

Negotiating attachments to plastic

Social Studies of Science
2021, Vol. 51(6) 820–845
© The Author(s) 2021



Article reuse guidelines:
sagepub.com/journals-permissions
DOI: 10.1177/03063127211027950
journals.sagepub.com/home/sss



Lukas Sattlegger^{1,2} 

Abstract

Drawing on ethnographic research conducted in the office and warehouse of an organic wholesaler in Germany, this article presents a trans-sequential analysis of an innovation that aimed to reduce the use of plastic wrap. During the analytical reconstruction of the innovation process, the substitution of plastic wrap turned out to be a precarious process of negotiating attachments to plastic. Against this background, innovation is not simply about the implementation and substitution of technology by human actors, but about negotiating attachments that humans have towards objects within socio-technical assemblages. Drawing on actor-network theory and the sociology of attachment, the article highlights the dynamic interplay between persistence and problematization of plastic wrap, which characterizes the innovation process. This interplay is seen along several steps during the innovation process: from (1) the problematization of plastic dependency to (2) the mobilization of alternatives, to (3) resistance against measures to be implemented and (4) the enforcement of reusable strings as technological substitution and (5) to conclusive retrospection on the innovation process. The trans-sequential analysis shows that ‘getting rid of something’ might be an imperfect approach to dealing with unsustainable object relations. Instead, withdrawing is a double-sided process of detaching and attaching, removing constraints and building new ones.

Keywords

plastic packaging, attachment, actor-network theory, trans-sequential analysis

¹ISOE – Institute for Social-Ecological Research, Frankfurt, Germany

²Goethe–University Frankfurt/Main, Germany

Corresponding author:

Lukas Sattlegger, Institute for Sociology, Department of Social Sciences, Goethe-University Frankfurt/Main, Theodor-W.-Adorno-Platz 6, 60323 Frankfurt/Main, Germany.

Email: sattlegger@isoe.de

Introduction: Withdrawing from unsustainable object relations

Since the 1950s, plastic packaging has become part of the organization of food supply in Western countries, and today plays a decisive role in how we produce, transport, store, buy and sell food (Cochoy, 2007; Hawkins, 2018; Phillips, 2016; Sattlegger, 2021). Through practices like layering, bundling, storing and displaying, plastic packaging has enabled new types of products (e.g. ready-made meals), shop concepts (e.g. self-service supermarkets) and expanded supply chains (Sattlegger et al., 2020). Packaging determines the presentation and assessment of products and is a crucial factor in the organization and evaluation of work practices and supply chain logistics (Sattlegger, 2021). However, in recent years, the recognition of the ecological challenges of plastic pollution and marine litter has problematized plastic packaging and other single-use plastics (Kramm and Völker, 2018). In this process, packaging has been transformed from a black-boxed tool into an epistemic object that demands attention and work by human actors (Knorr-Cetina, 1997; Miettinen and Virkkunen, 2016). Importantly, the negotiations between packaging as a useful and ubiquitous tool and packaging as a social-ecological problem are challenging and conflictual (Hawkins, 2012, 2020). For exploring the potentials of packaging waste reduction and promoting a sustainable transformation of packaging use, it is crucial to understand the concrete processes of negotiation in the contestation of plastic packaging.

Beyond my interest in the practical aspects of barriers against plastic reduction, the article aims to enrich sociological debates on ending unwanted object relations in everyday practices, especially those considered as unsustainable. For Offe (2019), modern societies and their ever-growing production of options have generated problems of coordination and compatibility, which led to rigidity instead of changeability. While ever faster in generating options and things, societies are often paralyzed by the exigency to reduce or step back from unsustainable options. Studying concrete processes of doing away with something helps to better understand the difficulties of withdrawal and the resulting affordances in transformations towards sustainability (Le Velly et al., 2020). Although practices such as retracting and delimiting are central concepts in discourses of degrowth economy, sufficiency, or the anthropocene, there is still a lack of empirical work on how to eliminate (material) dependencies in concrete practices (Hawkins, 2020; Le Velly et al., 2020; Speck, 2016). Acknowledging this research gap, the concept of exnovation (Kropp, 2015) was introduced as a concept for studying the withdrawal of unsustainable technologies. Studies on exnovation focus mainly on the interplay between innovation and exnovation during different phases of transformation processes (David, 2015). This implies that the introduction of renewable energy (innovation) must be linked to the rejection of fossil fuels (exnovation). However, in the literature dealing with this topic, the problematization of unsustainable and habitual dependencies to materials or objects like fossil fuels, cars, airplanes, meat or plastics is rarely done in a way that takes the interplay between human and material agency seriously. Instead, the focus is mainly on political governance and organizational management of such innovation cycles. Science and technology studies (STS) and actor-network theory (ANT) (Latour, 1996, 2007) provide theoretical concepts to study the

'socio-technical assemblages' (Çalışkan and Callon, 2010) that structure such negotiations of the interrelation between people and things.

Analysing socio-technical change via ANT has foregrounded the interplay between strategies and tactics of human actors and the performance of things and objects. Acknowledging that agency is not bound to human behaviour, but distributed in assemblages of human and non-human actors, ANT allows grasping objects as actors that define practical procedures and path-dependencies. While ANT can shed light on the conflictual and non-linear trajectories of such negotiations, it has been criticized for its actor-centrism (Nicolini, 2010). Especially when it comes to routines and non-intentional processes, ANT loses some of its explanatory power (Hultin et al., 2020). Shifting the focus from intentional actions to the flow of practices, the 'sociology of attachment' (Gomart and Hennion, 1999; Hennion, 2017) is a reaction to these criticisms. The concept of attachment encourages the highlighting of situations and processes, rather than actors. Especially in the problematization of established technologies (like plastic packaging), withdrawal is not so much a question of successful translations of interests, but one of redefining relations to these technologies (Hawkins, 2020). Accordingly, innovation is not the implementation of something new, but a relational process of negotiating attachments to, and also detachments from, technology. In current literature, such attachments and detachments to technologies are mainly discussed as consumer-product attachments, including an analysis of the role of marketing and product design in affecting these attachments (Cochoy et al., 2017). However, negotiating attachments to technology is also an inseparable part of everyday work practices that are dealing with these technologies (Janssen et al., 2015). I want to contribute to the emerging discourse on attachment and detachment by highlighting the importance of material attachments in habitual work practices.

Based on these theoretical considerations, the article presents an ethnographic study of an innovation process for the reduction of plastic waste at an organic wholesaler in Germany. The central epistemic object in the innovation process (as well as in this sociological study) is a plastic wrap used for securing pallets of empty containers. Workers use the wrap to merge and stabilize returned containers for turning them into units that can be better handled and returned to the beverage company. In the course of a corporate campaign for plastic reduction, 'step by step plastic free', the company managers problematized the use of the wrap. They initiated an innovation process in order to replace the wrap by a reusable string. However, efforts at omitting and supplanting the wrap encountered difficulties and resistance that the managers did not expect, making several practical adaptations necessary. In a trans-sequential analysis (TSA) of the process, I show how attachments to plastic wrap hinder an easy replacement. TSA provides a methodological approach for studying dynamic object relations in everyday work practices (Scheffer, 2013, 2018a). Reconstructing the concrete steps and turns in the innovation process, plastic reduction appears as a complex and precarious undertaking. The innovation process for 'step by step plastic free' was not running smoothly, but was staggering on a tortuous path of uncertainty. In the presentation of findings, I use the 'step by step' metaphor to reconstruct the complexities, turns, obstacles and success factors that were largely flattened in the company's presentation of this path towards plastic reduction.

Theoretical approach: Innovation as negotiation of attachments

Innovation and technological change (for an overview see Ramella, 2019; also Blättel-Mink et al., 2020) are bound to technology use in everyday work practices. Studies in workplaces (Suchman and Bishop, 2000; Suchman et al., 1999) have shown that technology's materiality sets constraints and affordances for use that are not easy to foresee. These constraints and affordances demand the adaptation of practices and potentially push practice in one direction rather than another: 'Technologies also resist, in the sense that they do not allow users to do whatever they want. However, the fact that technologies resist does not mean that users are at the mercy of the technology, only that they must adapt their practices accordingly' (Leonardi and Barley, 2008: 163f). In this light, a reusable string is not only a substitute for a single-use plastic wrap, but a different way of dealing with packaging. Designers and promoters of technologies cannot predict or control such practical implications of technology use (Wajcman, 2006). Instead, as a mundane innovation, an alternative packaging technology must prove itself in practice (Cochoy, 2009).

