waste governance there is a clear demand for participation in the decision-making process; otherwise the conflict will go on and on. Based on this knowledge, ways of integrating participation in decision-making have to be found which are sufficient and satisfactory to participants, stakeholders and the interested public. It is still open whether the StandAG, the BfE and the NBG will be effective in enabling an acceptable standard of participation. Acceptability does also mean that participatory elements have to be in line with the representative democracy model and its decision-making structures.

In summary, decisions which are based on participatory processes are not necessarily improved, for instance in terms of content it might mean that not the geologically best site will be chosen but a site which is acceptable for other reasons, such as its closeness to already existing nuclear infrastructure, as has happened in Sweden and Finland (Forsmark/Sweden and Olkiluoto/Finland) (Kåberger & Swahn 2015; Lehtonen et al. 2017). Another example is that it might not be better in terms of representation, because equal representation of all social groups has not been guaranteed, but still participants and the interested public might value the participatory process in terms of transparency, inclusion of more views and enhancement of knowledge rendering decisions more accountable and legitimate. As a result, both procedural fairness and outcome fairness are important for the acceptability of decisions. Establishing procedural fairness might be easier than having an effect on attitudes towards nuclear energy and radioactive waste governance in order to achieve outcome fairness (Visschers & Siegrist 2012). Subsequently, the first step should be the implementation of a fair process which then

might create acceptability. Regarding the wicked problem of the storage and disposal of nuclear waste a broad and open debate as well as an early involvement of stakeholders and the interested public might help to open-up new perspectives. Participation needs to be directed towards codetermination in terms of a higher level of participation as is described in Arnsteins' 'ladder of participation' (1969) with 'partnership' or even 'delegated power'. Reversibility and the recurrent validation of possible alternatives should as well be part of robust nuclear waste governance. The StandAG including the NBG is one step towards a more participatory approach, but still more work has to be done in order to base discourses on an equal footing and integrate findings of participatory elements in decision-making. Therefore, a clear concept of the participatory process is needed, which is one of the main tasks of the BfE that includes a validation of alternatives and of course how findings of participatory processes will be integrated in decision-making on nuclear waste governance with regard to democratic structures and for a long time period.

References

Alcantara, Sophia, Bach, Nicolas, Kuhn, Rainer and Ullrich, Peter (Eds.) (2016), *Demokratietheorie und Partizipationspraxis: Analyse und Anwendungspotentiale deliberativer Verfahren*. Wiesbaden: Springer VS.

Andersson, Kjell, Westerlind, Magnus and Atherton, Elizabeth, Besnus, Francois, Chataîgnier, Stéphane, Engström, Saida, Espejo, Raul, Hicks, Tim, Hedberg, Björn, Hunt, Jane, Laciok, Ales, Leskinen, Antti, Lilja, Christina, O'Donoghue, Mike, Pierlot, Sandrine, Wene, Clas-Otto, Vira, Juhani and Yearsley, Roger (2003), *Transparency and Public Participation in Radioactive Waste Management.* RISCOM II Final Report. https://www.stralsakerhetsmyndigheten.se/contentassets/ 875908ece0364f338ecaa174c0 031529/200408-transparency-and-public-participation-in-radioactive-waste-management- pdf-575-kb [downloaded 15 April 2018]

Arnstein, Shally R. (1969), 'A Ladder of Citizen Participation', *Journal of the American Institute of Planners* 35 (4): 216–224.

Benighaus, Christina, Wachinger, Gisela and Renn, Ortwin (2016), *Bürgerbeteiligung: Konzepte und Lösungswege für die Praxis*, Frankfurt/Main: Wolfgang Metzner Verlag.

Bergmans, Anne, Sundquist, Göran, Kos, Drago and Simmons, Peter (2015), 'The Participatory Turn in Radioactive Waste Management: Deliberation and the Sociotechnical Divide', *Journal of Risk Research* 18 (3): 347–363.

BfE (2017), *Grundsätze für eine gemeinsame Organisationskultur.* English: *Principles of a Corporate Organisational Culture* (unpublished document), Berlin.

Biegelbauer, Peter and Hansen, Janus (2011), 'Democratic Theory and Citizen Participation: Democracy Models in the Evaluation of Public Participation in Science and Technology', *Science and Public Policy* 38 (8): 589–597.

Blowers, Andrew and Sundqvist, Göran (2010), 'Radioactive Waste Management – Technocratic Dominance in an Age of Participation', *Journal of Integrative Environmental Sciences* 7 (3): 149–155.

BMJV (2017), '*Gesetz zur Suche und Auswahl eines Standortes für ein Endlager für hochradioaktive Abfälle (Standortauswahlgesetz – StandAG)*', Berlin. https://www.gesetze-im-internet.de/standag_2017/BJNR107410017.html [downloaded 14 March 2018]

Brunnengräber, Achim, Di Nucci, M. Rosaria, Häfner, Daniel and Isidoro Losada, Ana Maria. (2014), 'Nuclear Waste Governance - ein wicked problem der Energiewende', in Brunnengräber, Achim and Di Nucci, M. Rosaria (Eds.), *Im Hürdenlauf zur Energiewende. Von Transformationen, Reformen und Innovationen.* Wiesbaden: Springer VS, 389–399.

Craig, Tobin (2014), 'Citizen Forums against Technocracy? The Challenge of Science to Democratic Decision Making', *Perspectives on Political Science* 43: 31–40.
Crouch, Colin (2004), *Post-democracy*. Malden/MA: Polity Press.

Dalton, Russel J. (2014), *Citizen Politics: Public Opinion and Political Parties in Advanced Industrial Democracies,* Los Angeles: SAGE.

Decker, Frank (2014), 'Volksgesetzgebung und parlamentarisches Regierungssystem: Eine schwierige Kombination', in Münch, Ursula, Hornig, Eike-Christian and Kranenpohl, Uwe (Eds.), *Direkte Demokratie. Analysen im internationalen Vergleich*, Baden-Baden: Nomos, 23–37.

Decker, Michael and Fleischer, T orsten (2012), 'Participation in 'Big Style': First Observations at the German Citizens' Dialogue on Future Technologies', *Poiesis & Praxis: International Journal of Ethics of Science and Technology Assessment* 9 (1-2): 81–99.

Di Nucci, M. Rosaria, Brunnengräber, Achim and Isidoro Losada, Ana Maria (2017), 'From the "Right to Know" to the "Right to Object" and "Decide". A Comparative Perspective on Participation in Siting Procedures for High Level Radioactive Waste Repositories', *Progress in Nuclear Energy* 100: 316–325.

Dryzek, John S. (2010), *Foundations and Frontiers of Deliberative Governance,* Oxford: Oxford University Press.

Feindt, Peter, H., Newig, Jens (2005), 'Politische Ökonomie von Partizipation und Öffentlichkeitsbeteiligung im Nachhaltigkeitskontext: Probleme und Forschungsperspektiven', in Feindt, Peter H. (Ed.), *Partizipation, Öffentlichkeitsbeteiligung, Nachhaltigkeit. Perspektiven der politischen Ökonomie*. Marburg: Metropolis, 9–40.

Geißel, Brigitte (2012), 'Democratic Innovations: Theoretical and Empirical Challenges of Evaluation', in Geißel, Brigitte and Newton, Kenneth (Eds.), *Evaluating Democratic Innovations. Curing the Democratic Malaise?* New York: Routledge, 209–214.

Geißel, Brigitte (2009), 'Participatory Governance: Hope or Danger for Democracy? A Case Study of Local Agenda 21', *Local Government Studies* 35 (4): 401–414.

Grande, Edgar (2012), 'Governance-Forschung in der Governance-Falle?: Eine kritische Bestandsaufnahme', *Politische Vierteljahresschrift (PVS)* 53 (4): 565–592.

Grunwald, Armin (2005), 'Zur Rolle von Akzeptanz und Akzeptabilität von Technik bei der Bewältigung von Technikkonflikten', *TATuP* 14 (3): 54–60.

Haug, Volker M. and Zeccola, Marc (2018), 'Neue Wege des Partizipationsrechts - eignet sich das Standortauswahlgesetz als Vorbild?' *ZUR* 75: 1–15.

Hocke, Peter and Grunwald, Armin (Eds.) (2009), '*Wohin mit dem radioaktiven Abfall?*', Berlin: edition sigma.

