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Comparative Heuristics from an STS Perspective.
Inquiring "Novelty" in Material Practice

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Abstract: *»Komparative Heuristik aus Sicht der Wissenschafts- und Technikforschung. Die Suche nach ‚Neuheit' in materiellen Praktiken«.* This article proposes reconfiguring comparison as a method for innovation studies. It explores how two objects – a media installation and a robotic hand – are configured as novel through a complexity of materialities, stories, and bodies. In focus are small-scale interactions that signify relations between technological objects and their stories. The methodological approach advanced in this article focuses on the construction of comparability, the perspective from which something is compared, and one's own bodily involvement in co-producing situations. Through two configurative moments, *rendering imagined objects* and *material referencing*, this article delineates how the installation and the robotic hand materialise imaginaries and how they articulate stories of their difference. The proposed reconfiguration avows novelty as a concept through which continuities can be drawn, just as it acknowledges the locality of its articulation in different forms. Its perspective is local, as it is immersed in the net of materialities, stories, and bodies, while it moves on and re-arranges what is understood and what needs to be understood.

Keywords: Methods, comparative research, ethnography, innovation, novelty, materiality, media art, robotics.

*Reflections on the form of narration and the otherness of one's
subject matter are also reflections on the kinds of connections
these concepts make possible.*
Strathern (1991, 51)

1.   Configuring Novelty[1]

The opening chapter of this HSR Special Issue reiterates a common critique on science and technology studies (STS) (Jungmann et al. 2015, in this HSR Special Issue). It refers to STS's tendency to neglect to identify patterns that appear

across cases, in favour of focusing on contingencies within single cases and stressing the situatedness of processes. According to the critique, this focus has certainly brought about interesting insights for innovation studies by, for example, implicating heterogeneous relations among humans and non-humans, but it hinders comparison of different innovative realms. A methodological impediment for comparison is STS's paradigmatic insistence on thick descriptions, which hinders formulating the abstract processes that structure practices in different fields of innovation. In this article, I respond to this criticism, not by claiming it is entirely false and unjustified, but by using heuristic resources from STS to reconfigure issues concerning comparison. By reconfiguring, I mean to stress issues concerning how comparison is done. However, instead of claiming that previous approaches are false and outdated, I build upon methods and use recent questions concerning novelty as an occasion to re-arrange issues and re-articulate how to compare differently in order to overcome a methodological paradox. This methodological paradox, on the one hand, accounts for the situatedness and performativity of discrete events, which is a trademark of ethnography and STS, and, on the other hand, goes beyond descriptions and identifies continuities and patterns across sites to foster the definition of abstract processes. The consequential question for the methods of innovation studies is less how to make ethnographic data comparable and more how to use comparison to learn something about innovation or novelty, without giving up the specificity of its local emergence. In this article, I do not approach comparison by defining deductive categories and searching for their manifestation, but propose comparison as a method to inductively address questions related to the emergence of novelty – and by enhancing and using subjectivity instead of fighting its infiltration. In the focus of this attempt are small-scale interactions occurring in material practice. I approach the comparison with the research question: How is novelty enacted through materialities, stories, and bodies?

The intent to stress comparison as a method for innovation studies stems from observations concerned with the construction of two objects. One object is a media installation, for the investigation of which I visited an artist's studio and accompanied him during his creative process. The installation consists of different mechanical and electronic elements that are assembled to create a kind of floating movement. The movement is made visible through a laser projection that reacts to the contingent interaction of these elements. The other object is a robotic hand, which is made out of silicon. Silicon is not a common material used for robotic hands. Usually, robotic hands are made from solid materials that are electronically steered. Hence, the silicon hand's grasping is not programmed, but based on compliance with an artefact's surface. The hand is a current research challenge of a robotics laboratory, but is mainly engineered and researched by one scientist. Both objects are technically complex; that is, their engineering requires advanced technical knowledge and a specific material infrastructure to build them. Furthermore, their complexity entails opacity, which makes the

exact principles of their working not only hidden from the lay spectator, but to all actors involved. Over the course of approximately two years, I encountered both objects' developments through various situations. I visited experiments in the studio and laboratory, followed mundane tinkering practices, recurrently conducted interviews, went to robotics conferences and art exhibitions, and analysed discursive documents such as research papers and exhibition catalogues. During the time of the empirical observations, which I compare in this paper, both objects were prototypes. The installation at the time was materialised as a test structure consisting of wooden plates and mechanical elements, and the silicon hand consisted of three rudimentary fingers and a palm, which could not yet be attached to a robot's torso and arm.

To focus my comparison and to find continuities[2] in constructing the installation and the robotic hand, I draw on configurations as a heuristic. Configurations address the ways in which entities are put in relation – in their semiotic as well as material sense. They address how a specific figure is given a particular form, as well as how the material figures cultural imaginations. Lucy Suchman characterises configuration as a "heuristic device that has two broad uses for the study of technoscientific objects." First, she describes configurations as an aid "to delineating the composition and bounds of an object." Delineating boundaries is not only a methodological approach to the study of technologies, but is also integral to their very existence as objects. Suchman refers to objects not in the sense of fixed, materialised units, but as compositions that require rendering to exist as entities, just as it is a methodological aim to capture and re-articulate them. Second, by using configurations as a heuristic, she draws our analytic attention to "the ways in which technologies materialise cultural imaginaries, just as imaginaries narrate the significance of technical artefacts" (Suchman 2012, 48). The rendering of objects not only entails the assemblage of materialities, but also imaginaries and stories that signify an object's existence (cf. Strathern 1999). Understood in this heuristic sense, configurations stress studying technological objects with particular attention to the imaginaries and materialities that they join together. Novelty, in this regard, is not a property or universal good, but an articulation that calls out differences to whatever is referenced as the thing that came before (Suchman 2011, 15).