I am drawing on actor-network theory (ANT) to conceptualize the innovation process as a socio-technical assemblage that connects heterogeneous human and non-human actors including workers and plastic packaging (Çalışkan and Callon, 2010). For ANT, innovation is not the result of an evolutionary determinism nor is it the product of ingenious inventors. Instead, it is the outcome of dynamic alliances between humans and objects. ANT helps to reveal how various actors compete for the power to frame processes and practices in heterogeneous practices of mobilization and resistance, internalization, and externalization. 'Framing' stresses the contested process of including, excluding, untangling and structuring object relations (Callon, 1998, 1999). Power and determination in these processes is exerted by the ability to mobilize associations (Latour, 1984). Via practices of translation (Callon, 1984), actors build networks of associations to stabilize or change certain assemblages. This means that innovation processes are a dynamic product of conflictual negotiations of connections between several actors. It is important to point out that analysing such negotiations must not be restricted to central delegating agents (such as company managers and engineers) but needs to highlight the often invisible work of more marginal actors (human and non-human) that enable successful innovation (Star, 2016). ANT has inspired innovation researchers to study socio-technical negotiation processes regarding work organization (Harrisson and Laberge, 2002), product innovation, (Jarrahi and Sawyer, 2019; Weaver and Lahtinen, 2011) and infrastructural development (Kjellberg, 2010) in different fields such as health care and digitalization. While ANT studies are powerful in explaining how the distributed agency originating from such negotiation processes stabilizes certain networks, their actor-centred approach has the danger of focusing too much on central actors and their actions. The focus on actors makes it difficult to study the more subtle and unintentional processes of translation in everyday work practices (Hultin et al., 2020; Nicolini, 2010). As a reaction, post-ANT studies distance themselves from delimiting central actors and rather focus on the flow of mundane and situated practices. Abandoning the idea that behind every action there is an assumed actor, they focus on the 'ongoing flow of

practices inheriting conditions of possibility from prior actions and imparting conditions of possibility to subsequent actions' (Hultin et al., 2020: 3). Drawing on the non-actor-centric vocabulary of Ingold (2007, 2010), Hultin et al. (2020) have developed a de-centred theoretical perspective on the translation of management ideas. The focus shifts from intentional doings to attentional undergoings: 'actors do not act, as such; it is the flow of action that acts them' (Hultin et al., 2020: 13). The sociology of attachment introduced by Gomart and Hennion (1999) reconciles such considerations with ANT terminology. 'Attachment' (Gomart and Hennion, 1999; Hennion, 2017) emphasizes the hybridity and inseparability of human-object relations in technology. Expressing the duality of making and being made in relationships to objects, the term highlights a specific form of connection between material objects and human actions, which blurs the allocation of agency. When studying attachments, the focus shifts from 'who acts?' to 'what occurs?' (Gomart and Hennion, 1999: 225) and the oppositions between active and passive or past and present become blurred (Hennion, 2017).

The concept of attachment has been developed through the sociological study of drug addiction and musical passion. Gomart and Hennion (1999) describe addiction and passion as an attachment between humans and objects that is characterized by the combination of acting and being affected. In her article about a methadone program in a French clinic, Gomart (2004) describes the change of perspective initiated by a non-deterministic perspective on addiction. Refusing the idea that only clean people are treatable, she shows how methadone can be an element of a technique for acting with the drug user instead of excluding him/her from treatment. Through the lens of attachment, users not only need support once they have stopped taking drugs, but especially when taking drugs. With the possibility of substitution, treating addiction is not a question of either/or, but of stabilizing attachments between people and drugs. Consequently, allowing humans to act entails influence, seduction and multiple constraints, other than withdrawing constraints, which is the traditional way of addiction treatment by drug withdrawal. For the case of music amateurs, Hennion (2010) shows how taste is a reflexive practice, rather than being determined by the social origins of the fan or by the aesthetic properties of the songs. Musical passion is not an individual choice nor simple the consequence of social causes, but is constantly redefined in the interplay of subjects and bodies with specific objects and procedures. Practices such as playing, listening or recording music are not the consequence of a musical taste that is already there; rather, taste itself is a reflexive performance, being simultaneously a cause and result of these practices. Accordingly, beauty and pleasure are neither inherent to the music nor to the listener, instead taste is discovered and developed in relational and reflexive practices.

For ANT-inspired innovation studies, the concept of attachment allows for highlighting the bounded agency of human actors in the negotiation with objects. Human actors are not only part of interconnected networks of human and non-human actors, but their agency is situated within these socio-technical assemblages. Accordingly, innovation becomes a matter of ongoing negotiation with material technology and is an inseparable part of everyday practices. A sustainable and intentional shift of object relations needs to consider existing attachments and recognize their constraints and possibilities. Accordingly, socio-technical change and innovation are more likely when existing object attachments are mobilized rather than denied (Hawkins, 2020; Le Velly et al., 2020).

The evolution of attachment has unpredictable and surprising dynamics. Hence, socio-technical change cannot be foreseen, controlled or planned from scratch but involves experimenting and engaging with concrete technologies. Innovation then is not the consequence of the material properties nor caused by human valuations of technology. It is a reflexive and relational process, enacted in the practical interplay of people and things. The concept of attachment allows for portraying technologies and tools as merged in habitual work practices. Hence, the problematized plastic is not simply an exchangeable tool; it co-constitutes the practice of securing pallets. It is important here that attachment does not mean that there are no actors; rather, it allows the highlighting of constraints on acting. Attachments do not free humans from deciding which relation should be transformed and which should be left alone. Hence, innovation is a matter of navigating responsibility and the capacity to act in recognition of attachments. As the boundaries and functioning of technologies are ambiguous and fluid rather than clear-cut (De Laet and Mol, 2000), success and failure are not distinct categories but part of the negotiation process.

Negotiating object relations for the transformation of unsustainable material dependencies means detaching from connections that are hindering innovation, while acknowledging attachments that are crucial for innovation (Le Velly and Goulet, 2015). The importance of examining detachment (Candea et al., 2015) as an essential counterpart of attachment was recently stressed by studies on market innovation, which focus on the ending of certain practices (Goulet and Vinck, 2012) or technologies (Hawkins, 2020), the competition between practices (Le Velly and Goulet, 2015) or the confinement of determinants for human actions (Harvey and Knox, 2015). Acknowledging the interdependency of attachment and detachment in innovation research emphasizes several factors:

First, existing attachments to technologies (e.g. plastic packaging) follow socio-technical path dependencies. They are sticky, binding and hard to overcome, even when they are not satisfying for human actors (Le Velly et al., 2020). Hence, abolishing single-use plastics is not a question of willingness alone, but means dealing with existing material constraints and path dependencies (Sattlegger, 2021).

Second, detachment from certain entities generally requires new attachments to other entities. Withdrawing unwanted elements of socio-technical assemblages affords the inclusion of new entities that are more desirable. For example, replacing single-use packaging by reusable packaging allows distinct forms of care, which disqualify plastics as single use or disposable and requalify them as reusable, replaceable or completely unnecessary (Hawkins, 2020: 12).

Third, detachment processes are always partial and human actors cannot control them totally. Innovation is not about opposing a bad attached world by a good detached one, but it is about reconfiguring the interplay of attachments (Le Velly et al., 2020). To stay capable of acting in a network of complex attachments and responsibilities, human actors have to detach themselves partially from certain responsibilities, uncertainties and contextual factors (Harvey and Knox, 2015). For example, replacing single-use by reusable packaging is dependent on other actors in the supply chain and therefore needs situational adaptation and flexibility.

I draw on ANT and the sociology of attachment to describe socio-technical change as a process of deconstructing and reconstructing connections, constraints and relations between humans and objects. Describing the substitution of plastic wrap as the negotiation of attachments is an attempt to provide more insights into the interplay between intentional actors and habitual attachments in the course of innovation processes. Such insights are crucial for understanding barriers against and possibilities for the withdrawal of unsustainable object relations in work practices and beyond.

Methodological approach: A trans-sequential analysis of the innovation process

This article reconstructs a process of negotiating attachments in a trans-sequential analysis (TSA) (Scheffer, 2013, 2018a) of an organic wholesaler's innovation project, 'step by step plastic free'. Originating in ethnomethodology, TSA is based on ethnographic observations of dynamic practical contexts such as procedures, debates or work processes. This is in line with the recent call to study innovations in the making and for unravelling complexities and controversies involved in their implementation (Hoholm and Araujo, 2011; Langendahl et al., 2016). TSA methodically reproduces these processes by focusing on social situations in which participants jointly create something. It combines a processual 'step by step' approach with a situational 'turn by turn' approach that analyses the presence of practical accomplishments (Scheffer, 2008: 368). This connection of intentional turns of actors in certain situations vis-à-vis a processual involvement of object relations fits well with my theoretical approach that focuses on the interplay between acting and occurring: The situational turns relate to the ANT-inspired analysis of conflictual negotiation processes while the processual steps allow for an analysis of progressing object attachments.