Hocke, Peter and Kallenbach-Herbert, Beate (2015), 'Always the Same Old Story? Nuclear Waste Governance in Germany', in Brunnengräber, Achim, Mez, Luz, Di Nucci, M. Rosaria and Schreurs, Miranda (Eds.), *Nuclear Waste Governance. An International Comparison*. Wiesbaden: Springer VS, 177–201.

Hocke, Peter and Renn, Ortwin (2011), 'Concerned Public and the Paralysis of Decision- making: Nuclear Waste Management Policy in Germany', in Strandberg, Urban and Andren, Mats (Eds.), Nuclear *Waste Management in a Globalised World*, 43–62.

Hocke, Peter and Smeddinck, Ulrich (2017), 'Robust-parlamentarisch oder informell- partizipativ?: Die Tücken der Entscheidungsfindung in komplexen Verfahren', *GAIA - Ecological Perspectives for Science and Society* 26 (2): 125–128.

Hoppe, Robert (2010), *The Governance of Problems: Puzzling, Powering, Participation,* Bristol: The Policy Press.

IAEA (2017), *Communication and Consultation with Interested Parties by the Regulatory Body,* General Safety Guide 6, Vienna. http://www- pub.iaea.org/MTCD/Publications/PDF/P1784_web.pdf [downloaded 03 April 2018]

Kåberger, T omas and Swahn, Johan (2015), 'Model or Muddle? Governance and Management of Radioactive Waste in Sweden', in Brunnengräber, Achim, Mez, Luz, Di Nucci, M. Rosaria and Schreurs, Miranda (Eds.), *Nuclear Waste Governance. An International Comparison.* Wiesbaden: Springer VS, 203–225.

Kriesi, Hanspeter (2013), 'Democratic Legitimacy: is there a Legitimacy Crisis in Contemporary Politics?', *Politische Vierteljahresschrift (PVS)* 54 (4): 609–638.

Krütli, Pius, Stauffacher, Michael, Flüeler, Thomas and Scholz, Roland W. (2010), 'Functional-dynamic Public Participation in Technological Decision-making: Site Selection Processes of Nuclear Waste Repositories', *Journal of Risk Research* 13 (7): 861–875.

Krütli, Pius, Stauffacher, Michael, Pedolin, Dario, Moser, Corinne and Scholz, Roland W., (2012), 'The Process Matters: Fairness in Repository Siting For Nuclear Waste', *Social Justice Research* 25 (1): 79–101.

Lehtonen, Markku (2010), 'Deliberative Decision-Making on Radioactive Waste Management in Finland, France and the UK: Influence of Mixed Forms of Deliberation in the Macro Discursive Context', *Journal of Integrative Environmental Sciences* 7 (3): 175–196.

Lehtonen, Markku, Kojo, Matti and Litmanen, Tapio (2017), 'The Finnish Success Story in the Governance of a Megaproject: The (Minimal) Role of Socioeconomic Evaluation in the Final Disposal of Spent Nuclear Fuel', in Lehtonen, Markku, Joly, Pierre-Benoît, Aparicio, Luis (Eds.), *Socioeconomic Evaluation of Megaprojects. Dealing with Uncertainties.* London, New York: Routledge.

Linden, Markus (2016), 'Beziehungsgleichheit als Anspruch und Problem politischer Partizipation', *Zeitschrift für Politikwissenschaft* 26: 173–195.

Mackerron, Gordon and Berkhout, Frans (2011), 'Learning to Listen: Institutional Change and Legitimation in UK Radioactive Waste Policy', in Strandberg, Urban and Andren, Mats (Eds.), *Nuclear Waste Management in a Globalised World*, 111–130.

Mbah, Melanie (2018), *Teilnehmende Beobachtung der Sitzung des Nationalen Begleitgremiums in Karlsruhe*; English: *Empirical Findings of the Participant Observation of the Meeting of the NBG in Karlsruhe*, Karlsruhe.

Michels, Ank (2011), 'Innovations in Democratic Governance: How Does Citizen Participation Contribute to Better Democracy?', *International Review of Administrative Sciences* 77 (2): 275–293.

Renn, Ortwin (2013) 'Partizipation bei öffentlichen Planungen. Möglichkeiten, Grenzen, Reformbedarf', in Keil, Silke I. and Thaidigsmann, S. Isabelle (Eds.), *Zivile Bürgergesellschaft und*

Demokratie, Wiesbaden: Springer Fachmedien Wiesbaden, 71– 96.

Renn, Ortwin and Schweizer, Pia-Johanna (2009), 'Inclusive Risk Governance: Concepts and Application to Environmental Policy Making', *Environmental Policy and Governance* 19: 174–185.

Römmele, Andrea and Schober, Henrik (Eds.) (2013), *The Governance of Large-Scale Projects: Linking Citizens and the State,* Baden-Baden: Nomos.

Saward, Michael (2016), 'Fragments of Equality in Representative Politics', *Critical Review of International Social and Political Philosophy* 19 (3): 245–262.

Schaal, Gary S. and Ritzi, Claudia (2012), 'Deliberative Partizipation: Eine kritische Analyse des Verhältnisses von Deliberation, demokratischer Öffentlichkeit und staatlicher Entscheidung', in Riescher, Gisela and Rosenzweig, Beate (Eds.), *Partizipation und Staatlichkeit. Ideengeschichtliche und aktuelle Theoriediskurse*, Stuttgart: Franz Steiner Verlag, 131–153.

Schäfer, Armin and Schoen, Harald (2013), 'Mehr Demokratie, aber nur für wenige?: Der Zielkonflikt zwischen mehr Beteiligung und politischer Gleichheit', *Leviathan* 41 (1): 94– 120.

Seidl, Roman, Krütli, Pius, Moser, Corinne, Stauffacher, Michael (2013), 'Values in the Siting of Contested Infrastructure: the Case of Repositories for Nuclear Waste', *Journal of Integrative Environmental Sciences* 10 (2): 107–125.

Swyngedouw, Erik (2011), 'Interrogating Post-Democratization: Reclaiming Egalitarian Political Spaces', *Political Geography* 30 (7): 370–380.

Swyngedouw, Erik (2005), 'Governance Innovation and the Citizen: The Janus Face of Governance-beyond-the-State', *Urban Studies* 42 (11): 1–16.

Thaa, Winfried (2016), 'Issues and Images - New Sources of Inequality in Current Representative Democracy', *Critical Review of International Social and Political Philosophy* 19 (3): 357–375.

van Deth, Jan W. (2009), 'Politische Partizipation', in: Kaina, Viktoria (Ed.), *Politische Soziologie. Ein Studienbuch*, Wiesbaden: VS Verlag für Sozialwissenschaften, 141–161.

Visschers, Vivianne H.M. and Siegrist, Michael (2012), 'Fair Play in Energy Policy Decisions: Procedural Fairness, Outcome Fairness and Acceptance of the Decision to Rebuild Nuclear Power Plants', *Energy Policy* 46: 292–300.

Modest contemplations in the public sphere of walking and eating

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Abstract

The street is one of the key spaces of public and private life. For its central role in making of modern life and contributing to the quality of social and personal life, it is a space worth probing in its multiple spheres of being and usage. We explore a nexus of human experience – where walking, eating, pleasure, social interaction, and more converge. In this particular case, we examine eating and walking and speculate on *social facilitation*: effect of social interaction on shift of state from *noneater* to *eater* while walking in the street. We take parameters from a survey and execute an agent-based model. In the survey, participants had scored ten theoretical factors as instigators of eating while walking in the street. In the current paper, we compare results with an earlier design which employed means of factors to define center of distribution for random-normal assignment of factor scores. In the current iteration, we use multiple regression to estimate a center, reasoning that factors tend to work in consonance with one another. Our model suggests chance of social facilitation. Any aspect of human behavior in the city that is known or understood facilitates programming the context in which the behavior happens. Those who design or manage urban settings either ground or supplement their versatility through encounter with a broad range of insights which inform urban space. Modelling provides one such consequential pathway to apprehension. Using the computer as a modelling tool facilitates managing the problem of anticipation of social action in space.