Accounting for configurations methodologically stresses that objects be regarded as *enacted* as distinguishable units through the temporality of interactions (cf. Strathern 1991; Pickering 1995; Rammert 1999; Barad 2007). They are performed through the circularity of interactions that mutually constitute an object's and subject's temporal modes of existence (i.e. Myers 2008; Alač

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[2] In the remainder of this article, I speak of continuities instead of empirical patterns. These terms are not contradictory. I understand continuities as the more basal term and refer to it as elements, which are the same or similar in two or more situations and provide a connection between them.

2009). Distinctions as, for instance, "art object" versus "scientific object" or "old" versus "new" are not fixed properties, but relations (or configurations) that may change across and *within* cases. This entails not regarding the installation and the robotic hand as samples of two institutionalised units of a field. This is not to say that their contextualisation does not matter. On the contrary, it means acknowledging the variety and situatedness of relating and referencing. In the methodological contexts of innovation studies, this perspective is relevant a fortiori. If modes of innovation change because they become more "reflexive" (Hutter et al. 2015, in this HSR Special Issue), our methodology cannot reproduce positions or act upon technological objects as given and significant in their own right. Enactments stress considering novelty and difference to be repetitively reproduced in resonance with an object's temporal and spatial location within innovation processes.

This paper makes an attempt to delineate specific moments through which the installation and the robotic hand are configured in their becoming. It proposes comparing configurations and going beyond thick descriptions of ethnographic observations. To begin this exploration, I problematize comparison as method and stress three issues regarding the methodological paradox mentioned above. Later, I pick up these issues again and re-articulate them through the notion of novelty informed by Marilyn Strathern's distinctive style of analogical comparison.[3] For that reconfiguration, I further draw on the exemplary findings of two configurative moments.

2.   Stressing Comparison

A major challenge for the comparative approach stressed in this article is to not assimilate the installation and robotic hand into existing categories. This implies breaking somewhat with traditional comparisons found in innovation studies, which compare factors that cause or favour innovations and determine whether these are specific to innovation systems, communities, or niches (i.e. Nelson 1993; Rogers 2003). Such comparisons are commonly based on ex-post rationalisations of innovation paths and might not account for unpredictable situations through which novelty is enacted.[4] Furthermore, stressing novelty and its multiple configurations through different materialities seems to require moving beyond comparison as presently discussed in qualitative research. A

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[3] My approach is informed by but not like Strathern's analogical comparison. In the main body of her work, she compares cases that need to be understood through those she has explored more, based on analogies, whereas I investigate and compare the installation and the robotic hand in parallel.

[4] This argument entails actors, who may retrospectively rationalise their behaviour, just as it entails research perspectives that favour rationalities, which fit innovation models.

major concern of textbooks teaching qualitative comparison is how to move from single case studies towards typologies (cf. Kelle and Kluge 2010; Rohlfing 2009). Their solutions (and "rules" (Kelle and Kluge 2010, 108-13)) stress, for instance, considering case selection and sampling so as to foster variance and similarity in data sets and to cope with the complexity of collected information. In this regard, investigating innovation and novelty in material practice encourages the rearrangement of some elements of qualitative comparison. In material practice, complexity is less a methodological problem than a constitutive condition for objects to exist as novelty. John Law stresses that events and processes are not simply complex in the sense that they are technically difficult to grasp, but rather that they "*necessarily exceed our capacity to know them*" (Law 2004, 6, author's emphasis).[5] This entails the often peculiar, opaque, nebulous, and mystified ways through which technological objects are brought into being (cf. Rheinberger 1992; Pickering 1995; Haraway 1997; Suchman 2007). Hence, considering complexity stresses the entanglement of heterogeneous material, semantic, and bodily agencies. Furthermore, there might be no precise vocabulary of novelty that marks a situation or case as a relevant sample. This lack of vocabulary is twofold: first, it becomes semantically apparent as neither "novelty" nor "innovation" is necessarily a relevant label within an object's location. Second, it becomes apparent in theoretically accounting for the pragmatics through which novelty emerges. These pragmatics might not follow established categories of innovation genesis, but instead appear in various situations, the significance of which is only seen through comparing real-time observations.

Hence, I see investigating novelty as an opportunity to reconfigure comparison as a device for asking how an object becomes different to others and why there is alteration and continuity across cases. For this endeavour, I draw on ethnographic methods that open a symmetrical perspective on human and material agencies and which account for complexity and contingency of situations. However, as already stated, in order to identify abstract processes across cases and fields, one needs to go beyond thick descriptions and compare. This requirement entails the aforementioned methodological paradox: On the one hand, STS and ethnography usually argue that contexts exhibit different and incommensurable traits, whereas, on the other hand, comparison involves the investigation of discrete contexts to elucidate their similarities and differences (cf. Jensen et al. 2011; Niewöhner and Scheffer 2010; Morita 2014). I want to break down this paradox into three entangled issues.