From one working episode to the next, actors make connections to carry forward what has already been done, discussed or decided. These connections are made through the mediation of objects (e.g. human bodies, sketches, texts, tools or work pieces) and make previous episodes relevant as necessary precursors to the current situation. In order to evaluate the practical relevance and permanence of observed situations, the researcher seeks to classify objects in a productive and symbolic context, which they equip, promote or integrate. That is, TSA studies the careers of objects to reconstruct the relevance of observed situations for the subsequent course of events. By portraying objects in their practical and symbolical connections and formations, TSA allows the observation of distributed and double-sided processes of object formation. It studies the mediating characteristics of objects that are simultaneously (a) formable, (b) to be formed and (c) have forming effects on the course of practices and procedures (Scheffer, 2013). Applying TSA, one starts by examining situations and their actors. The researcher asks for the ways in which actors continue to bring forward processes and productions in observed situations. In a second step, the researcher analyses the accumulated connections of a series of situations. In particular, the turns of actors accumulate in mediating objects, which stabilize and steer processes by changing the conditions for subsequent situations. In a third step, the analysis centres on the formative objects and their consolidations along the process. The formative object integrates once loose and multiple connected elements into a coherent and solid

form – a black box in ANT terms. Such processes of object formation have been studied in different settings: from the rise and fall of an alibi-story at court (Scheffer, 2003) to negotiations of an army order to kill (Scheffer, 2018b). Analysing the trans-sequential accomplishment of interlinked object formations facilitates an empirical disentanglement of observed processes. Having a series of situations, it becomes possible to study shifting objects relations in the course of the innovation process. That way, the ‘steps’ of the innovation process ‘step by step plastic free’ can be decrypted and analysed in reference to different ‘turns’ that reveal conflicting negotiations and powerful attachments to plastic.

My empirical analysis is grounded in ethnographic research that I conducted at an organic wholesaler in the summer of 2018 in Germany. With a forty-year history and more than 120 employees, the company has been involved in the infrastructuring of organic food supply in Germany. Relying on eco-friendly customers, the organic food sector is more strongly affected by the problematization of plastic and packaging waste than is the conventional food industry. In this situation, certain pioneering companies and associations for organic food have been pushing for a reduction of plastic waste in the organic food sector. This has resulted in guidelines for sustainable packaging (BÖLW, 2011) and service packaging in organic food stores (BNN, 2015). The amount of plastic used for transport and secondary packaging has not yet been captured by these guidelines, but has been increasingly problematized in recent years (Kröger et al., 2020).

Via an association for organic food, I got in touch with the wholesaler, which is working on a company-wide plastic reduction strategy. I offered my support as a researcher and volunteer to get access to the field and to investigate these undertakings. I specifically studied the problematization and replacement of a plastic wrap that was used for securing pallets in the warehouse. As part of a transdisciplinary research project, my research approach was designed around the handling of practical problems regarding plastic waste. Therefore, it connected observations and active involvement in the innovation process at different levels. This included working with the company managers on planning the campaign, supporting office workers on researching alternatives and accompanying warehouse workers in the implementation of new technologies. I participated in everyday work activities in the warehouse, to directly interact with the technology and become familiar with work requirements and specifications. In the course of my field stay, I created field notes memos and conversation recordings (see Breidenstein et al., 2015). Apart from one month of on-site-participation, the ethnographic research process included processes of joint preparations as well as follow-up activities and post processing. These communications via telephone and e-mail provided important supplementary data for the analysis. To get a broader view on plastic reduction in organic food supply, I conducted twenty interviews with key persons of the observed innovation process (managing director, warehouse manager) as well as with further representatives from food producers, the retail business, the packaging industry and the association for organic food. I anonymized all informants and modified some descriptive details to minimize personal traceability.

This article does not provide a fully external perspective, as I was an active participant of the innovation process. However, as a volunteer and researcher I did not have any official role with rights or duties, I did not earn any money and I did not make any commitments to the innovation process. Therefore, my involvement in the practical negotiations of

plastic reduction was part of my ethnographical interest. Nonetheless, I constantly had to balance my role as scientific researcher against my daily involvement and support of the innovation. This was challenging and not free from ambivalence (Breidenstein et al., 2015). For example, I had to mediate the ecological interest in plastic reduction, the sociological interest in unveiling innovation processes and the ethical responsibility of protecting research partners. I wrote this article being aware of these difficulties; the presented results take this ethnographical reflexivity into account (Eitel, 2019). Therefore, while I cannot claim objectivity or neutrality, I am convinced that my findings provide a multifaceted picture of the process, respecting personal involvement as well as theoretical interest.

‘Step by step plastic free’ – reconstructing the course of an innovation process

To reconstruct the evolving process of attachment and detachment, I organize the presentation along specific steps that took place in the course of the innovation process: from (1) problematization to (2) mobilization, via (3) resistance and (4) enforcement to (5) retrospection. The demarcation of these steps is an analytical simplification and the observed innovation process has several overlaps and simultaneities. However, analysing the process along these steps allows a condensed presentation of difficulties and dynamics in the transformation of plastic use and unsustainable object relations.

Step 1: Problematization – proclaiming plastic dependency and withdrawal

Upon my arrival in the field, the ‘step by step plastic-free’ campaign was in the planning stage. My collaboration with the wholesaler and the process of replacement started with the co-construction of a communicable problematization of plastic use. The draft for the campaign’s leaflet outlined a problematic dependency on plastic packaging in food supply, including a presentation of side effects, consequences and treatment options. The following field note on negotiating the campaign’s problem description gives insight into the conflictual process of framing the plastic problem.

While Markus (the environmental manager) shows me the figures on the company’s plastic consumption, I overhear a telephone call between Sarah (the managing director) and a woman from the advertising agency that they have assigned to design the campaign. Sarah criticizes some aspects of the draft; she states that ‘presenting plastic waste as an old hat is the opposite of what I have said. We should focus on the problematic dependency of plastic packaging that also characterizes the organic food supply chain. We have nearly the same problems as the conventional sector and we have to communicate this default actively and self-critically to make matters urgent’.

While the advertising agency had created a story that presented the company at the forefront of ecologic pioneers who had already been tackling the plastic waste problem for a long time, Sarah proposed a different storyline, which connected a general plastic dependency in food supply to problematic plastic use in the specific practices of the company. Mobilizing specific attachments to single-use plastics (Hawkins, 2020), Sarah

argued for a narrative that admits the company's own shortcomings in order to make the societal critique more credible, while simultaneously blaming general shortcomings for preventing them from correcting their own deficits. This self-critical position is visible in the text of the final campaign-leaflet:

For forty years, the organic sector has been a pioneer in many environmental and nutritional areas. However, when it comes to packaging and plastic avoidance, we have followed the 'conventional' path towards more and more complex packaging, smaller containers and more packaged-to-go products. ... Together with our customers, let us ensure that organic also stands for sustainable and plastic-free packaging. (author's translation)

To propose a transformation, the leaflet resorts to public debates about plastic as well as to specific practices within the company. It accents the interrelation of the company's own innovation process to a societal process of plastic reduction in at least three different ways:

General and workplace-specific plastic dependency are co-constitutive: According to the campaign's storyline, society has a problem with plastic overuse (e.g. increasing plastic waste in the oceans), the organic food supply system has a problem with plastic overuse (e.g. trend to convenience and to-go-products) and the company itself has a problem with plastic overuse (e.g. securing pallets with single-use wrap). The campaign presents these problem levels as co-constitutive. Accordingly, there is a demand for simultaneous action at all these levels in order to overcome plastic dependency. Local waste reduction is thus directly related to a wider zero waste movement.

External and internal problem diagnosis are co-constitutive: The entanglement of societal and company-specific elements is also visible in the problem description. The campaign leaflet combines a scientific diagnosis of a problematic plastic usage (by citing a report on marine plastic and micro plastic) with a normative self-diagnosis of the company's own plastic dependency (by stating shortcomings and transformation goals).

Addressing an external and internal target audience: Finally, the managers point out to the co-constitution of general and specific plastic dependency with the campaign's target audience. When the campaign invites the reader 'to go down this transformation path together', this invitation is directed to customers and the public, while simultaneously addressing the company's own employees, to whom the company directors personally handed out leaflets.

Leaving the multi-dimensional diagnosis of plastic dependency, I turn my attention and analysis to the succession of one central innovation attempt, that is, getting rid of the plastic wrap that is used in the warehouse for securing pallets of empty containers. The campaign leaflet presents this attempt as the next important step of the innovation: 'Our next goal: the return of all empty pallets to our suppliers and the delivery of all palletized goods to our customers, takes place without wrapping'. This announcement marks the starting point of an innovation process towards the reduction and replacement of plastic wrap.