Introduction

"I'm a great one for eating while I'm walking." (Anecdote 1)

"You'll see people...buy breakfast...already eating it on the way home." (Anecdote 2)

"Eating a sandwich...on my way to the office. I had to walk along a busy street and cross a few intersections....It's an intimate journey." (Anecdote 3)

In experimental science, a time-tested pathway for fostering understanding of a phenomenon is through directed attention at its effects within a defined context – with the insight that variation of the value represented by the phenomenon-as-variable would precipitate a concomitant change in the environment of the problem. Exposition learns from experimental manipulation. Ensuing solutions to contingent problems can then be crafted to fit the as-described experimental problem unilaterally or are crafted in such a way that their ranges and tolerances are aimed at accommodating appropriate parameters of the problem, thereby accounting for real-life variances.

So, imagine the case of pedestrians walking on a city street – more particularly, a sidewalk. The sidewalk must be able to move pedestrians along effectively as a primary function. The problem, however, is more complicated than that. The sidewalk must also accommodate people roaming while sightseeing, maundering on an idle stroll, stopping to talk, window-shopping, searching for

a trash receptacle, pausing to watch a street entertainer, exploring objects and their use, testing limits of engagement with objects and events [e.g. sitting on steps], and performing a host of other actions. The upshot for a designer is necessity to learn to anticipate this new layer of intricacy within the problem space, as it is possible that estimates of critical parameters might shift. Examples of those parameters are sidewalk width, pavement surface design (e.g. to minimize risk effects prompted by distraction), walking speed, and physical and managerial constraints to curiosity about objects in space.

The pre-eminent logic of the type of scientific exploration described above is *cause --> effect*. In this paper, we explore the potential that, in a social context such as the street, pedestrians might influence one another in/about a particular behavior in public space. For the purpose of that exploration, we have taken up the diversionary act of eating while walking. We frame our exploration of *cause --> effect* around the context of inducement of *non-eaters* to eat, following influence by *eaters*. We ask the question: Given a few people eating in the street, and given social interaction, could the number of eaters increase?

We will enquire into the prospect that, in a social context such as the street, repeated encounter with those who are already eating, in concord with other conditions which might affect the possibility of eating on the street (see below), might gradually stimulate some people who were originally non-eaters, in the instance, to consider eating while walking. The critical mediating construct is expressed as *social facilitation* (Stroebele & De Castro 2004). To the extent that social facilitation might increase number of eaters, the designer should aspire to recognize the possibility of *organic* changes in the parameters that shape and ultimately define the sidewalk.

Food in the Street

According to the Food and Agriculture Organization of the United Nations in a 2001 report, an estimated 2.5 billion people world-wide consume street food (FAO 2001). As might be expected, some of these foods are eaten at point of purchase, but it is to be expected that some are also eaten on-the-go, while the eater is walking (or riding, driving). Our population frame is larger, as it includes those eating foods purchased on the street as well as those who have either purchased food in a setting such as a restaurant and taken it out into the street or have brought the food along from home. Eating while walking adds new layers to the dynamic dialogue of ambulation and space: slower pace of movement, translocation of waste (from point where eating is initiated to where it ends), sidewalk surface management (level changes, trip obstacles [since attention is divided], slip resistance), and so on. There are, however, also more deep-seated layers of the phenomenon: personal agency, social relationship, composite awareness-shaping (in the process of tasting while moving across landscape), and so on.

Factors associated with consumption of food.

People eat in the street or in a public space for a variety of reasons. Satisfying hunger is a direct reason (homeostatic regulation [Kringelbach 2004]). There are other motivations, however. One street eater speculated on the following: "tempting street vendor;" "happen to have a fruit or snack with me;" "just purchased from vending machine;" "I have someone with me and the food is [one] he/she likes;" "when I see delicious food;" "warm you up in...winter;" "celebrate a relationship;" "crush's favorite;" "[your] stomach is already full, [but] for some reason, when a friend or relative asks for your company to eat...you accept their offer;" habit; curiosity;

availability (De Leon 2011).

Beyond anecdotes, there are theoretical factors that have been linked to consumption of food.

Hunger.

Two systems are known to drive human consumption of food. First, food is a function of the homeostatic mechanism, the system which works to serve nutritional needs (Alonso-Alonso et al. 2015; Stroebe, Papies & Aarts 2008). In the second system, homeostatic needs do not primarily drive consumption. As Lowe and Butryn (2007) have stated, an increasing proportion of food consumption by humans seems to be driven, not by a homeostatic need, but by pleasure. They termed that drive hedonic hunger.

Happiness and positive emotions.

Happiness before consumption has been shown by Appleton (2006) to correlate positively with daily energy intake. Evers et al. (2013) explored the role of positive emotions as trigger for food intake. They reported on three studies which they conducted that "the results pointed towards the essential role of positive emotions in food indulgence" (p. 5).

Availability and presence of food.

In a study described by Stroebele and De Castro (2004), participants indicated a greater desire to eat after food was exposed to them. Provokingly, fourteen percent (14%) of participants who had indicated no appetite for pizza actually ate a slice by the end of the described experiment, during which pizza was exposed to them.

Proliferation of vending machines and convenience stores have been discussed as issues when considering eating behaviours among youth. In some societies, these sources of food are ubiquitous, accounting for multiple billion dollars of youth expenditure annually (Story, Neumark-Sztainer & French 2002). Convenience is a factor of interest in Western society, noted Stroebele and De Castro (2004). Research indicates, they wrote, that "accessibility and availability increase food intake" (p. 825). Food that is made easier to access might be chosen to be consumed.

Other people and other people eating.

Socio-environmental factors which affect food intake include social interaction. Meals and snacks consumed in social contexts last longer (Gemming et al. 2015). People also eat more when in the presence of other people who are eating, according to Stroebele and De Castro (2004). These latter authors observed that "presence of other people during food consumption can have profound effect on intake" (p. 822). They termed the effect, social facilitation. Social facilitation is powerful enough that it takes place "regardless of time of day [or] place" (p. 822).

Physical space.

Stimuli associated with physical surroundings have an influence on food consumption. Stroebele and De Castro (2004) recognized the role of properties of location such as odour, temperature, lighting and colour. Other peculiar things about physical setting might influence food choice or intake. Physically-constrained locations (e.g. office desk, car), for instance, are associated with higher likelihood of selection of snacks (Stroebele and De Castro 2004). In our case, we

speculated on a particularity of place: familiarity. We included the construct in our set of questions to see how familiarity with a space might affect choice to eat.

Variety.

Food intake "increases when participants are offered multiple foods with different sensory characteristics." Wilkinson et al. (2013) termed it the "variety effect" (p. 175). Rolls et al. (1981) have also argued that variety of food might enhance intake during a meal. We see a signal which increases intake as also possibly one which might act as a spur to consume.

Freshness.

Food freshness is defined as "the level of closeness of a food product to its original state, in terms of distance, time and processing" (Gvili et al. 2015, p. 352). In a general sense, freshness plays a role in perception and assessment of food quality and thus has impact on food choice. Indeed, Gvili et al. indicated that food freshness has been shown by studies to be the leading cause of food choice. They also noted that food appeal and taste are mediated by freshness. In our study, we have conceptualized freshness as closeness-in- time to moment of purchase of food that is being prepared and sold on the street.

Movement.

Gvili et al. (2015) proffered arguments linking movement to food choice. Living animals move. Healthy ones display more motion than the diseased or infected. Thus, at both an intellectual and visible level, motion becomes associated with freshness. Growing edible plants also move in the wind as opposed to plants and fruits that have been plucked and have begun a post-harvest decay process. So, the same kind of intellectual and visible connection between movement and freshness could be applied to plants. The perception (and reality) extends to inanimate things (e.g. running water is fresher, has less bacterial proliferation, reduces build-up of chemical contamination) and food supplied by humans (e.g. items just brought in by the hunter or farmer are "fresher"). Items judged recently moving are considered fresher than those that have been in storage. As already indicated above, freshness encourages food choice – and desirableness might be linked to consumption.

In our study, we went out a bit further and speculated on the role of movement as transferred to the consumer – particularly since walking while eating involves movement of the agent. We included it as an item on our questionnaire for respondents to see what association their own movements might have with choice to eat.

Methods

We have explored a model of the influence of social facilitation on eating in the street (Stephen, in press). Based on our parameters, we found a significant effect of social facilitation on [likelihood of] eating while walking in the street as expressed in increase in the number of eaters. We began by carrying out a survey of factors that might influence participants' likelihood of eating in a street. Ten theoretical factors were contained, including factors described above as part of the conceptual framework of the current paper. Participants (n = 103; convenience sample) scored each factor as an instigator of eating while walking in the street. Each item was

scored on an 11-point scale, zero representing no influence and ten representing absolute act of eating as a result of the factor.