The first issue regards the *construction of comparability* as an explicit part of the research process. Strathern stresses that comparability is not intrinsic to

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[5] Law's argument can be found in different forms among several sources cited in this article. For instance, Marilyn Strathern speaks of the "unpredictability" of initial conditions (Strathern 1999, 5), or Joachim Matthes claims that believing in the universality of sociological terms is "*Realitätsausblendung*" ("blinding out reality," own translation) (Matthes 1992, 94).

anything, but is created through the perceptual tools of the researcher that relate phenomena (Strathern 1991). Objects of comparison are not found "out there" as predetermined units, but are produced through contextualisation, including analytical and cross-contextual framings that foster the production of meaning and inductive theory building (Niewöhner and Scheffer 2010). This includes re-arranging situations across different sites over the course of investigation in order to evoke comparability (Sørensen 2010). Objects of comparison are then a matter of inductive reasoning that is open for new experiences that may shift foci and research questions. The main issue stressed through the paradox is how research objects are made comparable, without assimilating empirical phenomena into deductive categories or giving up ethnographic trademarks like the specificity of location.

These remarks already indicate that a researcher's *perspective* is deeply entangled with how comparability is produced. This second issue stresses decisions that create conditions and consequences of difference and sameness (Matthes 1992; Strathern 1991; Jensen et al. 2011). Drawing a connection between practices and their configurations is made possible by concepts articulated from the researcher's point of view. Joachim Matthes stresses the implications of this view and its consequences for using comparison as method. As an example, he refers to "small family" as an indicator for progressing modernisation. The discovery of this in non-Western societies might show the universal character of the sociological term, but this is not to be understood as comparison. Searched and found methods neglect social realities in which phenomena grow. This is a false epistemology that stems from a lack of reflexivity in terms of a sociological concept's origin. Matthes stresses that sociological comparison should rather be understood as what it is: a cultural operation in which the experience of alteration is faced (Matthes 1992, 94). He proposes stepping back and asking what constitutes the experience of sameness and difference. This includes addressing the subjectivity of comparison and one's own socialisation within a specific research context, which biases the identification of specific continuities. In my case, this is the STS perspective, which guides my view on configurations and relates what I see in the field with concepts that I know from reading a specific kind of literature.

The third issue concerning comparison is not sufficiently addressed within methodological literature. It is one's own *bodily involvement* within situations. As I show in the following empirical section, my bodily presence in the artist's studio and the robotics lab actively co-produced the situation through which both objects were enacted as novel. The bodily engagement of the researcher is not only black-boxed in traditional forms of qualitative comparison since data formats like interview transcripts erase the physical context of the interview, but also in ethnographic comparison, which commonly treats what is observed as if it would have happened the same way independent of the presence of the ethnographer. I would like to propose an alternative to silencing the witness

and implicate my own engagement in the field by considering my bodily agency as physically co-producing what is compared.

3.   Two Configurative Moments

Considering the following comparison as configurative moments refers to what Strathern called an "ethnographic moment" (Strathern 1999, 3). By using this term, she describes the relationship between what is observed in the ethnographic field and what is to be understood at the moment of analysis. The ethnographic moment is a relationship between what is apprehended and what seems to demand apprehension – between observing and understanding. It highlights the dual relationship of the researcher with his or her field. The researcher is immersed in the field and becomes part of the observed activities, just the same as the analysis entails spatial and intellectual movement away from the field (Strathern 1999, 9). Thus, the following moments are not to be understood as empirical incidents; they are rather the relation between what I want to understand about novelty and what I observed in the artist's studio and the robotics laboratory.

I.   Rendering Imagined Objects

The first moment delineates the rendering of objects. The installation and the robotic hand are not concrete yet in this moment, but only partly materialised in sketches, experimental set-ups, and prototypes, as well as communicated through the semiotics of images and theories. The two empirical incidents sketched in the following were video-recorded in the artist's studio as well as in the robotics laboratory.[6] The first sequence is an excerpt of a participatory observation, whereas the second was scheduled as an appointment for an interview.

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[6] The analysis of the video recordings has been methodologically informed, in particular, by Charles Goodwin's sequential interpretations (Goodwin 2000), Hubert Knoblauch's focused ethnography (Knoblauch 2001) and Lorenza Mondada's focus on multiple temporalities that conflate in material practice (Mondada 2012). Charles Goodwin's studies also point out ways to compare small-scale interactions. For instance, he compares interactional patterns in sequences of young girls playing hopscotch with archaeologists classifying colour.