Step 2: Mobilization – establishing an alternative to plastic wrap

Once the managers had diagnosed and communicated the problem, it became necessary to start an implementation process by constructing and mobilizing a practical alternative. In my first meeting with Robert (the warehouse manager), he presented a clear picture of the replacement and my role in this process. Robert used my request for participant observation to get support in the mobilization of resources and actors necessary to bring forward the anticipated innovation. This was visible in his instructions: ‘That’s part of your research, isn’t it? To find out how employees assume the transformation. What criteria do they have and what is important to them?’ In his request, Robert combined an anticipation of innovative technologies – ‘search the internet for technological alternatives to the stretching wrap’ – to a recourse of existing work practices – ‘ask people how they do it, how often they wrap it, let them show you’. Robert did not ask me to find new solutions, but to implement and apply existing technologies: ‘I know five alternatives for the wrap, but now it’s a matter of choosing what is practical for us. It would help us a lot, if you can move this transformation process forward!’ Thus, as an external scientist, I was asked to help reconcile the ecological enterprise of plastic reduction and the plastic dependency of everyday work practices. As for the problematization, the mobilization of the treatment builds on connections that are external (anticipating available solutions) and internal (adapting practical circumstances) to the company. Both of these mobilization strategies involve recourses and imports from the campaign.

Building a supporting network for the substitution: Anticipating technological alternatives involved engagement with actors and objects outside the company. We used the plastic reduction campaign as a reference to connect with potential suppliers and informants. The availability and selection of these relationships affected the innovation process, as they brought up specific constraints and possibilities. When researching alternative technologies and obtaining quotes from providers, Robert and I figured out which characteristics were useful or obstructive for implementing a supplement for plastic wrap. Anticipating a solution involved drawing on different forms of knowledge practices (e.g. scientific expertise, online research, calling other companies, involving employees) and materials (e.g. searching for well-tried technological substitutes that can be tested as prototypes) (Çalışkan and Callon, 2010). External connections also provided a normative background for the implementation of reusable strings, which are associated with sustainability values.

Avoiding tempting situations in the company’s day-to-day activities: To allow a successful supplementation, we had to compliment the mobilization of technological alternatives by testing and adapting them in everyday work practices. This required an exchange with actors and objects that were directly involved in these practices. Robert contemplated the risk of internal opposition: ‘It’s clear that there’s skepticism. We have to find a solution that convinces everyone and that does not mean a lot of extra work in the warehouse. It certainly needs persuasion’. Therefore, Robert encouraged me to be in touch with the employees while different options were tested, as the employees influence the possible success or failure of implementing new measures (Süßbauer et al., 2019). Procuring a replacement means dealing with the object to be replaced, including the attachments

associated with it: What is the function of the wrap and how do employees use it? To better understand attachments to plastic wrap, I observed and engaged in the wrapping of pallets and talked to employees about this practice and potential variations. Moreover, I took part in the handling and transportation of the (wrapped) pallets and measured the amount and variation of wrap that was used. The supporting campaign helped to assemble actors in favour of the innovation. In particular, my involvement as an external supporter and the normative background of the plastic reduction campaign attracted attention and emphasized the urgency of this innovation goal. This enabled material (e.g. adapting tools and infrastructures) and knowledge-based (e.g. providing participation and learning possibilities as well as technological guidance) adaptations in the innovation process.

After gathering information through discussions and testing various options, we chose to order a reusable string (made of recycled plastics) as a replacement that was then to be systematically tested. We selected the string, because some beverage suppliers were already using the same string, because it was cheaper than the wrap and because its producers provided useful product information and guidance. Based on the experience of daily work practice, we accompanied the purchase of strings by the installation of hooks (to enable the collection of strings), the provision of information sheets and personal support of workers (to explain the application of the strings) and an appeal to use and reuse the strings. This combination of different supporting measures acknowledges the interrelation of heterogeneous constraints in the innovation.

Remarkably, the mobilization of reusable strings also affected the campaign. When Sarah (the managing director) passed by, seeing me testing alternative ways of securing pallets, she said: ‘We really need to record what you’re doing. Please tell Anna [a secretary] to take a picture of you’. This incident indicates that mobilization was not linear and one-directional, but characterized by multiple interactions between different forms of plastic replacement (e.g. corporate campaign and technological substitution). The shift from problem diagnosis to the tackling of unsustainable plastic use involved taking over some elements from the campaign while omitting others. In contrast to the campaign’s idea of abolishing the use of plastic, the technological enquiry about alternative materials was handled in a more open and flexible way, resulting in the ordering of strings made from recycled plastic. From the campaign narrative that presented the company as one consistent actor in a complex supply chain, the focus in the actual handling shifted to internal differences and constraints that affected the success of the innovation (Cochoy, 2009; De Laet and Mol, 2000; Star, 2016). The idea of a joint effort changed to a practical tinkering of constraints and options. As mobilized associations cannot be totally controlled and unified, they create vulnerabilities and risks of counter-mobilization (Le Velly et al., 2020; Scheffer, 2003).

Step 3: Resistance – refusal and practical failures

Notwithstanding their collaborative mobilization, the use of strings was contested and resisted. In various situations, employees challenged the diagnosis of plastic dependency, the idea of replacement and the selection of the strings. Importantly, this counter-mobilization was driven not only by human actors, but also fostered by the material

agencies of objects, including the substitutes (strings) and aids (e.g. hooks for collecting, written instructions) that were introduced in the course of the supplementation.

The workers' resistance and practical reasoning: Confronted with the instruction to participate in the change of work practices, employees in the warehouse verbally opposed the treatment plan on different levels. They formulated opposition to my and Robert's expertise: 'Some ideas are probably good, but a lot is not practicable'. They questioned the suitability of the proposed substitute: 'It's not properly secured with the string', 'The string is not stable enough'. They challenged the commensurability of the treatment: 'I know many warehouses, wrap is used everywhere, by using the trolleys we have already reduced lots of plastic anyway'. They doubted their own responsibility: 'If you want to change something, you have to talk to Alvin [foreman]. Who knows how long we'll work here in the empties warehouse'. They disputed the commitment and participation of other actors: 'It's hard when someone's been doing this for 20 years. Then he is not interested in anything that could be done better', 'You see, he still does it that way ... we want to do everything well, but if he does it that way'. Moreover, they criticized lacking resources for the treatment process: 'I have to work now, I want to go home on time – I can't talk for two hours about strings for securing pallets'. Moreover, opposition was not always verbalized directly. For example, employees agreed to do something without actually doing it, or gave evasive, brief and vague answers to questions and suggestions. Employees repeatedly delayed the treatment process by postponing their participation: 'Put it in the warehouse, I'd like to try that tomorrow'. Furthermore, their non-compliance manifested itself in ignoring me as a handling adviser: I sometimes felt like an intruder and nuisance who disturbed the situation, as some workers were very reserved towards me and not open to involving me in work practices and innovation processes. Finally, resistance took the form of the non-integration of colleagues in practices and decisions: By not fulfilling his role as foreman in support of the innovation process, Alvin caused a lack of agency that could not easily be made up for. It is important to consider that obedience and resistance are not mutually exclusive, but coexist in practice (Scheffer, 2018b). Verbal opposition need not indicate disagreement, but can be a sign of uncertainty or of being overworked. In addition, expressing agreement can hide tactics of resistance and purely be aimed at a successful and suitable conversation. To understand resistance, it is not enough to look at direct refusal or disregard by human actors. It is important to reconstruct attempts and failures in the adaptation of everyday work practices.

Resistance caused by practical failures and obstinacy of the strings: The interplay of technological constraints and workers' practical competences and habits caused difficulties that hindered the normalization of string use. One central problem was the tangling and knotting of strings when being collected and reused by employees. The strings were very recalcitrant when it came to bundling and unbundling them. Installing hooks and giving instructions for appropriate use (e.g. always hanging the strings with the knots upside down and taking them from the hook carefully) should keep the strings from becoming tangled, but their tendency to tangle was hard to control for the managers or workers

involved. The stubborn and untamable agency of strings stood in opposition to their successful application, as the following episode illustrates:

I notice that Maike leaves the pallets unsecured when operating them. Obviously, she leaves the task of securing them to Alvin. When he comes back with the forklift to take away the pallets, he enters the warehouse and takes collected strings from the hook. ... With the third pallet being secured this way, the strings start to tangle up when Alvin takes them off the hook. I join him and ask if there is any problem. Alvin answers annoyed: 'This is the biggest crap you can imagine'. He starts pulling on the strings, so that they knot more and more. Frustrated, he leaves empty handed while I try to untangle the strings. Subsequently, Maike (who observed the scene) comes across telling me that the same problem occurred the day before: 'Yesterday he pulled them out and then the strings knotted. Then he took the whole bundle like this [Maike gesticulated with her hands] and threw it down on the floor where they stayed until this morning and until I hung them up again. He was really annoyed.