Using results of the survey, we structured an agent-based model in Netlogo (Netlogo, n.d.; also see Railsback & Grimm, 2012). Agents walked along a one-mile stretch of street. (See figure 1.) One agent parameter was walking speed, which was random-normally distributed

Fig. 1. Pedestrians on street: Portion of model world

(*eaters* on a slower distribution than *noneaters*) based on a survey of the literature (see Bosina & Weidmann, 2017; Johansson & Kretz, 2012; Sharbafi & Seyfarth, 2017; Wagnild & Wall-Scheffler, 2013). Pedestrian density was derived by combining data from three United States cities (Chicago, 2008; Minneapolis, 2009; Tempe, 2015).

Another set of agent parameters was a score on each theoretical factor. Scores on factors taken from the survey were aggregated into an indicator and each agent acquired own scores-on-factors as state variables assigned within a random-normal distribution around the indicator (parameters: mean, standard deviation). If an agent's composite score (likelihood-to-eat score) generated by these factors exceeded a threshold, then the agent became an *eater*. If the threshold was not exceeded, the agent maintained a *noneater* status and continued on its way. In order to derive the threshold, we first conducted a one-mile visual observational field run on a business/commercial urban street and recorded proportion of eaters against noneaters. Then, taking likelihood-to-eat scores from survey data, the threshold was derived as the point which split survey respondents into the same proportion of eaters and noneaters as the field-obtained proportion.

An emergent condition was built around *social facilitation*. Encounter with an eater and repeated encounters with eaters gradually increased the noneater's likelihood-to-eat score. Some of these agents finally crossed the threshold after as many as nearly three-dozen encounters which were either distinct, continuous by virtue of consistent proximity over time or both distinct and continuous. Even with so many encounters, many an agent continued to remain a non-eater, as its likelihood-to-eat score never crossed the critical threshold.

In the current paper, we wish to compare results, using a different method of agent parameter estimation. In the previous analysis, means of factors were used to define center of the distribution for random-normal assignment of scores-on-factors. In the current study, we are using multiple regression to estimate the center. The reasoning is encapsulated in the argument that factors tend to work in consonance with one another. A regression equation distributes factor weights based on consideration of factors involved. The reader should be aware that we are not using multiple regression here to generate a prediction model. We are using it as a rational means for articulating a more networked, wholistic expression of the phenomenon.

As mentioned above, we took beta coefficients and used them as proxy values for the center of distribution on each factor. We then estimated standard deviation based on that center.

These values of center and variability became parameters for the current version of the model.

As we hoped, there was gradual increase in number of eaters as a consequence of gradual conversion of some noneaters into eaters. Figure 2 shows a generalized change in number from noneater definition to eater definition ("slow" green line near bottom of plot).
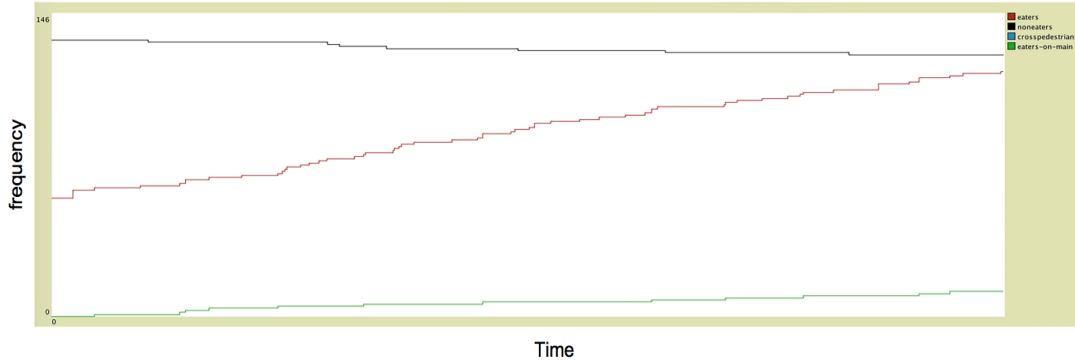

Fig. 2. Typical increase in eaters. Bottom green line is critical line.

Figures 3a and 3b depict more micro-focussed views of gradual increase in likelihood-to-eat scores of selected agents.
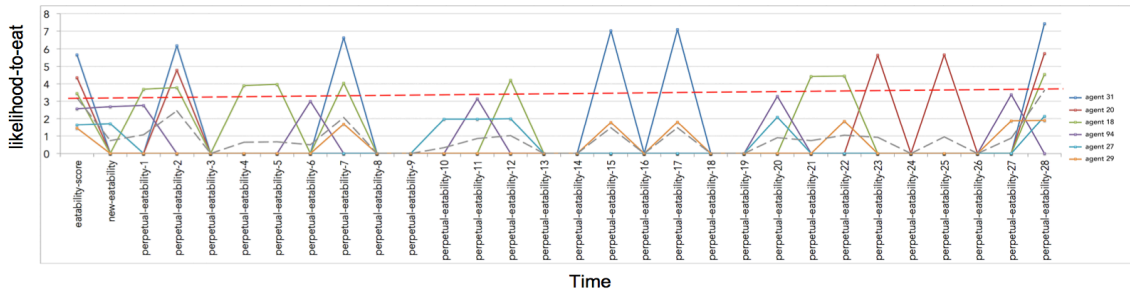

Fig. 3a. Increase in likelihood-to-eat score. Six selected agents. Dashed red line shows gradual increase.
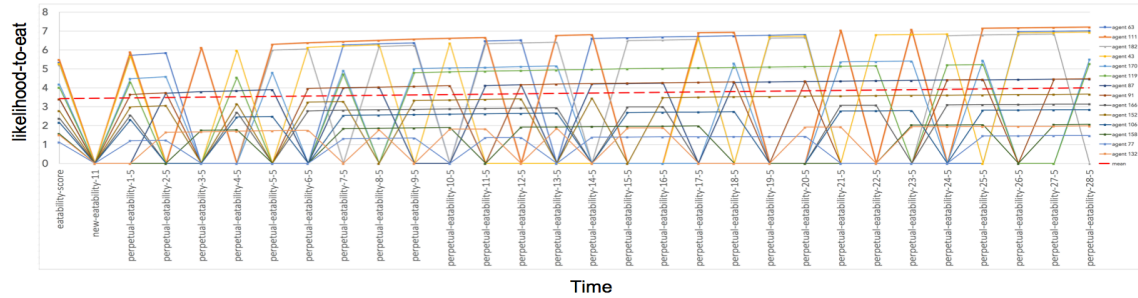
Fig. 3b. Increase in likelihood-to-eat score. Fourteen selected agents. Dashed red line shows gradual increase.

Results

Below, we present observed changes in eater-noneater counts as generated by the models. We conducted fifteen runs per condition. In order to test increase among eaters, we employed a Wilcoxon matched-pairs signed-rank test (including an alpha correction). We conceptualized each model world state as a variable with two observations: a before and an after. Each procedure (pre-, social facilitation, post-) was a unit/case. Table 1 presents some summarized data analysis from the earlier study.

Condition	Beginning eater count (15 runs each condition)	Ending eater count: Mean	Ending eater count: Median	Difference/ increase in eaters
S(0.15/0.5)+P(1492)+E(0.05)	9	31.47	30*	22.47
S(0.15/0.5)+P(1492)+E(0.10)	19	41.73	42*	22.73
S(0.15/0.5)+P(1492)+E(0.30)	57	76.80	76*	19.80
S(1.52/5)+P(1492)+E(0.05)	9	69.93	70*	60.93
S(1.52/5)+P(1492)+E(0.10)	19	77.07	78*	58.07
S(1.52/5)+P(1492)+E(0.30)	57	107.40	106*	50.40
S(3.35/11)+P(1492)+E(0.05)	9	32.60	32*	23.60
S(3.35/11)+P(1492)+E(0.10)	19	40.40	41*	21.40
S(3.35/11)+P(1492)+E(0.30)	57	74.13	74*	17.13

S (m/ft) = max. proximity of an eater in order to have effect (Multiply by 4.5 to get distance.)
P = street density (# of ppl. on street). NOTE: 1/4 P was used due to burden on model.
E = existing (starting) proportion of eaters on street
* = significant at .05. Test: Wilcoxon matched-pairs signed-rank test

Table 1. Results of earlier study. Mean used as parameter

We ran the same test for the same conditions during the current iteration. Results are presented in Table 2 below. All conditions showed a significant increase of eaters. None of the 95% confidence intervals per condition contained zero.