Figure 1: Video Sequence Recorded in the Artist's Studio

No.	Time	Still of the Video	Transcript
I.	02:35		A: "When you attach this one here, then it moves... *[points to the pulley]* The idea is now, if you build in an elastic element somewhere, or an extra noose, so when I make the movement here, it arrives over there three seconds later, as a kind of delay.
II.	03:06		And then you have a kind of line, which propagates through it. *[makes a snake movement with his hand]* I would additionally hang that separate. *[orientates his gaze and hands towards the wooden panels]* ... so this is hard.
III.	03:35		Imagine this was there in every row, like four, five times, then I would replace this hanger with that. *[makes a bow movement with his hand]* [...] So the whole system is hung in two dimensions, totally detached, actually totally sprung. And then only at every entrance does a signal enter. *[points to the end of the wooden structure, orientates towards JS]*
IV.	04:10		And you actually have a wafting area. You have a wafting area through which this is wandering through slowly. The best is a closed circuit that is only triggered once... [4s] I always had something like a landscape situation in mind." *[continues to pull the string through the eyelets]*

The first sequence shows the artist and me during my observation of his mundane creative practice. He explains to me how and why he is building a test

structure for an installation. The structure is made out of two wooden plates, hooks, threaded bars, strings, nuts, and bolts, as well as customised pulleys. In the stills of the video sequence (Figure 1), the test structure is in front of the artist (in a black t-shirt) and me on his workbench. The sequence begins with him explaining the workings of the test structure. First, he points to the elements that are already in place. He signifies these by referring to "a kind of delay" that is supposed to evolve through a specific ordering of strings, pulleys, and an elastic element. In the second frame, he starts to refer to the anticipated aesthetics, which are supposed to evolve through a kind of movement that appears to propagate through the structure. By moving his arm like a snake, he mimics what kind of behaviour he would like to achieve. He emphasises that this is a challenge. In the following frame, he relies on my ability to imagine what he has in mind. He expects me to imagine how he will continue to build the test structure in order to figure out if he is able to establish the propagating movement within a closed circuit (Frame III). Furthermore, I should also grasp the image that he has in mind. The first image is a "wafting area" – an image close to the movement of the strings, which lie partly assembled in front of us. The second image is "a landscape situation" that he has had in mind as an initial idea for the installation.

Shortly after my visit to the studio, I had an appointment for an initial interview with the robotics scientist in the lab that he works in. In contrast to the first sequence, which took place in a mundane setting, this appointment was framed as an interview. The sequence shows the scientist and me talking about what his project, the silicon hand, is about (Figure 2). We are sitting at a table with the first prototype of the hand. The hand is connected to an air compressor and a computer, so that its basic grasping function can be demonstrated. The scientist opens the conversation by explaining the basic advantage of a robotic hand made out of silicon, which he sees in the low signal processing needed for enabling complex grasping. He points out that this is not the typical case in robotics, which is still dominated by hands operated by electric motors. A crucial difference between his hand and others is the "many interactive things" that happen in relation to the environment. He enacts this in Frame II, in which he demonstrates the hand's softness by easily spreading its fingers with his fingertips and placing an artificial apple into it in order to show its ability to adapt to its environment. After this practical task, he continues in Frame III by explaining the more abstract principle behind it. His and his colleagues' idea is to "create another kind of communication" for a robotic hand, as opposed to steering it. In the last frame, the pragmatics of this "communication" are again emphasised by referring to the importance of the contact surface for a good grasp. The fact that this "does not always work" highlights the exploratory character of their novel approach to grasping.

Figure 2: Video Sequence Recorded in the Robotics Laboratory

No.	Time	Still of the Video	Transcript
I.	00:55		S: "That is how the actuators work. The advantage is that you only need one signal: inflating, releasing. This is something that is usually not done in robotics. Usually, grasping is done in a very linear relation. Typically, electric motors have very good characteristics. With these rubbers, many interactive things happen with the environment. When I now... *[presses some keys; the silicon hand coils up]*
II.	01:45		*[positions his spread fingers between the finger tips and palm of the silicon hand]* It is soft. *[puts an artificial apple into the silicon hand]* When something gets into the hand, its form adapts to it.
III.	01:56		*[mimics a round form with his hand; the apple rolls out of the silicon hand]* This is exactly what we want to make use of here. That the hand... that it is not steered where the fingers have to be or how much pressure or power has to be applied. But we create another kind of communication of the hand.
IV.	02:24		*[takes the apple in his hand, waves it, and puts it back onto the box]* And we just try to establish as much surface for contact as possible. The more contact surface you have, the better it grasps. Surely, it does not always work, but this is the basic principle, that we have as much contact surface as possible."

Transcribing both scenes is already a step toward producing comparability (cf. the first issue stressed in Section 2). It allows the contextualization of situations in a new way and relating previously disparate events. However, it is also selective and technically navigates the analysis. By juxtaposing the transcripts, a similarity in both situations comes to the foreground, which is the unfinished state of the objects. This is of little surprise, because the not-readiness of both projects was a sampling criterion. Interesting, rather, is that both actors do not consider the materials that lie in front of them as preliminaries. It is unclear if the material elements that lie in front of the artist, the scientist, and me will be developed further. However, juxtaposing transcripts does not go much beyond thick description and cannot relate the similarity to the enactment of novelty. To do so and to signify the similarity of the uncertain states further, I introduce a new, more provocative question that is reasonable in the new contextualisation; I ask: What are the enacted objects actually? This question is not arbitrary, but influenced by my own socialisation and reading of a specific kind of literature (cf. the second issue). It is influenced by Hans-Jörg Rheinberger's term "epistemic things," which captures the changing statuses of objects in experimental systems (Rheinberger 1992). An epistemic thing is not defined by a specific material state, but rather through its position "at the centre of the investigative effort" (Rheinberger 1992, 310). It is characterised by an irreducible vagueness as "it translates the fact that one does not exactly know what one is looking for" and "is yet in the process of becoming materially defined" (Rheinberger 1992, 310). Similarly, the structure that lies in front of the artist and me in Figure I is part of the "wafting area's" material becoming. The wooden plates, hooks, strings, and pulleys are not the locus of his investigation; they are rather the experimental system through which he partly materialises the image he has in mind. Likewise, the prototypical silicon hand in Figure II is not the scientific object under investigation. The scientist emphasises in his story that he and his colleagues research the abstract principles of grasping, which he refers to as "another kind of communication" – the basic principle of the hand's functioning. In this way, the silicon hand materialises the exploration of these principles. In particular, the assemblage of an air compressor, computer, and artificial apple is used to give shape to the hand's scientific principle – the assemblage renders the object's agency.

