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### Theory instruments

#### helping designers see the invisible

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# THEORY INSTRUMENTS: HELPING DESIGNERS SEE THE INVISIBLE

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## ABSTRACT

With increasingly complex technologies entering the daily lives of people, human-technology relations have become more difficult to observe and make sense of. In this paper we discuss experiments with designing ‘Theory Instruments’ that allow designers to collaboratively play with multiple theoretical perspectives on field research material. We argue that the physical, tangible nature of these instruments helps to convey and experience the richness of theoretical frameworks and can make designers and researchers aware of easily overlooked aspects in ethnographic observations. We unfold the case of ‘charging electric vehicles’ across theories of Product Ecology, Rites of Passage, Exchange & Reciprocity, and Actor Network Theory.

## INTRODUCTION

When it comes to understanding how humans relate to products and services, design draws on theories from several disciplines including anthropology, psychology, and sociology. Theoretical concepts and frameworks help us better understand complex design challenges. However, from our studies in industry, it has become clear that theories play a negligent role in design practice (Kjærsgaard et al, 2021). While, for instance, ethnographic method has become quite widespread, the theories that design anthropologists draw upon to make sense of field studies receives little attention. In our work we attempt to find practical ways of bringing theories of human-technology practices and relations into design. In particular we have been successful with making theories ‘tangible’ to shift abstract discussions into hands-on sensemaking. This does however bring new challenges: How is it possible to ‘translate’ theoretical concepts into materials? How can interacting with materials map onto theoretical propositions? And is that even the point?

“*The map is not the territory*” Korzybski famously said (1933) thus suggesting that an abstraction derived from something, is not the object itself. This has led to the aphorism “*all models are wrong, but some are useful*” often attributed to Box (1976). In our attempts to make theories ‘tangible’ we had to ask ourselves, how can we make physical objects that help us engage with theoretical concepts and frameworks without reducing the complexity to an extent where ‘the map’ becomes ‘the territory’. This paper explores the prospects and challenges of making theory tangible with design materials, and what it means to design practice.



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Kirsch (2010) draws on embodied and extended cognition, to establish several reasons why people create external representations. Apart from reducing the overall cognitive load, Kirsch emphasises that:

*“When someone externalizes a structure, they are communicating with themselves, as well as making it possible for others to share with them a common focus. An externalized structure can be shared as an object of thought. This reification of internal object—this externalization—has benefits for both parties.”* (p.444).

Most representations of theory are visual models – because they usually need to be displayed in papers and books. But perhaps visual models become a *fait accompli* with little opening for further development, something that stands before us as complete and final (Ingold, 2012) - unless presented in interactive forms.

Recently, we have introduced what we call “Design Anthropological Theory Instruments” – physical models of theories commonly found in anthropology and related fields (Buur et al,2023). The instruments were originally

developed to address challenges experienced by interaction designers in response to increasing digitalization in a particular organizational context.

This paper investigates the prospects and challenges of making theory tangible and creating theory instruments.

### RESEARCH METHODS

We follow a research-through-design approach (Koskinen et al, 2011) to develop our understanding of how theories in tangible form may offer new perspectives for professionals working with design research in companies and organizations. We experiment with ‘building’ theories in various materials and with trying out the constructs we build with professionals. This paper rests primarily on experiments with developing a set of tangible Theory Instruments for professional designers, who might not know the (design anthropological) theories these tools represent. A smaller part of our studies also draws on material from experiments with social work students and teachers who