While increase in eaters is recorded in both cases, it is notable that increases in the beta-weighted conditions are more modest than those of the mean-weighted conditions. The former

are also more stable, more consistent about the increases.

Overall, we expected to see a systematic increase in number of eaters created as one moved from lower to higher S conditions (i.e. As allowable distance of effect of an eater on a noneater is liberalized, one expects a greater number of noneaters to be impacted). The pattern of increase observed was mixed – ranging across increase, slight increase, flat to slight reversal.

Condition	Beginning eater count (15 runs each condition)	Ending eater count: Mean	Ending eater count: Median	Difference/ increase in eaters
S(0.15/0.5)+P(1492)+E(0.05)	9	20.40	19*	11.40
S(0.15/0.5)+P(1492)+E(0.10)	19	32.07	32*	13.07
S(0.15/0.5)+P(1492)+E(0.30	57	67.60	68*	10.60
S(1.52/5)+P(1492)+E(0.05)	9	24.80	25*	15.80
S(1.52/5)+P(1492)+E(0.10)	19	32.27	32*	13.27
S(1.52/5)+P(1492)+E(0.30)	57	67.60	67*	10.60
S(3.35/11)+P(1492)+E(0.05)	9	24.60	25*	15.60
S(3.35/11)+P(1492)+E(0.10)	19	33.27	33*	14.27
S(3.35/11)+P(1492)+E(0.30)	57	68.40	69*	11.40

S (m/ft) = max. proximity of an eater in order to have effect (Multiply by 4.5 to get distance.)
P = street density (# of ppl. on street). NOTE: 1/4 P was used due to burden on model.
E = existing (starting) proportion of eaters on street
* = significant at .05. Test: Wilcoxon matched-pairs signed-rank test

Table 2. Results of current study. Beta as parameter

A curious succession, seen earlier in the older study, seems to have been largely mitigated. As one moves from the lowest "starting proportion of eaters" (E) to the higher proportion immediately greater, there is increase in new eaters spawned (visible in the last column of each table) – and that comes as little surprise. As one moves from the middle "starting proportion" to the highest, however, in the earlier set of results, instead of an increase once again in eaters created, there is decrease. In the current iteration, the peculiarity is visible only in the first triplet. We plan further exploration in order to be able to articulate a coherent explanation.

Conclusion

We explored a case of pedestrian behavior in the city street. We looked particularly at the case of pedestrians who might eat while walking. We enquired with regards to the effect of social facilitation on noneaters. Our model results suggested that, overall, the possibility exists. For modelling, we compared means of theoretical factors against regression betas. Both systems showed an overall increase in eater count, but the latter showed more modest gains.

In addition to the overall expectation of increase, we reported two critical observations. In the first, low to high S conditions were expected to yield higher new eater counts along that S condition progression, but current observations are mixed. In the second case, under the E conditions, we expected a higher beginning proportion of eaters to yield higher new eater counts. This happened as expected in transition from the first to second levels of E, but there

was a reversal at least once in each model. Among other things, these two questions suggest enquiries to pursue in further studies.

Implications for design.

The matter of eating while walking in the street is of interest to the designer and other managers of the urban context. A change of behavior holds potential of changing parameters of design and management.

As mentioned earlier, an example of a critical parameter of design that might be affected by pedestrian behavior is walking speed. Multiple factors which affect free walking speed have been identified in past research. They include, body mass, sex, culture, purpose of trip (e.g. going to the fair, as opposed to making a court appointment), circumstances of trip (e.g. casual sightseeing, opposed to a timed scavenger hunt) and air temperature (Chattaraj, Seyfried and Chakroborty, 2009 ; Johansson & Kretz, 2012; Wagnild & Wall-Scheffler, 2013).

In one example involving cultural difference, Chattaraj, Seyfried and Chakroborty (2009) compared free flow in a corridor space using an Indian and a German case. They found that density influenced speed once personal space (which they characterized as cultural) was taken into account. Speed was more dependent on density among participants in the German case than among participants in the Indian case.

Wagnild and Wall-Scheffler (2013) looked at speed choices of persons alone, with friends of the same sex, with friends of the opposite sex and, particularly, with a friend who is a "significant other." They found that, while men's optimal speed is generally faster than women's, when a man walks with a woman, he slows down in order to match the woman's speed. Speed was slowest when the woman was a "romantic partner." Wrote the authors:

> It has been suggested that dyad walking speed is correlated to relationship status....Thus, if male and female couples walk together, they may walk at significantly slower walking speeds than walking alone or with other acquaintances." (paragraph 4)

They added elsewhere that the degree of a man's accommodation to fit the woman's pace "is linked to the relationship status of the male-female pair, such that males will nearly match the females' paces only if they are in a romantic relationship" (paragraph 15).

A notable exception to the above is the case of a woman walking with a female friend, which recorded overall slowest speed:

> Previous work has noted that women report feeling extremely close to their female friends and here we show that women walk more slowly together even than they do with their Partner. (paragraph 15)

How might walking speed, for instance, be influenced by eating? While we do not currently possess extant data, there are logical indications. Barkley and Lepp (2016) explored the impact of cellular phone usage on walking speed. They examined cellular phone use conditions/behaviours of talking, texting, partial use (i.e. one of the behaviours only over a portion of length of the observation space) and no use. Results indicated that subjects in both the talking and texting conditions "took a significantly ($p < 0.001$) greater amount of time traversing the walkway

(i.e., walked more slowly) versus those in the 'no-use' category" (paragraph 11). They found no statistical difference between the talking and texting conditions.

Bosina and Weidmann (2016) recorded walking speed for different trip purposes. Between purposes of business, commuting, shopping and leisure, they found walking speed for leisure (1.10ms-1) to be slowest.

In the current study, we considered the case of people eating while walking. We speculated that eating, as other behaviors (such as talking on the phone) which demand some attention, is matched generally with a slower walking speed. We speculated that while there would be a range of walking speeds while eating, it could be as slow as walking pace for leisure, particularly since it is the case that, often, people eating are doing so at leisure.

The point in all this is not to assail eating in favor of more rapid movement of people along the street. The appropriate design response – and here is a critical, significant matter, a worthy lesson, a design realization incumbent on the designer – must consider experience of the city wholistically: i.e. at a grander, richer level of engagement and meaning. While a city is intended to work for commerce, it ought to be recognized also that the city is meant to be a *wellspring* and framer of experiences for people – and that includes core human pursuits encapsulated by related ideals such as enjoyment, pleasure, amusement, diversion, recreation and leisure. The perceptive, thoughtful designer recognizes that what needs to be pursued is the kind of probe that can proffer some insight into dynamics, ebbs and flows and mutations of behaviors that city dwellers might exemplify in their pursuit of pleasure and happiness within the city.

Landscape deepening: Contemplations on augmenting value of landscape

Scheuch (in Godbey, 1976) introduced the term, "time deepening" (an analogy of the economic term, capital deepening), to frame an episode of performing multiple tasks simultaneously in order to fulfil a greater number of personal needs or desires and, by that, using time more efficiently. We extend the analogy to landscape and space. We propose that people heighten experience of landscape by performing more actions that go beyond merely looking at it. For instance, we add *movement through* landscape and thereby accumulate points of view (and appreciation) of it. We test aspects of landscape by provoking our encounter with them through probes by senses other than visual. We re-mould landscape by co-insertion of self in it conjointly with other people. We re-plot, re-conceptualize or model a cognitive map of landscape by allowing ourself to be seduced by landmarks to which we are drawn. In all these engagements, we ep-aestheticize landscape. We re-mobilize landscape through intensification or magnification of our affective relationship with it. Inertia is decoupled from discovery of landscape. Landscape is "dynamicized." In short, we *deepen landscape*.

Some of the most deepened experiences of the physical and social landscape have occurred, for us, while eating and walking. Complementarily, experience of food has also been characteristically enjoyable – but in a paradoxically pervading, yet uncentered-on-food or unkeen-about-food way. The experience simply reduces physicalness of food into an aura or an impression of pleasure.