Despite the similarities to Rheinberger's epistemic things, both situations further stress consideration of the objects' enactments as framed through interaction. Although the sampling of both sequences considers them as framed differently – the first as a participatory observation and the second as an interview – the use of video recordings shifts the focus to framings through specific interactions taking place within the situations (cf. Goodwin 1994). The simultaneous re-encountering of the situated entanglements of technical apparatuses, accompanying stories and bodily movements enabled through the video, allows me to re-frame both situations as demonstrations. In particular, the stills of the

video recordings capture distinct bodily activities of these interactional framings. First, there are pointing gestures. They accompany explanations and indicate what the artist and the scientist are referring to when they talk (cf. Goodwin 2000). In the first sequence, for instance, these pointing gestures select those parts of the structure that are described as crucial for establishing the anticipated movement. Secondly, there are gestures that mimic and physically enact the future object. This bodily simulation is a distinctive form of enacting epistemic objects that have not yet materialised, but are referenced in communicative situations. Natasha Myers calls such body-work "embodied imagination" (Myers 2008, 165). In her study on protein modelling, she argued that material and mental models are not to be regarded as dualistic, but rather as deeply entwined. Through embodied imagination, researchers incorporate the inner structure of models and enact these as epistemic objects. They use their bodies to make graphical objects tangible, and they employ gestures and movements in communication with novices in order to flesh out and relay their knowledge about otherwise only virtual objects (Myers 2008, 180). In both sequences, I am such a novice. The snake movement in the first sequence (Frame II) gives body to the not-yet-realised aesthetics of the future installation. Its materialisation might still be far away, but the image of "a kind of line, which propagates through it" already structures the situation at hand. In a similar but not equal way, the scientist makes use of his body in the second sequence. He uses his body not precisely to mimic the hand, but to enact the distinctive difference of his silicon hand against how he expects me to think robot hands typically work. In order to do so, he demonstrates the softness of the silicon hand by easily spreading its fingers with his. He does so without force or additional programming, so I can comprehend the hand's compliance. This compliance is a basic principle of the hand's distinctive kind of grasping and is referenced through bodily movements. Both situations are co-produced by my bodily presence, which is reflected in the specific gestures the artist and the scientist use to enact their objects (cf. the third issue). I cannot tell whether they would have acted similarly toward somebody else (probably yes), but what the sequences crucially indicate is the need to consider one's bodily involvement in co-producing the situations that are being compared.

Through the comparative analysis of both sequences and the successive focus on single aspects in accordance with studies and concepts found in literature, I can go beyond describing similarities and articulate processes of general significance for the emergence of novelty within material practice. This is how bodily enactments render future objects' agencies, which are partly materialised, partly imagined. The configurative moment through which I delineate the continuities of both situations is *rendering imagined objects* and can be summarised as situated enactments of imagined objects' agencies through material assemblages, bodily movements, and accompanying stories.

II.   Material Referencing

In the introduction of this article, I adopt an understanding of novelty, which regards referencing as elementary to novelty instead of an intrinsic quality of objects. The transcripts of Figures I and II already indicate that referencing is not only a narrative practice. Certainly, the narratives of the artist and the scientist reference either their own work or their field, but the materials used seem to carry additional semiotics. These material semiotics are delineated through the second moment of *material referencing*, for which I analyse two situations similar to those mentioned above, as well as some brief observations that I made during an exhibition and at a conference.[7]

The first situation is an excerpt from a conversation with the artist that took place in his studio a few days prior to the one transcribed above. We talked about an already finished and exhibited piece of his. For that particular piece, he worked with wooden staffs, strings, plumb weights, and small electric motors that were digitally programmed. All these elements are similar to those used for the test structure mentioned in Figure I. In contrast to the rather small test set-up, the components of the installation form a large structure, approximately two meters in both height and diameter. The wooden staffs serve as a frame that holds together a complex, three-dimensional mesh of strings. Through the plumb weights and pre-programmed motors, the mesh moves in such a way that the spectator cannot exactly tell what causes the deformation or where the strings move next. At an exhibition of the piece, I witnessed how visitors engaged with it. Most people changed their perspective several times: first, they looked at the frame and the tautened mesh from a distance, capturing the piece as a whole as they simultaneously watched the mesh's movements and the overall construction. Afterwards, they moved closer and looked at single mechanical elements and how one string with a plumb weight was reacting to the pull of a motor. As I watched the visitors from a bench beside the installation, it occurred to me as obvious that the installation's aesthetic effect was materialised through the opaque complexity of its technical assemblage. People were attracted by the duality of seeing simple materials move, but not being able to ascribe what exactly caused specific deformations. Besides its aesthetic effects, the material also carries specific semiotics. The artist recounts that his intent to use wood as the main material was purely pragmatic in the beginning. It was cheap and easy to work with. Later on, he explains, he became aware of the fact that the assemblage of wooden parts, strings, and plumb weights is a reference to mechanical technologies of the 17th and 18th centuries. This reference, which was not intended by him during the initial conceptualisation of the work, was re-produced through an invitation to install the piece in another exhibition that was celebrating the