The strings became tangled while being used, their material characteristics causing trouble because of how they were handled by employees and because of the infrastructure used for their collection. Reuse affords consistent care on the part of the workers and that is a difference to the handling of single-use plastic wrap, which is appreciated as a flexible and easy solution that has become normalized in multiple attachments (Hawkins, 2020). Moreover, plastic wrap has been proven to function in practices exceeding the direct contact and assessment of employees. Hence, even when the problem of tangling was solved, the employees' doubts about the stability of strings in pallet transportation remained an obstacle.

Summing up, practical difficulties and verbalized resistance were connected in the contestation of the innovation. Difficulties in the practical adaptation of practices prompted a resistance aiming to maintain self-control and perhaps reduce feelings of personal failure; this verbal opposition aggravated existing practical problems. Analysing the instances of resistance shows cumulative and habitual interrelations between actors and objects that exceed the observed situations: criticizing the managers' lack of practical expertise or the obstinacy of the foreman entails experience of hierarchical organization. The employees' refusal to get involved in (in their opinion) exaggerated sustainability goals related to rigid work assignments and normalized plastic use. Practical problems of adaptation and a lack of support, agreement and clear responsibilities led to a gradual relapse into the use of plastic wrap. Being a contested and precarious process, the innovation needed continuous modification of constraints (Le Velly et al., 2020).

Step 4: Enforcement – pushing through the technological replacement

In this critical state of the innovation process, I talked to Robert about possibilities for promoting the wrap replacement. I told him that I noticed a lack of clarity (the warehouse workers criticized the absence of clear guidelines and responsibilities) that led to a virtual stalemate. Robert agreed with my assessment and announced a change in management practices. He proposed going to the warehouse with me to give clear instructions to the employees: 'Apparently the bottom-up democratic process doesn't work

here anymore'. When we had gathered the employees, Robert explained: 'renouncing disposable plastic is company policy, which we communicate to our customers. Therefore, it is important to implement these changes. Our goal is to end the use of plastic. If any practices speak against it, you must tell me, then we can consider how to solve this, but the goal must be to abolish plastic wrap'. Robert drew attention to the connection of his announcement to the initial problematization in the campaign: 'It's about the bigger issues of microplastic and plastic waste. We want to do something about that'. He referred to the practical challenges of the substitution and the limited risk scope of potential accidents: 'In the past, pallets have often fallen over, then you just cleaned up the road and that was it'. By emphasizing the prospects and offering reassurances regarding the risks, Robert sought to persuade workers to get involved with the new technology. Moreover, he underlined the economic advantages of the substitution that offered financial possibilities for experimentation: 'The cords are much cheaper than the wrap, so you can easily use an additional one if you're unsure. Saving cords isn't top priority'. Finally, he appealed to the common sense of his employees: 'You are people capable of thinking, so switch on your brain, use your common sense and take responsibility to decide how many strings you need in each case'.

In his announcement, Robert mobilized several elements from the previous steps to enforce the replacement: He referred to the interrelation of specific and general plastic dependency that was central in the problem diagnosis. He encouraged the importance of general solutions while allowing specific exceptions and adaptations. He addressed resistance by stressing the economic value of the change and by removing the fear of failures and accidents. Importantly, Robert connected verbal enforcement to an adaptation of practical coping strategies, strategies that considered the interrelation of technology and employees in the accomplishment of concrete work practices. The following scene illustrates his attempt to mobilize object-related associations that foster a successful innovation:

We are going through the warehouse to discuss how the individual boxes should be secured. Robert (R) sets the tone, but often turns to Alvin (A), asking him for his opinion.

R: How many strings do we need for the Voelkel boxes? (pointing to a box)

A: One is enough.

R: And if they are empty?

A: Also one.

R: And Neumarkter, they deliver with two strings, are they less stable? (shaking the box)

A: No, one string is enough.

R: Then let me put it differently: Are there any beverage crates which require more than one string?

A: Lauretana, some of them still use the old crates, they are unstable.

R: Is it even possible with cords? How do they deliver?

A: They also deliver with cords.

R: Ok, then we take two cords there, and also for St. Leonards, because they are stacked so high.

We are continuing our round; Robert goes ahead, speaking mainly to Alvin while Maike, Sergan [warehouse workers] and I are not actively involved in the discussion.

R: What about milk?

A: They just deliver with wrap, I don't know if they accept the string.

R: That's our company policy, and they are customers, we do it that way and they have to live with it. As long as it arrives safely, otherwise they should come to me.

A: Ok.

R: So one string for the milk, for the small boxes maybe two, because there are so many layers. Or do you think three?

A: No, two must be enough.

R: For the vegetable boxes we'll take a string too, that'll do, won't it?

A: Our own drivers will complain, if it is only secured with a string.

R: Then they should come to me! This is now company policy – we won't use wrap just because of the vegetables.

The sequence shows how the allocation of responsibility was a negotiation between warehouse manager, employees, material infrastructures and objects. To fill the vacuum of responsibility, Robert emphasized Alvin's experience with the different boxes and their requirements. By giving Alvin confidence and conveying the need to act, Robert refined the setting for the treatment process. Importantly, his conversation with Alvin was also directed to the warehouse workers Maike and Sergan, and Robert tried to motivate them to act according to the agreements he and Alvin had made. Therefore, what seemed to be a participatory dialogue was about enforcing clear guidelines and eliminating lax interpretations and intentional delays of treatment. The boxes were actively engaged in this process. By going through the warehouse and jogging on the stacks of boxes, Robert empowered them to inform the agreements. This material immediacy of the intervention could be observed when Robert intended to take away the wrap.

R: Are there still any questions? Otherwise, I want you to do it that way – and in any doubt, come to me if something doesn't work out! Is that all right? Don't just slam the cords on my desk this afternoon saying that it doesn't work (directed to Alvin; Maike laughs). Then I'll take the wrap away from you right now. This is a symbolic act of change.

A: For the mushroom boxes we still need the wrap. They are so light; otherwise the stacks will fall apart.

R (laughing): Are you afraid that I will take the wrap away from you? Good, then I'll just take the spare box with me and we'll put the rest of the wrap there (Robert points to the corner of the warehouse). However, I still want you to change practices, I know it isn't easy, but we have to undergo this process.

Robert's intervention did not end the employees' hesitance. As discussed above, the resistance to the innovation was too complex to be overcome by simply providing work guidelines or trying to convince or force employees. Hence, the reactions of employees was ambivalent. On the one hand, employees welcomed the clearer work instructions and

responsibilities. On the other hand, they reacted in a reserved and skeptical way, fearful of additional work and increased errors. However, Robert narrowed possibilities for resistance by eliminating uncertainties and ambiguities that had allowed hidden and indirect oppositions. While he actively mobilized some material relations (e.g. the stability of stacks) to consolidate the transformation process, he left out or loosened other relations to give scope for adaptation by employees. Robert did not practically intervene in practices of collection and reuse, leaving it to the employees to deal with the reusability of the strings as long as they visibly replaced the stretching wrap. The success of implementing the strings became detached from the consistence of their reuse. This partial detachment (Harvey and Knox, 2015) became apparent, when I phoned Robert two weeks after my stay. In this call, Robert stated that the treatment ‘works quite well, I have checked a few times and less and less wrap is used’. When I asked him if the employees were using new strings or reusing collected ones, he did not know, but promised to find out for my next call.

After entering the meeting room as key elements of an ecological project, and causing frustration and uncertainty for the workers, the reusable strings eventually supplemented the wrap as a new standard technology for securing pallets in the warehouse. However, they neither ended plastic dependency in the company nor did they change all material constraints from work practices: Wrap was still sometimes used, string reuse was a struggle and the supplementation was fragile. The official claim that strings had been substituted for the wrap was clearly not yet the end of the innovation process.

Step 5: Retrospection – unravelling the plastic replacement process

After the enforcement of the substitution, newly established work practices in the warehouse were still not firmly established. In my phone calls with Robert, I got the impression that the process was not quite finished and that the danger of relapses remained. Even one year after my stay, Robert articulated an instability of the new practices. Without any visible problems or complaints by vendors and clients, employees challenged the substitution as soon as top down control weakened. In fact, while the shift to a more hierarchical innovation management accelerated the replacement, it loosened the employees’ emotional attachments to the innovation. Robert reported about a situation where the warehouse ran out of the strings: ‘Workers instantly used wrap again instead of getting new strings from the depot’. He assumed that the reason lies in instabilities in the particular working situation and not in constraints of the new material’s properties: ‘It is a more general problem in the warehouse’. Robert questions the control over employees and not the control over technology, defining the potential relapse as an individual problem of the warehouse, rather than a more general problem of the company, the supply chain or the society. This individualization of failures allowed Robert to portray the campaign for plastic reduction as not constricted by instabilities in the practical supplementation of wrap. While Robert individualized failures, he used achievements in the innovation process to enhance the general message of the campaign. For example, the company produced and promoted a short video explaining the application of reusable strings. Disregarding failures and generalizing the success of an innovation is a process that shows that power is not only exerted by mobilizing associations (Latour, 1984), but also by excluding them (Star, 2016). Including several return flows from practical

undertakings, the process of becoming step-by-step free of plastic did not happen as linearly as it might appear from this article. In fact, the specific treatment of the plastic wrap in the warehouse was never detached from the overall campaign.