Eating, however, is not the point or the question anymore, as it dissolves into delight of landscape and landscape, in turn, percolates into taste to co-author a new, blended form of emotional substantiality. Aesthetic [or experience] of landscape amalgamates with experience [or aesthetic] of taste. Landscape becomes an indulgence.

Charm of landscape assumes perceptible embodiment in association with delectabilities served by the palate. Landscape is tasted.

Harris (2005) revisited the idea of *adding value* to goods and experiences we consume. Value is evinced and assimilated during the process of consumption. Sometimes it is a result of predesign into the good or experiential offering. At other times, value is a fluid, spontaneous outcome. Tschumi (1994) has recounted the idea of experience of urban landscape as one set eminently in the frame of *movement* – across space, across events. While walking and eating, value is added to both landscape and food.

There is a space where discourse on *pleasures* (Harris, 2005) can be carried out without retreat to externally-defined (and sometimes non-evidentially-robust) behavioral hedges, without the smother or strangulation of thou-shall-nots, a pure space where aesthetics, hand-in-hand with experience, is the lingua franca and where possibilities of genuine experiences can be honestly and authentically explored.

Future directions

There is still work to be done. It was mentioned above, for instance, that pattern of the S conditions (eater proximity) was mixed. More model runs will need to be carried out in order to identify more stable outcomes. Above, we also discussed some curious increase-decrease transitions under the E conditions (eater starting proportions). That is another enquiry which merits further exploration. It will be insightful to be able to conduct more model runs with a higher population density. In the current explorations, we have been compelled to employ only a proportion of desirable population. Running models with larger population densities require considerable computational power. That is a significant challenge. Finally, it will be instructive to collect a range of additional data on walking while eating – for instance, data on the effect of eating on walking speed. In relatively unexplored areas of enquiry, it is often the case that multiple questions and issues arise, but those also open up avenues of research and discovery.

References

Alonso-Alonso, Miguel, Stephen C. Woods, Marcia Pelchat, Patricia S. Grigson, Eric Stice, Sadaf Farooqi...Gary Beauchamp (2015), 'Food reward system: Current perspectives and future research needs', *Nutrition Reviews* 73: 296–307. doi: 10.1093/nutrit/nuv002

Anecdote 1. https://travel.stackexchange.com/questions/14853/what-is-wrong-with-eating-while-walking-in-japan-it-doesnt-seem-to-be-an-issue [21 April 2018]

Anecdote 2. https://www.researchgate.net/post/Do_you_eat_in_the_street [21 April 2018]

Anecdote 3. Retrieved from https://www.researchgate.net/post/Do_you_eat_in_the_street [21 April 2018]

Appleton, K. M. (2006), 'Behavioural determinants of daily energy intake during a 28

day outdoor expedition in arctic Norway', *Scandinavian Journal of Food and Nutrition* 50: 139-146. doi: 10.1080/17482970600947522

Barkley, Jacob E. and Andrew Lepp (2016), 'Cellular telephone use during free-living walking significantly reduces average walking speed,' *BMX Research Notes* 9: 195. DOI 10.1186/s13104-016-2001-y

Bosina, Ernst and Ulrich Weidmann (2017), 'Estimating pedestrian speed using aggregated literature data', *Physica A* 468: 1-29. http://dx.doi.org/10.1016/j.physa.2016.09.044

Chattaraj, Ujjal, Armin Seyfried and Partha Chakroborty (2009), 'Comparison of pedestrian fundamental diagram across cultures', *Advances in Complex Systems: A Multidisciplinary Journal* 12: 393-405. https://doi.org/10.1142/S0219525909002209

Chicago Department of Transportation (2008) *Executive summary: Pedestrian*

activity in the Chicago downtown area, https://www.cityofchicago.org/content/dam/city/depts/cdot/ PedFINALreportDec08_Ex eSummary.pdf [downloaded 7 June 2017]

De Leon, Anthony. N. O. (2011), 'Pssst...Why do you eat street foods. Retrieved from https://onlinejournalism419.wordpress.com/2011/12/01/pssst-why-do-you-eat-street- foods/ [21 April 2018]

Evers, Catharine, Marieke Adriaanse, M., Denise T. D. de Ridder and Jessie C. de Witt Huberts (2013) 'Good mood food. Positive emotion as a neglected trigger for food intake', *Appetite* 68: 1-7. http://dx.doi.org/10.1016/j.appet.2013.04.007

FAO (2001), *Street foods made safer* http://www.fao.org/english/newsroom/highlights/2001/010803-e.htm [downloaded 21 April 2018]

Gemming, Luke, Aiden Doherty, Jennifer Utter, Emma Shields and Cliona Ni Mhurchu (2015), 'The use of a wearable camera to capture and categorise the environmental and social context of self-identified eating episodes', *Appetite* 92: 118-125. http://dx.doi.org/10.1016/j.appet.2015.05.019

Godbey, Geoffrey (1976), 'Time deepening and the future of leisure', *Journal of Physical Education and Recreation* 47: 40-42. https://www.tandfonline.com/doi/abs/10.1080/00971170.1976.10612341

Gvili, Yaniv, Aner Tal, Moty Amar, Yael Hallak and Brian Wansink (2015), 'All the right moves: Why motion increases appeal of food products', *Advances in Consumer Research* 43: 352-357. Retrieved from http://www.acrwebsite.org/volumes/v43/acr_vol43_1019481.pdf

Harris, David (2005), *Key concepts in leisure studies*. Los Angeles: Sage.

Johansson, Anders and Tobias Kretz (2012), 'Applied pedestrian modeling' in Heppenstall, Alison J., Andrew T. Crooks, Linda M. See & Michael Batty, M. (Eds*.), Agent-based models of geographical systems*, Dordrecht, Netherlands: Springer, 451-462.

Kringelbach, M. L. (2004), 'Food for thought: Hedonic experience beyond homeostasis in the human brain', *Neuroscience,* 126: 807-819. doi:10.1016/j.neuroscience.2004.04.035

Lowe, Michael R. and Meghan L. Butryn (2007), 'Hedonic hunger: A new dimension of appetite?', *Physiology and Behaviour* 91: 432-439. doi:10.1016/j.physbeh.2007.04.006

Minneapolis, (2009). *Minneapolis pedestrian master plan*, http://www.minneapolismn.gov/www/ groups/public/@publicworks/documents/webcon tent/convert_255385.pdf [downloaded 7 June 2017]

Netlogo (n.d.). Available at https://ccl.northwestern.edu/netlogo/

Railsback, Steven F. and Volker Grimm (2012), *Agent-based and individual-based modeling: A practical introduction*, Princeton/Oxford: Princeton University Press.

Rolls, Barbara. J., E. A. Rowe, E. T. Rolls, Breda Kingston, Angela Megson and Rachel Gunary, (1981), 'Variety in meal enhances food intake in man', *Physiology & Behaviour* 26, 215-221 [abstract]. https://doi.org/10.1016/0031-9384(81)90014-7

Sharbafi, Maziar. A. and Andre Seyfarth (2017), 'How locomotion sub-functions can control walking at different speeds?', *Journal of Biomechanics* 53: 163-170. http://dx.doi.org/10.1016/j.jbiomech.2017.01.018

Stephen, A. (in press). Eating while walking: Social facilitation as agent.

Story, Mary, Dianne Neumark-Sztainer and Simone French (2002), 'Individual and environmental influences on adolescent eating behaviors', *Journal of American Dietetic Association* 102: S40-S51. http://dx.doi.org/10.1016/S0002-8223(02)90421- 9

Stroebe, Wolfgang, Esther K. Papies and Henk Aarts (2008), 'From homeostatic to hedonic theories of eating: Self-regulatory failure in food-rich environments', *Applied psychology: An international Review* 57:, 172–193. doi: 10.1111/j.1464- 0597.2008.00360.x

Stroebele, Nanette and John M. De Castro (2004) 'Effect of ambience on food intake and food choice', *Nutrition* 20: 821-838. doi:10.1016/j.nut.2004.05.012

Tempe, (2015). *Pedestrian count report: FY 2014-2015*, http://www.downtowntempe.com/_files/docs/spring-2015-ped-count.pdf [downloaded 7 June 2017]

Tschumi, Bernard (1994), *The Manhattan Transcripts*, London: Academy.
Wagnild, Janelle and Wall-Scheffler, Cara M. (2013), 'Energetic consequences of human sociality: Walking speed choices among friendly dyads', *Plos One*, 8: e76576. doi:10.1371/journal.pone.0076576

Wilkinson, Laura. L., Elanor C. Hinton, Stephanie H. Fay, Peter J. Rogers and Jeffrey M. Brunstrom (2013), 'The "variety effect" is anticipated in meal planning', *Appetite* 60: 175-179. http://dx.doi.org/10.1016/j.appet.2012.10.001

A Sustainable Solution? Arguments for Nuclear and Renewable Energy in the Hungarian Expansion Debate

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Abstract

Hungary's energy policy dictates the increase of renewables and the maintaining of nuclear capacities. The reactors in the country's only nuclear power plant can operate until the 2030s, which prompted the discussion about the expansion. In the first part of this paper, the metho dology of *topos* analysis is used to identify the most common topics in the argumentation of selected political, environmental protectionist and scientific/expert discourses. The extent to which nuclear and renewable energy production can be considered sustainable is a relevant ethical question. In the second part, we analyse the arguments about sustainability in favour of both nuclear and renewable energy. We examine how sustainability is linked to the concern for future generations and how these two considerations are conn ected to the other *topoi* of the debate. The results show that it is economic risks and benefits that characterise the debate about the expansion, not the requirement of sustainability.