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[7]   The observations are documented in field notes, video recordings, and pictures. Additionally, discursive materials like exhibition flyers and conference contributions inform my literacies.

foundations of modern science. Similar to the wood used in that piece, he used fibreglass for another installation, mainly because he could process it easily. Additionally, he says, fibreglass brings along the aesthetics of a scientific experiment, which is an important analogy for his art. Such material references indicate the figures of his artworks, which are mainly drawn from forgotten scientific technologies.

In a similar way, material references are indicated by the scientist in Figure II. He states that the usage of silicon for robotic grasping in their approach differentiates their hand from others in the field. He emphasises that the field is still dominated by hands with electronic motors. Thus, using silicon is an exploratory endeavour, which surely "does not always work." Nevertheless, silicon not only structures his work as resistance, but also opens up opportunities. On the one hand, by using silicon, he and his research group are able to contribute to the rather young field of soft robotics, which attracts robotics that make use of soft and deformable structures. The field has its own conferences and research network and is characterised by robotic objects whose shape and functioning are inspired by biology. Thus, the use of silicon works like an admission to a new field. On the other hand, silicon is a material that is distinctively different from those typically used in the field of robotic grasping, which is an already established field. This difference encouraged the scientist to bring single fingers from the hand to a grasping conference and pass them around the audience. The attendees were able to touch and inflate these detached fingers and try out the ways in which they bent. During the scientist's presentation, I was sitting in the audience, too. As the finger and the air pump (which could be used to inflate them), were passed along to me, I realised that their basic functioning could be demonstrated rather easily. Everybody was able to make the finger deform and simulate a grasp. This interactive presentation materially referenced the concepts that were mentioned in his talk, and also indicated in the interview above.

The preceding two paragraphs are narratives for which I assembled and rearranged different kinds of observations. Both focus on the public enactments of materials used by the artist and the scientist for their respective objects. They are already guided by my theoretical intentions and do not consist of orthodox ethnographies. Nonetheless, assembling pieces of observations is reasonable for constructing comparability, as it makes my material accessible for the conceptual question I have concerning the relation of material practice and novelty (cf. the first issue). Still, my doing needs to be explicated, since the experience of similarity and difference is partly constituted through the new narratives. In that sense, they guide my perspective and comparative practice (cf. the second issue). My bodily presence is inscribed into the narratives. However, whereas my presence co-produced the situations in the first moment, I seem to have less agency here – rather, I am immersed in the public space of the exhibition and the conference, without causing a response that specifically addresses me. My

role within the situations is to take part as a participant, as one of the many who are addressed by the exhibition and talk. I can only take on this role through my bodily involvement: I can have a seat on the bench and watch people engaging with the artwork, and I am the person to whom the silicon finger is passed next. Most of the events would have happened the same way without me, but the elements of the events that I am comparing were produced through my physical encounters (cf. the third issue).

One similarity that I see in the narratives is that the materials are not merely instrumental, nor are they naive substrates that carry inscription without commentary (cf. Rammert 1999); the wood became not only a pragmatic choice just as the silicon of the hand is not only conceptual. Rather, the entanglement of semiotics and material is significant in both narratives. This correspondence of public space and materiality, which is so far only an empirical continuity constructed through my re-arrangements, might be better understood in analogy to what Strathern called the "aesthetics of substance" (Strathern 1999, 45). Based on her material collected in Papua New Guinea, she differentiated between inside and outside bodies. She draws on Etoro witch-children, who became victims of ritual homicide as newborns for having the "fat" body that presumably indicated the child's demonic possession. The bodily condition of the child became a presentation or shadow of the primary inner condition of the body, which was regarded as occupied by a witch's greed that made it swell. The visible outside body was an image of such hidden agencies. It had an aesthetic effect as it communicated the condition to others (Strathern 1999, 50). In a similar way, the objects analysed here are configured as outsides of their agencies. Read through Strathern's conceptualisation of ritually enacted bodies, the aesthetics of the artist's installation are an image of its inner agencies. Strings, plumb weights, and motors are a technological assemblage that is not perceived through its functionality, but its presence. The elements working-together is hidden and only aesthetically referenced through the installations outside body. The installation is a shadow of its complex, opaque assemblage. The robotic hand's silicon fingers are enacted in a similar way at the conference. They were passed around so the attendees could get an idea of the material's capacities. These capacities, such as the silicon's compliance and its deformability, were not communicated through a power-point presentation alone, but aesthetically referenced through sample fingers. The sample fingers were enacted as images because they materialised not the pragmatics of a complete grasp, but the silicon's hidden capacities.