Importantly, neither the campaign's diagnosis of plastic dependency nor its treatment remained stable. Looking back and referencing former events and situations has effects on current associations. Though the supplementation is officially completed, the innovation process for wrap-replacement is still in constant formation and reconfiguration. Looking back, we see that reusable strings changed from being a supplement for plastic wrap to becoming multi-modal and exemplary for the treatment of plastic overuse. Decoupled from the concrete objects and constraints of everyday work practices (Harvey and Knox, 2015), the supplementation of plastic wrap emerges in different practices and fields. It appears in the official campaign, in Robert's reflection of responsibilities and in work practices in the warehouse. The career of wrap replacement split into diverse courses, which are differently framed by different actors. While the innovation process temporarily connected the strands of conceptual problematization and practical replacement, its official completion again separated the two. Both still share the common history of treatment, but retrospections differ and continuations decouple. The success of the campaign becomes detached from the concrete process of wrap replacement (Harvey and Knox, 2015). Such practices of detachment are also part of my research project: To stay capable of acting and navigating in the network of complex attachments and responsibilities, I have to detach the theoretical discussions in the next section from the further proceedings of the innovation process, making my conclusions independent from the success or failure of the innovation.

Plastic dependency and passionate waste reduction – considering attachments in innovation processes

I have highlighted how innovation results from the interdependency between workers, practices and technologies. By reconstructing various steps of the process – from (1) problematization to (2) mobilization to (3) resistance to (4) enforcement, and finally to (5) retrospection – I have shown how successful innovation depends on framings that mobilize facilitating associations (e.g. knowledge, technology, support, meaning) while omitting blocking associations (e.g. malfunctions, expanses, path dependencies).

The analysis displayed this process as an interplay of situational actions, evolving interrelations and mediating objects. The innovation was pushed forward by very specific actions in specific situations. For example, Robert the manager was more than once confronted with the question of how to proceed and he made several turns to steer the process in his favour. However, the innovation followed its own path dependencies; Robert could not control the process, but had to work with the situations as they unfolded, and the actors present in those situations, including employees, material equipment, written specifications and assigned responsibilities. Finally, material technologies that were contested or mobilized in the innovation process had internalized records of preceding situations. Plastic wrap had become laden with years of habitual use that created feelings

of dependency, while the reusable strings contained the ecological passion for plastic waste reduction.

What is the benefit of viewing the results through the lens of attachment and its approach of decentred agency? Can we better understand persisting plastic use by an approach originating from studies on drug addiction and musical passion? Studying the use and problematization of plastic wrap, the embodied and emotional attachments foregrounded by Gomart and Hennion (1999) did not catch my eye at first sight. There were no signs of deep physical sensations or deliberate releases of control. The innovation process of wrap's replacement was not even in the centre of considerations and activities of human actors. It was rather popping up here and there in the flow of everyday work practices. This impression of a more distanced object relation made me doubt the use of attachment as a lens for better understanding the persistence of plastic use. Plastic use, as I observed it in the first place, did not appear as an addiction or passion. It seemed that analysing the various negotiations between different actors (managers, workers, materials) consistently explains the innovation process. However, several incidents occurred during my research that made me hold onto the concept of attachment as an important extension to such explanations. First, some of my research partners mentioned a plastic dependency in food supply that is hard to overcome. Hence, actors made connections to such strong object relations by themselves, stressing the persistence of plastic use in the campaign. Second, research partners expressed a passion for ecological sustainability. The process of plastic reduction in the company is related to a wider zero-waste movement that is based on an attachment to nature. The passion for sustainability is important for the process, as it internalizes elements that are outside of conventional innovation processes and managerial rationalities. This passionate attachments to waste reduction were mobilized by managers and employees to support the innovation process, but they were also contested. Third and most important, the challenges of handling the strings and changing work practices more generally are inseparable from everyday practices of object use. Hence, the innovation was dealt with as part of the habits and uncertainties of everyday practices rather than as intentional translations between conflicting actors. It was not as if the workers refused to use strings, nor was it that the strings opposed their application; instead, string-use itself was tricky. Importantly, this trickiness directly relates to the history of technological attachments. Workers judged the strings not only as a tool for securing pallets, but also as a supplement for the wrap.

These insights indicate that plastic reduction processes should be understood as attentional undergoings that are altered through the flow of practices (Hultin et al., 2020: 13). Detachments from plastic objects afford accompanying attachments to other entities, whereas persisting attachments to plastic determine possible detachments (Le Velly et al., 2020). The passion for waste reduction and the habit of plastic wrap use are not two opposites competing for support; rather they both constitute evolving attachments in everyday practices, out of the intentional control of single actors.

My analysis reveals how the evolving relationship between the wider campaign for plastic waste reduction and the concrete technological substitution of the wrap is crucial for understanding the innovation process. Every analytical step represents a specific relationship between campaign and technological substitution.

In the first step (Problematization) the company managers promoted the plastic reduction campaign and the wrap substitution by establishing connections between them. The campaign justified the substitution process while the substitution made the campaign applicable and measurable. The communicated aim was a removal of all plastics, so the relationship between campaign and wrap replacement became co-constitutive.

In the second step (Mobilization), previously created connections were selectively used for managing the attachments to waste reduction as well as plastic wrap. While problematization was dominated by the company managers and their aims, mobilization was a process of investigating connections and involving actors. Fostering the use of plastic strings as a substitute for wrap, the relationship between plastic reduction campaign and wrap replacement became more fluid.

In the third step (Resistance), opposing interventions into the campaign and technological substitution challenged the interrelation of both. Resistances emerged in the interplay of meanings, skills and materials and was not controllable by the company managers. The fragility of wrap substitution threatened the credibility of the campaign. Hence, the relationship between campaign and foil-replacement became precarious, including the danger of a failure of both.

In the fourth step (Enforcement), the company managers reacted to practices of resistance by proactively adapting relations between campaign and substitution. They reinforced some connections (e.g. defining concrete specifications for string use for different crates), while loosening other connections (e.g. weakening the plea for reuse). By prioritizing wrap replacement vis-à-vis reuse practices, the relationship between campaign and substitution became rearranged and reconciled.

In the fifth step (Retrospection), the company managers regained control over the evolving process by arranging connections between the campaign and substitution in favour of a successful innovation. They generalized achievements (e.g. string use) and individualized failures (e.g. scant recollection and reuse of strings) to entangle the paths of wrap replacement and plastic reduction campaign. By presenting the supplementation of wrap as finalized, the relationship between campaign and substitution became stabilized and supportive.

The analysis highlights the interplay of a passionate problematization of plastic waste (manifested in the campaign) and a perceived plastic dependency in everyday work practices (manifested in the substitution). This interplay between campaign and technology marks the scope for material attachments and detachments and therefore determines the possibility of a successful innovation process. The case shows that technological innovations are the unpredictable consequence of interactions between heterogeneous and interconnected human and non-human entities in habitual work practices. The mediation of work practices needs constant negotiation of freedoms and boundaries that originate from tools and technologies. This is not restricted to physical constraints, but includes symbolic and cultural barriers (Wajcman, 2016): Warehouse workers have to deal with the different material and symbolic characteristics of reusable strings as opposed to single-use plastic wrap. Consequently, neither the willingness and competences of the employees, nor the suitability of the technology alone are responsible for the success or failure of an innovation; their evolving interaction matters. The fact that human actors do not perform their practices autonomously but under the influence of technological

constraints (Leonardi and Barley, 2008), requires a dilution of personal responsibility by taking the distribution of agency seriously. However, this does not free human actors from the responsibility to act. Instead, my analysis shows that the active mobilization of supporting associations and the building of resiliencies and collaborations is crucial for overcoming difficulties. The interrelation of passionate waste reduction and the feeling of plastic dependency must not lead to overload and guilt by human innovation actors; instead, it can help to question specific object attachments in order to promote a sustainable transformation of work practices. Analysing the innovation process as an interplay of normative attachments to waste reduction and habitual attachments to plastic wrap, allows to identify wider conditions for plastic reduction strategies.

A focus on attachment can foreground the multiplicity and flexibility of plastic. The plastic wrap in the innovation process is not a consistent and stable actor, but simultaneously an ecological trait, a managerial problem and a practical tool. These states are intertwined with attachments that influence the negotiation process. Alternatives must function in all of these relations if they are to become potential supplements. Hence, the reusable string had to function in different work practices and in connection with the campaign. In several situations, workers or managers felt that the negotiation around plastic wrap had gone beyond their existing scope of knowledge and action. Plastic wrap already proved reliable in work practices out of actors' direct spheres of influence; for new technologies like the strings, testing their supply chain suitability could be a precarious process. Hence, actors involved in innovations must take the fluidity of technology (De Laet and Mol, 2000) seriously and broaden their horizon for different material relations and functions. This demands attention on how a technology will matter pragmatically, economically and politically (Hawkins, 2020).