1. Introduction

Sustainability is a definite requirement when deciding upon an energy policy. However, it is not straightforward what the term indicates. Arguments about sustainability are present in favour of nuclear as well as renewable energy production. This duality can be observed in the national energy strategies of various European countries. Germany set out to increase renewable energy sources to guarantee half of their electricity supply by 2030 (International Energy Agency 2013a). Although France has the largest number of nuclear reactors in Europe, they are still planning to have reduced the share of nuclear energy to 50% by 2025 with investments in renewables and energy efficiency (International Energy Agency 2016).

Although Finland is planning to renew their nuclear capacities, they set out to increase the ratio of renewable energy to 38% by 2020 (International Energy Agency 2013b). Slovakia aims to maintain a 50% share with new reactors (International Energy Agency 2012).

There are four nuclear reactors currently operating in Hungary's only nuclear power plant in the city of Paks. The approaching decommissioning prompted the discussion about the expansion of the power plant (named Paks 2) and the country's future energy policy. The objective of the National Energy Strategy is to decrease the ratio of fossil energy production by having increased renewables to 16-20% by 2030, and to maintain the 50% ratio of nuclear energy with the expansion (International Energy Agency 2017). However, certain political parties, environmental protectionists and experts argue for an even higher ratio of renewable energy production and a nuclear phase-out.

The debate surrounding the expansion is structured by the following questions about nuclear energy and renewable energy sources (henceforth RES):

Which mode of energy production could bring supply security and would make the country more competitive? Which would create more jobs and how high would electricity prices be? Would

investing in renewables cost more than the expansion of the power plant? Are renewables safer and cleaner than nuclear energy? How does the commitment to either nuclear or renewable energy production conform to international trends? Should Hungarians be worried about Russia as a contractor and creditor for the new reactors? Does the public support the expansion of the power plant or do they prefer renewable energy production? Which mode of energy production is sustainable and why?

This paper analyses the arguments about sustainability for Hungary's new nuclear reactors and renewable energy sources in political, environmental protectionist, scientific and expert discourses. We aim at exploring how the Hungarian Government, the green political party, LMP, Greenpeace, the Hungarian Academy of Sciences and Energy Club, an expert policy institute refer to sustainability and discuss the different aspects of it. The results of our *topos* analyses of nuclear and renewable energy suggest that sustainability is a marginal consideration in the Hungarian energy debate, which is centred around being economical.

2. Prevalent topics in the Hungarian nuclear energy debate

Topoi, in the rhetorical tradition, mean 'places' from which arguments are developed and are considered the subject-matter indicators of argumentative discourse. Speakers and writers can take *topoi* into account in the process of finding arguments (Culler 2015; Eriksson 2012; Rubinelli 2009; van Eemeren 2010). We carried out two separate *topos* analyses in order to show what subject-matters are the most prevalent in the discourse about the Hungarian nuclear expansion. The first *topos* analysis concerned the arguments about the expansion and nuclear energy (Egres-Petschner in press). In this paper, we contrast the result of our previous study with a second *topos* analysis in which we studied the arguments pertaining to RES in the same research corpus.

For both *topos* analyses, we examined all the articles that mentioned the expansion from 2009 (when the Parliament voted the provisional acceptance) until March 2017 (when the European Union gave permission to the construction) from the official websites[1] of the following actors. For political bodies, we chose the pro-expansion Hungarian Government (N = 111) and the green political party named LMP (N = 184). The environmental protectionist group Greenpeace (N = 38) has been campaigning for RES in Hungary, and so has the NGO turned policy institute called Energy Club (N = 69). To contrast this expert organisation, we selected the Hungarian Academy of Sciences (N = 10), which did not communicate a unified stance on the issue.

Our initial classification of *topoi* was based on previous literature (Gamson-Modigliani 1989; Kristiansen 2017; Sarlós 2014; Schweitzer 2013; Ylönen et al. 2015) and our familiarity with themes in political, media and public discourse. The list of *topoi* was refined in an iterative process. The analysis resulted in the following eight *topoi* which we found the most common in the selected discourses about the nuclear expansion: economy, finance, energy supply, safety, environment, legality, ethics and international politics[2] (Egres-Petschner in press). These *topoi* essentially cover the list of questions we mentioned in the Introduction. We first overview the

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1   Websites of the collected articles: http://www.kormany.hu/hu/hirek (articles are accessible only after 2014), http://lehetmas.hu/hirek/, http://www.greenpeace.org/hungary/hu/hirek/, https://www.energiaklub.hu/hirek, www.mta.hu/hirek

2   The **topos** of international politics was named 'Relationship with Russia' in our previous study.

topoi and what they encompass, then compare the ratio of *topoi* regarding the two modes of energy production in the Hungarian debate.

The *topos* of economy concerns the competitiveness of the country, the prospective change in electricity prices, employment, and how investing in either mode of energy production can result in the distortion of competition.

Within the *topos* of finance, we counted investment and further (including unexpected) costs, the risk of corruption, the amount and conditions of the loan the country took out from Russia in order to finance the expansion. The *topoi* of economy and finance are separated in the sense that the latter concerns decisive issues up until the new reactors begin functioning.

The *topos* of energy supply encompasses supply security and whether the two modes of energy production can serve the changing energy demands. The country's geographical factors are also considered in the case of RES.

The *topos* of safety includes the risks of accidents, incidents and intentional damage.

Within the *topos* of environment, the problem of radioactive waste disposal, the usage of the Danube's water for cooling the reactors down and the rate of CO_2 emissions for climate protection are listed.

Within the *topos* of international politics, we considered how the country should follow the international trends in energy production (both nuclear and renewable are referenced as such), and the implications of Hungary's political ties to Russia and Rosatom as the contractor for the new reactors.

For the *topos* of legality, we collected the arguments about the legitimacy of the plans and regulations. Actors justify whether the project should proceed based on the legitimacy. Within the *topos* of ethics, we considered arguments that relate to parties discussing if political, expert and public debates occurred and supported the expansion. Arguments about sustainability and the consequences of nuclear and renewable energy production have on future generations also belong to the ethical aspect of the issue.

Figure 1. shows the ratio of *topoi* regarding nuclear energy and the expansion of the nuclear power plant. Similarly, Figure 2. details ratio of arguments about RES in the same research corpus.
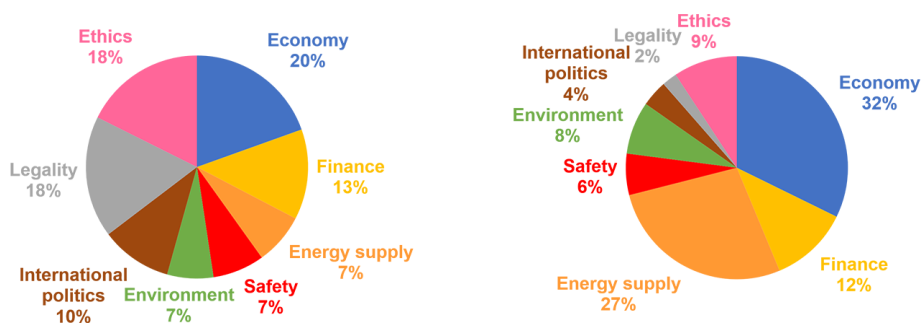

Figure 1. The ratio of topoi in relation to nuclear energy and the expansion of the nuclear power plant

Figure 2. The ratio of topoi in relation to renewable energy sources

3. Debating sustainability

In the classification of the arguments pertaining to sustainability, we proceeded from the definition given at the preamble of the Hungarian National Strategy: '*Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs.*' (Ministry of National Development 2012; United Nations General Assembly 1987). In our interpretation, the concern for future generations is an ethical issue, and therefore we categorised the arguments for sustainability under the *topos* of ethics.