However, in both narratives, the objects do not only refer to the insides of their bodies, but further evoke images beyond the immediate context. They evoke images in the sense that their materialities open opportunities for new relations. In a similar way, Sherry Turkle speaks of "evocative objects" as "things we think with" (Turkle 2007). In her examples, objects take on roles in which they unfold a reflexive, evocative efficacy. Evocative objects enable people to discover new perspectives and orderings of their life world. Especially objects

that do not assimilate into established categories challenge us to search for new relations (Turkle 2007). In such a way, references evoked through the combination of wooden staffs, strings, and digitally programmed electric motors re-negotiate images of technological objects. The artist's installation carries the semiotics of ancient apparatuses, just as its mechanics are governed by the micro-technologies of the digital age. Similarly, the softness of the scientist's silicon hand articulates the difference of his approach in opposition to others. It is bendable and compliant, and it interactively responds to its environment by deformation, as opposed to robotic hands made out of solid material, which need to be precisely programmed in order to grasp. The silicon's specific agency signifies the hand as distinctively different from the established categories of its field. The robotic hand, just as the media installation, not only materialises the present state of *what is*, but must be regarded as an agent within its own construction as novelty, as its material evokes thoughts of *what could be*.

The continuity in both objects' public enactments is their distinctive material referencing. Material referencing is the situated enactment of materialities as an image of an object's hidden capacities. Through this moment, the objects are channelled into discourses and technological tales that equally signify their material constitution. Delineating this continuity is not to say that the practices and intentions of the actors equal. The installation's referencing was produced through opacity, whereas the silicon hand's referencing was concerned with reducing it. However, despite their different articulation, the hidden quality of capacities and the enactment of both objects as images of these remain as abstract continuities that are significant for how novelty is publicly enacted.

4.   Reconfiguring Comparison

To begin this reconfiguration, I briefly discuss the two configurative moments regarding the research question of how novelty is enacted through materialities, stories, and bodies. From there, I re-articulate the three issues that I have stressed concerning comparison. To close this paper, I make two remarks on methods of innovation studies and reflexivity, which are central concerns of this HSR Special Issue.

"Novelty"

I mention in the beginning that, from a configurative perspective, novelty is not a property, but an articulation that calls out differences to whatever is referenced as the thing that came before. This perspective, which refuses to mark novelty as a universal good, is akin to other remarks on novelty found in social theory. From a different theoretical angle, Hubert Knoblauch reads two sources of novelty in Alfred Schütz's theory of action (Knoblauch 2011, 101): The first source is fantasy, which he sees as the subjective precondition for the culturally

influenced and communicated imaginary. The second source is comprised of situated actions and creativity through which situations are (re)configured (cf. Joas 1992; Rammert 1999). Both elements entail *difference* between what is typically expected and what actually happens. On the one hand, difference is enacted as the imaginary that is shared through the semiotics of narratives and stories; on the other hand, it is enacted through the creative re-organisation of a situation, which entails the pragmatic assemblage of material elements.

Read in light of the two configurative moments, novelty emerged through the joining of both elements. It is configured by relating the imaginary and material and by enacting stories and artefacts as different to what is expected or given. In the first moment, the test structure and the hand prototype were partly materialised objects that were signified through their relation to the landscape image and theories about grasping. These imaginaries were articulated as the difference between what had materialised so far and what was about to become. In the second moment, the mechanics of the media installation – just as the silicon of the hand – referenced what came before. The media installation enacted the semiotics of ancient apparatuses as an aesthetic tension in contrast to the mesh's contingent and non-functional behaviour. Similarly, the hand's silicon referenced its conceptual difference to expected approaches in robotics. All those articulations that rendered the compositions and bounds of the objects were enacted through spatial and temporal configurations of difference.

However, just as I am able to delineate continuities regarding the media installation, the robotic hand, and their enactments as novel objects, the articulations of novelty are also considerably diverse in both cases; neither actor stresses novelty explicitly. There are concepts like "aesthetics" or "scientific progress" that are more akin to the location of their practice than novelty is, which does not seem to be a relevant category or label for them. Concepts stressed by the actors were, for instance, images like "the wafting area" or the "communication of the hand." "Novelty" is my term and is an attempt to articulate continuities between the actors' concepts. My concept of novelty might thus be considerably different to the form articulated in a specific location at a certain time. It is, therefore, crucial to ask *where* attributes are found (Strathern 1991, 51). Stressing a concept's location acknowledges not only the institutional settings the two objects are a part of, but also the differences in the situations of their enactment. For instance, the difference of the robotic hand to its components in the field was articulated according to its situational framing, first in relation to my (lay) understanding of robotic hands and then in opposition to the expectations of the conference attendees. These are considerably different articulations of the same object. Hence, delineating novelty in the comparison of both cases is an attempt to give image to the experience of sameness, as the continuities of the two configurative moments, and difference, in the form of their concrete articulation.

Comparability, Perspective, and Bodily Involvement

I begin this article with a quote of Marilyn Strathern. She remarks that reflections on the form of narration and the otherness of one's subject matter are also reflections on the kinds of connections these concepts make possible (Strathern 1991, 51). In this vein, I make an attempt to reconfigure the three issues stressed earlier regarding comparison.