A focus on attachment stresses the importance of habits and routines. Ascribing resistance solely to actors and objects misses their embeddedness in everyday practices. Studying technology use via evolving attachments emphasizes change and resistance as a consequence of practices. The tangling of strings and the verbal contestation of their use are interrelated in practices. Actors involved in innovation must consider practices as a central point of engagement. This means that the focus shifts from persuading actors or manipulating objects to the dynamic interplay of practices and habitual attachments between humans and things (Hultin et al., 2020).

A focus on attachment underlines the bounded agency of actors involved in innovation (Gomart and Hennion, 1999). Employees and innovation managers are part of heterogeneous assemblages that restrict their actions. By negotiating the use of plastic wrap in work practices, they are simultaneously negotiating sustainability, hierarchies, responsibilities and economic rationality. Controversies between employees and innovation managers cannot be understood without acknowledging their power relations. The division between office and warehouse or between managers and employees influences the respective scopes of action. Actors involved in innovations must reflect their own positions and limitations in the course of navigating innovations. Hence, sustainable innovations cannot be simply planned and implemented top down, but require situational adaptations and trustful collaborations that must be habitualized in the corporate culture (Sattlegger, 2021; Süßbauer et al., 2019).

A focus on attachment emphasizes the unpredictability and surprising dynamics of innovation processes. The concern about plastic wrap is connected to the dynamic evolution of the zero waste movement, which has become more and more powerful in the past years. Hence, the passion for waste reduction is not the product of a rational consideration of ecological consequences, but underlies social dynamics that enforce the problematization of plastic. During the innovation process, the managers' idea of becoming plastic free evolved into a focus on waste reduction regardless of materials. Actors involved in innovation have to be open to react to unforeseen dynamics and changes in value. Sustainable innovation is a reflexive performance (Hennion, 2010) that requires constant experimentation with materials and their symbolic values.

Finally, a focus on attachment underlines that technological innovation is not a process of either/or with the option to simply withdraw. Instead, detachment is always partial (Hawkins, 2020; Le Velly et al., 2020). Despite all difficulties (e.g. entanglement of strings, frustration of employees, refusal or non-reuse of strings) the innovation process has successfully reduced the amount of plastic waste in the warehouse. Here, reducing plastic waste in work practices was not about abandoning plastic, but about reconfiguring its connections to work practices. Actors involved in innovation must be open to an innovation process that entails new interrelations between objects, people and practices, by fostering practices of including and excluding, opposition and embeddedness.

Conclusion: The problem is not withdrawing but controlling object relations

In the introduction, I asked how we can abolish unsustainable object relations. This analysis of the innovation process shows that we should not think merely in terms of getting rid of something. I have shown how avoiding plastic is an interactive process of negotiating object relations. Consequently, detachment and attachment are interconnected, two facets of the same process (Le Velly et al., 2020). Without giving room to new object relations and constraints, it is impossible to release existing ones. When societies struggle to reduce or step back, this is at the same time a matter of stepping forward and multiplying. Hence, environmental policy and sustainable innovations might need more attachments rather than fewer (Callén Moreu and López Gómez, 2019). The problem is not that society is unable to get rid of something (this is done regularly – plastic did in fact replace other technologies and practices), it is rather that unsustainable object relations (as the use of immense amounts of single-use plastic packaging) are not neutral and exchangeable. Instead, many associations and attachments try to hold them in place. Getting rid of unsustainable objects is so hard to achieve because we consider it the responsibility of human actors and their deliberate initiatives. On this perspective, the difficulty does not lie in reducing or stepping back (Offe, 2019), but in the intended and planned selection of single options favoured by certain human actors. Acknowledging that technologies evolve in a dense network of habitual relations between human and non-human actors, it is evident that all attempts of intervening in object relations are tricky and difficult to control. Negotiating object attachments is a process of acting and reacting, intervening and releasing. Therefore, fostering sustainable innovations and the withdrawal of unsustainable technologies is not about decoupling practices and objects.

It is about keeping the momentum of everyday practices in mind and fostering the participation and interplay of all relevant actors including workers and mundane technologies.

Acknowledgements

This article is part of my dissertation project in the interdisciplinary junior research group PlastX. I want to thank my colleagues and my supervisors Birgit Blättel-Mink and Thomas Scheffer for their valuable feedback and support. Furthermore, I want to thank the editor and the reviewers of *Social Studies of Science* for their helpful comments and recommendations on earlier versions of this article. Finally and most of all, I want to thank my research partners at the organic wholesaler under study. Without their openness towards my participation and investigation in the innovation process, this research would not have been possible.

Funding

The author(s) disclosed receipt of the following financial support for the research, authorship, and/or publication of this article: This work is funded by the German Federal Ministry for Education and Research BMBF (01001603A-C).

ORCID iD

Lukas Sattlegger  <https://orcid.org/0000-0002-8987-2061>

References

- Blättel-Mink B, Schulz-Schaeffer I and Windeler A (2020) *Handbuch Innovationsforschung*. Wiesbaden: Springer VS.
- BNN (2015) *Leitfaden zum Einsatz von Serviceverpackungen im Naturkostfachhandel*. Report, Bundeverband Naturkost Naturwaren, Berlin.
- BÖLW (2011) *Nachhaltige Verpackung von Bio-Lebensmitteln. Ein Leitfaden für Unternehmen*. Report, Bund Ökologische Lebensmittelwirtschaft e.V., Berlin.
- Breidenstein G, Hirschauer S, Kalthoff H, et al. (2015) *Ethnografie: Die Praxis der Feldforschung*. Konstanz and München: UVK/Lucius.
- Çalışkan K and Callon M (2010) Economization, part 2: A research program for the study of markets. *Economy and Society* 39(1): 1–32.
- Callén Moreu B and López Gómez D (2019) Intimate with your junk! A waste management experiment for a material world. *The Sociological Review* 67(2): 318–339.
- Callon M (1984) Some elements of a sociology of translation: Domestication of the scallops and the fishermen of St Brieuc Bay. *The Sociological Review* 32(1_suppl): 196–233.
- Callon M (1998) An essay on framing and overflowing: Economic externalities revisited by sociology. *The Sociological Review* 46(1_suppl): 244–269.
- Callon M (1999) Actor-network-theory—The market test. *The Sociological Review* 47(1_suppl): 181–195.
- Candea M, Cook J, Trundle C, et al. (2015) Introduction: Reconsidering detachment. In: Candea M, Cook J, Trundle C and Yarrow T (eds) *Detachment: Essays on the Limits of Relational Thinking*. Manchester: Manchester University Press, 1–31.
- Cochoy F (2007) A sociology of market-things: On tending the garden of choices in mass retailing. *The Sociological Review* 55: 109–129.