In a close reading of the arguments about sustainability in the actors' discourses, we firstly differentiated between those that explicitly mentioned the word and those that did not but referenced the effect on the future or future generations. Secondly, we made a distinction between arguments that appeared in the text separately and those that were tied to other topics, such as the economic or the environmental aspects of the expansion.

The results show that the Hungarian Government only employed arguments in favour of the expansion that explicitly included the word 'sustainability' (*"with the expansion of Paks nuclear power plant Hungary opted for a sustainable energy source"*) and did not refer to future generations.

Conversely, LMP, Greenpeace and Energy Club predominantly opposed the expansion with arguments invoking the future (*"the case of the planned construction affects the whole population and also the next generation"*).

The Hungarian Academy of Sciences presented a varied argumentation in terms of referencing sustainability and future generations, as well as linking sustainability to another topic (*"nuclear energy industry is currently not sustainable [...] however, if we use every uranium isotope, the resources would last for at least 10 or maybe 100 thousand years"*) When the actors who oppose the expansion specify (un)sustainability, there is rarely any mention of other topics. However, when discussing the consequences future generations will need to bear, a variety of topics are also present in the proximity of the identified arguments. Examples include:

- *"the decision which has an impact on our grandchildren risks the country's sovereignty"* (LMP)
- *"this new regulation gives the green light to an energy source which is a threat to the country in the next 60-70 years"* (Greenpeace)
- *"it is not just us who will pay the cost of the new reactors, but our children and also our grandchildren, furthermore, with interests"* (Energy Club)

Although the Government would not deny that RES are, in some respect, sustainable, they only employed 'sustainability' in favour of the new nuclear reactors. In our research material which only discussed renewables *in relation* to the expansion, we could not identify any arguments about RES in the texts of the Government and the Hungarian Academy of Sciences.

The argumentation of Greenpeace for RES was solely about sustainability and never about future generations, furthermore, they did not make any references to the other topics of the issue.

It is true for LMP and Energy Club as well that arguments about sustainability and future generations appeared both with and without other topics:

- *"we have to adopt the development of a decentralised and renewable alternative energy source because of nation's and our children's future"* (LMP)
- *"a system using renewable energy sources also takes sustainability into account"* (Energy Club)

4. Concluding remarks

There are various definitions of sustainability, one of which is undoubtedly more complex than the one referenced in the previous section. The three spheres of sustainability (Rodriguez et al. 2002) touch upon the environmental, economic and social aspects as well. By considering the economic sphere, it could be debated that the arguments categorised into the *topos* of economy could count as arguments about sustainability. However, the term sustainability barely appeared in connection with the other identified topics in the research material, therefore, we have no reason to believe that the examined actors specifically meant the three spheres.

Based on the *topos* analyses, we concluded that economic risks and benefits characterise the debate, and not the requirement of sustainability. The argument about sustainability is present on both sides of the controversy: those in favour of expanding the nuclear power plant argue that nuclear energy production is sustainable, and those opposing the expansion argue the nuclear is not, but renewables are sustainable. Therefore, the answer as to which energy policy is sustainable is not unequivocal. The debate should centre around discussing which mode of energy production is *more* sustainable according to which sphere (environmental, economic, social) and how we should prioritise them to get us closer to a sustainable future.

Acknowledgements

Bibliography

Culler, Connie (2015), 'Good Works: The Topoi of Corporate Social Responsibility in the Travel and Tourism Industry' (Doctoral Dissertation), retrieved from the University of Central Florida, STARS, http://stars.library.ucf.edu/etd/1449/ (downloaded 29 June 2018)

Egres, Dorottya and Anna Petschner (in press), 'The Paks Pact: *Topoi* in Hungarian Nuclear Energy Discourse' Under review, submitted In: *Controversies and Interdisciplinarity*, Controversies. Ethics and Interdisciplinarity, Ed. by G. Scarafile. Amsterdam: John Benjamins Publishing Company)

Eriksson, Anders (2012), 'Argumentative *Topoi* for Refutation and Confirmation', in van Eemeren, Frans H. and Bart Garssen (Eds.), *Topical Themes in Argumentation Theory: Twenty Exploratory Studies*, Dordrecht, Netherlands: Springer.

Gamson, William A. and Andre Modigliani (1989), 'Media Discourse and Public Opinion on Nuclear Power: A Constructionist Approach', *American Journal of Sociology* 95 (1): 1-37.

Kristiansen, Silje (2017), 'Characteristics of the mass media's coverage of nuclear energy and its risk: A literature review', *Sociology Compass* 11 (7): 1-10.

Rodriguez, Sandra I., Matthew S. Roman, Samantha C. Sturhahn and Elizabeth H. Terry (2002), *Sustainability Assessment and Reporting for the University of Michigan's Ann Arbor Campus*, Report No. CSS02-04, Center for Sustainable Systems, University of Michigan. http://css.umich.edu/sites/default/files/css_doc/CSS02-04.pdf (downloaded 29 June 2018)

Rubinelli, Sara (2009), *Ars Topica: The Classical Technique of Constructing Arguments from Aristotle to Cicero*, Dordrecht, Netherlands: Springer Netherlands.

Sarlós, Gábor (2014), 'Risk and Benefit Perceptions in the Communication Narratives of Nuclear Energy in Hungary' (Doctoral Dissertation), retrieved from Eötvös Loránd University, Budapest, http://tatk.elte.hu/file/Gabor_Sarlos_dissertation.pdf (downloaded 29 June 2018)

Schweitzer, Julie (2011), 'Media Framing of Nuclear Energy in France Before and After Fukushima' (Master's Degree), retrieved from https://shareok.org/bitstream/handle/11244/11122/Schweitzer_okstate_0664M_12701.pdf?s e (downloaded 29 June 2018)

van Eemeren, Frans H. (2010), *Strategic Maneuvering in Argumentative Discourse: Extending the Pragma-dialectical Theory of Argumentation*, Amsterdam, Netherlands: John Benjamins B.V.
Ylönen, Marja, Tapio Litmanen, Matti Kojo and Pirita Lindell (2015), 'The (de)politicisation of nuclear power: The Finnish discussion after Fukushima', *Public Understanding of Science* 26 (3): 260-274.

References
International Energy Agency (2012), *Energy Policies of IEA Countries: The Slovak Republic 2012 Review*, http://www.iea.org/publications/freepublications/publication/Slovak2012_free.pdf (downloaded 29 June 2018)

International Energy Agency (2013a), *Energy Policies of IEA Countries: Germany 2013 Review*, https://www.iea.org/publications/freepublications/publication/Germany2013_free.pdf (downloaded 29 June 2018)

International Energy Agency (2013b), *Energy Policies of IEA Countries: Finland 2013 Review*, http://www.iea.org/publications/freepublications/publication/Finland2013_free.pdf (downloaded 29 June 2018)

International Energy Agency (2016), *Energy Policies of IEA Countries: France 2016 Review*, https://www.iea.org/publications/freepublications/publication/Energy_Policies_of_IEA_Countries_France_2016_Review.pdf (downloaded 29 June 2018)
International Energy Agency (2017), *Energy Policies of IEA Countries: Hungary 2017 Review*, http://www.iea.org/publications/freepublications/publication/EnergyPoliciesofIEACountriesHungary2017Review.pdf (downloaded 29 June 2018)

Ministry of National Development (2012), *National Energy Strategy 2030*, http://2010-2014.kormany.hu/download/7/d7/70000/Hungarian%20Energy%20Strategy%202 030.pdf (downloaded 29 June 2018)

United Nations General Assembly (1987), *Report of the World Commission on Environment and Development: Our Common Future. Transmitted to the General Assembly as an Annex to document A/42/427 – Development and International Co-operation: Environment,* http://www.un-documents.net/ocf-02.htm (downloaded 29 June 2018)