The first issue concerns the construction of comparability. Above, I outline that objects of comparison are not found "out there" as predetermined units, but are produced through the research process. Regarding the construction of comparability, Strathern writes that it is the act of comparison that constitutes relationships, not intrinsic qualities of phenomena. In contrast to common approaches in innovation studies, the installation and the robotic hand are not being compared as already institutionalised objects. It was left to the research process whether particular articulations could be delineated that make an object identifiable as one of art or science – and, more crucial here, as a novel object. Such an approach to comparison does not assimilate two phenomena into a deductive category, but draws lines between discrete phenomena in order to delineate their sameness and difference, as well as to give image to the continuities that exist across the complexity of situations. In Strathern's work, continuities are not articulated as questions of homogeneity, but as "proximities in space and time" (Strathern 1991, 55). Through changes of perspectives, such proximities might appear as variants of some other form found elsewhere. The researcher's concepts and writings form a kind of integrated circuit between parts that work as significant continuities that can be delineated as moments through which novelty is configured.

The second issue stressed the perspective from which the comparison is made. Matthes urged the consideration of comparison as a cultural operation that calls on the researcher to step back and ask what constitutes the experience of sameness and difference (Matthes 1992). The experience of alteration is not substantive, but relational – including how the researcher relates to what is considered as different. To articulate her relation to the subject matter, Strathern makes use of Donna J. Haraway's cyborg figure (Strathern 1991, 54). Haraway later articulated her own research perspective by figuring a "modest witness" (Haraway 1997). Her modest witness is not oppositional to its subject matter, but implicated and literate, just as it is suspicious and worried. It is inside the "Net" of stories and agencies and simultaneously learns to avoid its narratives and realities (Haraway 1997, 3). In this sense, I went beyond the position of a silent ethnographer and instead engaged with the actors. I asked about how things worked and took part in conversations; I took the liberty of re-arranging observations and have assembled these into narratives according to my interest in novelty; I re-arranged what I saw and entered into dialogue with the literature that I am familiar with. This practice has allowed me to go beyond description in order to identify the continuities of the two configurative moments. A mod-

est perspective enacts connections that respond to one's own agency *within* just as it may render continuities between units to re-join them. This implies one's otherness to a place and equally stresses sameness and how it comes about.

The third issue addresses the reconfiguration of perspective as a concrete and physical matter. My agency within situations does not only matter in terms of my intellectual perspective, but also in terms of my bodily involvement. I was implicated in the situatedness of practices, which I simultaneously witnessed. The artist and the scientist reacted to my engagement with gestures and the rhetorical use of imperatives in their stories ("Imagine, this would be there in every row, like four, five times…"). If an object is enacted as new, it is referenced as different in anticipation of my response. I was figured through the situation, just as my perception figured the subsequent account of what happened. In the first moment, my bodily engagement became vivid while the movements of the artist and the scientist addressed me personally and enacted the objects according to my presence in the studio and lab. I was addressed as a person, whereas my body was immersed in a crowd in the second moment. Meanwhile, the second moment is signified through relating materials, stories, and the public space created by bodily presence. A modest witness who is comparing needs to consider and use his or her own bodily and intellectual position in the circuits of materialities, stories, and bodies that articulate an object.

The reconfiguration of these three issues addresses the methodological paradox of comparison from the STS perspective. This paradox is how to account for the situatedness of events while identifying continuities to define abstract processes. My strategy for solving this is not to predefine deductive categories, but to enhance subjectivity and use one's own engagement to make visible elements that signify how novelty is enacted. By contextualizing what is found in one location with what is observed in another and relating these to what is already understood concerning a particular question, I identify and name processes that are significant and accountable across sites. Reconfiguring comparison connects different temporalities of encounters, changing literacies, and the flux of questions and contingencies. Its witness is local, as it immerses in the net of materialities, stories, and bodies just as it moves on and re-arranges what is understood and what needs to be understood.

Innovation Studies and Reflexivity

To close this paper, I want to make two remarks on methods of innovation studies and reflexivity. What can we learn from this reconfiguration for methods of innovation studies? My article suggests not an understanding of novelty as a preliminary step on a path with innovation at its end, but rather as a concept that connects several steps in innovation cycles: novelty signifies inquiries in research and development laboratories just as it legitimises market-ready goods as innovations. However, this reconfiguration is simultaneously involved and critical. Field semantics like "improvement," "progress," or "development"

are akin to "innovation" and must be understood as figures of scientific and technological discourses that reinforce boundaries. Comparison is the possibility of reading such concepts diffractively and stressing their isomorphism.

To entail oneself in a reconfiguration is to acknowledge reflexivity not only as a particular mode of innovation found out there in "fields of innovation" (Hutter et al. 2015, in this HSR Special Issue), but also as a way of positioning oneself *within* the situations through which novelty is enacted. Our concepts figure what we see just as we are figured through the relations we derive. What I explore in this paper is the connectedness of my bodily and intellectual disposition with situated enactments of novelty. Reflexivity in the two configurative moments not only concerns the institutional frame of activities in "art" or "science," but also responds to the situatedness of referencing and one's own locatability in the heterogeneity of semiotics, literacies, and materialities that are bent, torn apart, whirled, and re-joined to enact an object as new. Furthermore, it has encouraged my motion to re-articulate my questions about novelty and how materialities, stories, and bodies in differing locations are connected.

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