- Cochoy F (2009) Driving a shopping cart from STS to business, and the other way round: On the introduction of shopping carts in American grocery stores (1936—1959). *Organization* 16(1): 31–55.
- Cochoy F, Deville J and McFall ER (2017) *Markets and the Arts of Attachment*. London and New York, NY: Routledge.
- David M (2015) Fundamente von Exnovations-Governance im Transformationsdiskurs: Ein erster disziplinübergreifender Literaturvergleich. In: Arnold A, David M, Hanke G, et al. (eds) *Innovation, Exnovation: Über Prozesse des Abschaffens und Erneuerns in der Nachhaltigkeitstransformation*. Marburg: Metropolis-Verlag, 77–99.
- De Laet M and Mol A (2000) The Zimbabwe bush pump: Mechanics of a fluid technology. *Social Studies of Science* 30(2): 225–263.
- Eitel K (2019) Reflexivität als Prinzip. Für eine Ökologie des Forschens und über die methodologische Anschlussfähigkeit an eine Soziale Ökologie. In: Sattlegger L, Deppisch L and Rudolfi M (eds) *Methoden umweltsoziologischer Forschung. Tagungsband der 15. Tagung der Nachwuchsgruppe Umweltsoziologie*. ISOE-Materialien Soziale Ökologie, vol. 56. Frankfurt am Main: ISOE - Institut für sozial-ökologische Forschung.
- Gomart E (2004) Surprised by methadone: In praise of drug substitution treatment in a French clinic. *Body & Society* 10(2–3): 85–110.
- Gomart E and Hennion A (1999) A sociology of attachment: Music amateurs, drug users. *The Sociological Review* 47(1): 220–247.
- Goulet F and Vinck D (2012) L'innovation par retrait. Contribution à une sociologie du détachement. *Revue Française de Sociologie* 53(2): 195.
- Harrison D and Laberge M (2002) Innovation, identities and resistance: The social construction of an innovation network. *Journal of Management Studies* 39(4): 497–521.
- Harvey P and Knox H (2015) Virtuous detachments in engineering practice: On the ethics of (not) making a difference. In: Candea M, Cook J, Trundle C, et al. (eds) *Detachment: Essays on the Limits of Relational Thinking*. Manchester: Manchester University Press, 58–79.
- Hawkins G (2012) The performativity of food packaging: Market devices, waste crisis and recycling. *The Sociological Review* 60: 66–83.
- Hawkins G (2018) The skin of commerce: Governing through plastic food packaging. *Journal of Cultural Economy* 11(5): 386–403.
- Hawkins G (2020) Detaching from plastic packaging: Reconfiguring material responsibilities. *Consumption Markets & Culture* 114(2): 1–14.
- Hennion A (2010) Loving music: From a sociology of mediation to a pragmatics of taste. *Comunicar* 17(34): 25–33.
- Hennion A (2017) Attachments, you say? ... How a concept collectively emerges in one research group. *Journal of Cultural Economy* 10(1): 112–121.
- Hoholm T and Araujo L (2011) Studying innovation processes in real-time: The promises and challenges of ethnography. *Industrial Marketing Management* 40(6): 933–939.
- Hultin L, Introna LD and Mähring M (2020) The decentered translation of management ideas: Attending to the conditioning flow of everyday work practices. *Human Relations* 3(2): 1–34.
- Ingold T (2007) Materials against materiality. *Archaeological Dialogues* 14(1): 1–16.
- Ingold T (2010) *Lines: A Brief History*. London: Routledge.
- Janssen M, Stoopendaal AMV and Putters K (2015) Situated novelty: Introducing a process perspective on the study of innovation. *Research Policy* 44(10): 1974–1984.
- Jarrahi MH and Sawyer S (2019) Networks of innovation: The sociotechnical assemblage of tabletop computing. *Research Policy: X* 1: 1–14.
- Kjellberg H (2010) Struggling to perform a warehouse: Buildings as symbols and tools. *Construction Management and Economics* 28(6): 675–694.
- Knorr-Cetina K (1997) Sociality with objects. *Theory, Culture & Society* 14(4): 1–30.

- Kramm J and Völker C (2018): Understanding the risks of microplastics: A social-ecological risk perspective. In: Wagner M and Lambert S (eds) *Freshwater Microplastics: Emerging Environmental Contaminants? Handbook of Environmental Chemistry*, vol. 58. Cham: Springer, 223–237.
- Kröger M, Sattlegger L, Wittwer A, et al. (2020) Verpackungsreduzierte Beschaffung. Protokoll einer fiktiven Gesprächsrunde zwischen Einzel- und Großhandel. In: Kröger M, Wittwer A and Pape J (eds) *Einfach weglassen? Ein wissenschaftliches Lesebuch zur Reduktion von Plastikverpackungen im Lebensmittelhandel*. München: Oekom.
- Kropp C (2015) Exnovation - Nachhaltige Innovationen als Prozesse der Abschaffung. In: Arnold A, David M, Hanke G, et al. (eds) *Innovation, Exnovation: Über Prozesse des Abschaffens und Erneuerns in der Nachhaltigkeitstransformation*. Marburg: Metropolis-Verlag, 13–34.
- Langendahl P-A, Cook M and Potter S (2016) Sustainable innovation journeys: Exploring the dynamics of firm practices as part of transitions to more sustainable food and farming. *Local Environment* 21(1): 105–123.
- Latour B (1984) The powers of association. *The Sociological Review* 32(1_suppl): 264–280.
- Latour B (1996) On actor-network theory: A few clarifications. *Soziale Welt* 47(4): 369–381.
- Latour B (2007) *Reassembling the Social: An Introduction to Actor-Network-Theory*. Oxford: Oxford University Press.
- Leonardi PM and Barley SR (2008) Materiality and change: Challenges to building better theory about technology and organizing. *Information and Organization* 18(3): 159–176.
- Le Velly R and Goulet F (2015) Revisiting the importance of detachment in the dynamics of competition. *Journal of Cultural Economy* 8(6): 689–704.
- Le Velly R, Goulet F and Vinck D (2020) Allowing for detachment processes in market innovation: The case of short food supply chains. *Consumption Markets & Culture* 15(1): 1–16.
- Miettinen R and Virkkunen J (2016) Epistemic objects, artefacts and organizational change. *Organization* 12(3): 437–456.
- Nicolini D (2010) Medical innovation as a process of translation: A case from the field of telemedicine. *British Journal of Management* 21(4): 1011–1026.
- Offe C (2019) Die Utopie der Null-Option. Modernität und Modernisierung als politische Gütekriterien (1986). In: Offe C (ed.) *Institutionen, Normen, Bürgertugenden*. Wiesbaden: Springer Fachmedien Wiesbaden.
- Phillips C (2016) Alternative food distribution and plastic devices: Performances, valuations, and experimentations. *Journal of Rural Studies* 44: 208–216.
- Ramella F (2019) *Sociology of Economic Innovation*. London: Routledge, Taylor & Francis Group.
- Sattlegger L (2021) Making food manageable: Packaging as a code of practice for work practices at the supermarket. *Journal of Contemporary Ethnography* 50: 341–367.
- Sattlegger L, Stieß I, Raschewski L, et al. (2020) Plastic packaging, food supply, and everyday life. Adopting a social practice perspective in social-ecological research. *Nature and Culture* 15(2): 146–172.
- Scheffer T (2003) The duality of mobilization: Following the rise and fall of an alibi-story on its way to court. *Journal for the Theory of Social Behaviour* 33(3): 313–346.
- Scheffer T (2008) Zug um Zug und Schritt für Schritt: Annäherungen an eine transsequentielle Analytik. In: Kalthoff H, Hirschauer S and Lindemann G (eds) *Theoretische Empirie: Zur Relevanz qualitativer Forschung*. Frankfurt am Main: Suhrkamp.
- Scheffer T (2013) Die trans-sequentielle Analyse – Und ihre formativen Objekte. In: Hörster R, Königter S and Müller B (eds) *Grenzobjekte: Soziale Welten und ihre Übergänge*. Wiesbaden: Springer Fachmedien Wiesbaden, 87–112.

- Scheffer T (2018a) Spielarten der Trans-Sequentialität: Zur Gegenwartsdiagnostik gesellschaftlicher Problembearbeitungskapazitäten entwickelt aus Ethnographien staatlicher Verfahren. In: Gießmann S and Röhl T (eds) *Materialität der Kooperation*. Wiesbaden: Springer VS.
- Scheffer T (2018b) Micro-politics by hesitation: How combat soldiers work on and against an order to kill. *Ethnographic Studies* 15: 122–158.
- Speck M (2016) *Konsum und Suffizienz: Eine empirische Untersuchung privater Haushalte in Deutschland*. Wiesbaden: Springer Fachmedien Wiesbaden.
- Star SL (2016) Power, technology, and the phenomenology of conventions: On being allergic to onions. In: Bowker GC, Timmermans S, Clarke AE, et al. (eds) *Boundary Objects and Beyond: Working with Leigh Star*. Cambridge: MIT Press.
- Süßbauer E, Maas-Deipenbrock RM, Friedrich S, et al. (2019) Employee roles in sustainability transformation processes: A move away from expertise and towards experience-driven sustainability management. *GALA - Ecological Perspectives for Science and Society* 28(1): 210–217.
- Suchman L and Bishop L (2000) Problematizing ‘innovation’ as a critical project. *Technology Analysis & Strategic Management* 12(3): 327–333.
- Suchman L, Bloomberg J, Orr JE, et al. (1999) Reconstructing technologies as social practice. *American Behavioral Scientist* 43(3): 392–408.
- Wajcman J (2006) New connections: Social studies of science and technology and studies of work. *Work, Employment and Society* 20(4): 773–786.
- Weaver B and Lahtinen M (2011) Technological change and users: An actor-network perspective on the digitalization of video surveillance. Paper presented at 27th EGOS Colloquium, July 6–9, 2011, Gothenburg, Sweden. Lund: Lund University.

Author biography

Lukas Sattlegger works as a research scientist at ISOE – Institute for Social-Ecological Research in the research unit Energy and Climate Protection in Everyday Life in Germany. He is a PhD student at the Institute of Sociology at Goethe University Frankfurt/Main. As part of the junior research group PlastX, he investigates the role of plastic packaging in the food supply chain. He studied sociology, and social and cultural anthropology at the University of Vienna, and he studied social and human ecology at IFF Vienna, University Klagenfurt. In his work, he focuses on ethnography and qualitative methods of social research, material attachments in everyday life practices and social dimensions of plastic use.