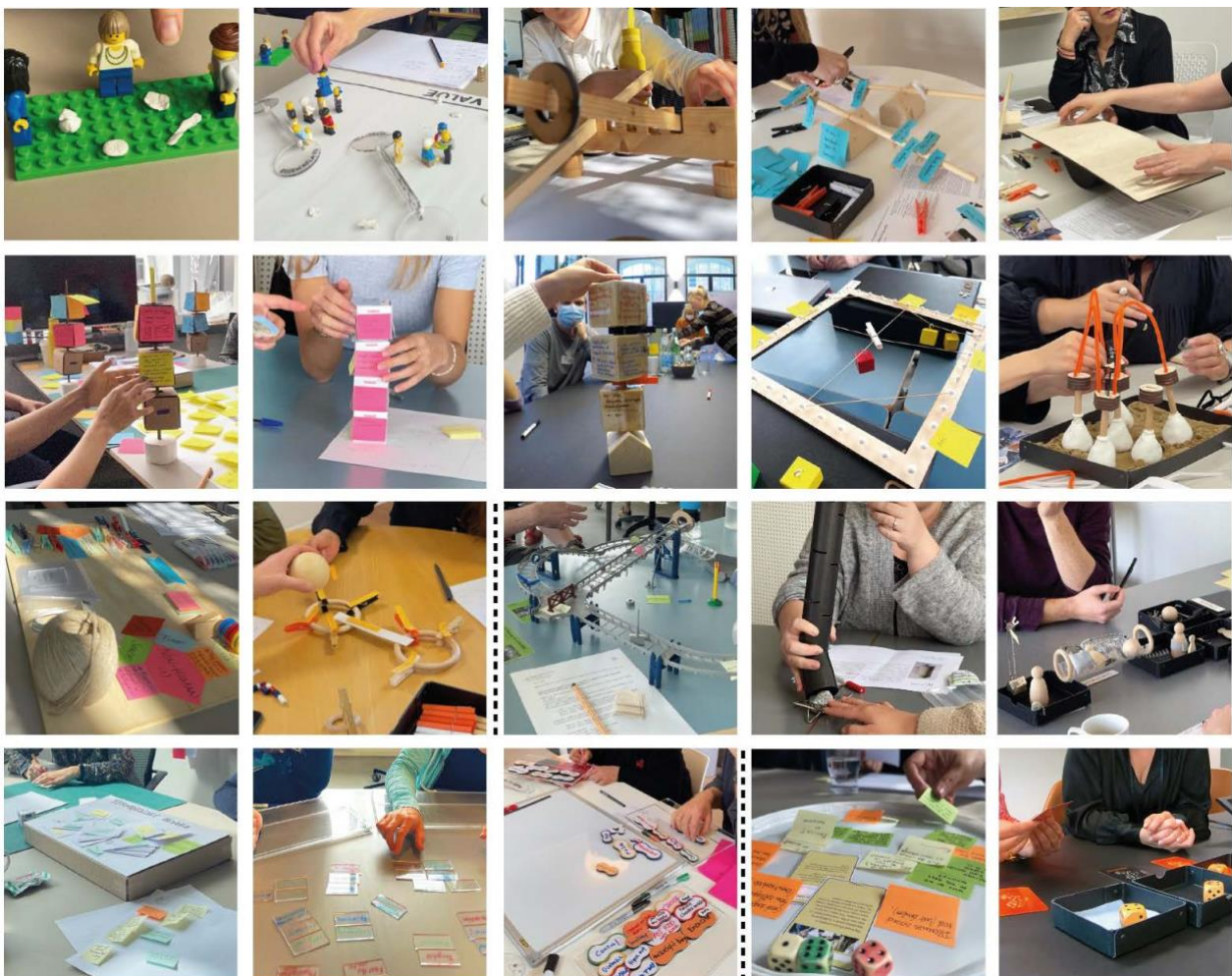


Figure 1: Six Theory Instruments developed through several iterations: Reciprocity & Exchange (line 1), Product Ecology (line 2), Actor Network Theory (line 3), Rites of Passage (line 3), Classification (line 4), Forms of Capital (line 4).



build their own Theory Instruments of theories they are familiar with.

The research activities included 8 half-day idea sessions with a small group of 4-6 design research colleagues. Each session aimed to generate ideas for making a particular theory tangible. One researcher would present a particular theory, and other participants would suggest examples and questions to explore. Then we would each sketch ideas for turning the theory tangible and make a video recorded presentation.

The theories we chose to work with were: Rites of Passage (Van Gennep 2013, Turner 1969); Actor-Network Theory (Latour 1992); Product Ecology (Forlizzi 2008); Exchange & Reciprocity Lévi-Strauss 1996, Mauss(2002); Classification Douglas (1984); Forms of Capital Bourdieu (1996).

Different agendas influenced our choice of theories. Initially the theories selected were meant to help us explore concepts and perspectives of relevance to a particular project on 'connectivity' in healthcare that we worked on at the time. We were aiming for a mix of classic anthropological theories and more STS inspired perspectives. Although one could argue for other equally relevant theories to include, this particular combination of theories allowed us play with quite different perspectives on the world, making different facets of our field material visible in the process.

Following each idea session, 1-2 researchers would select a concept, build a mock-up and develop written instructions of how to interact with it. The mock-ups were subsequently tested first with our researcher group and later with a wider circle of colleagues, professionals, and graduate students. 14 trial sessions were video recorded for later analysis, and comments from participants served to develop new iterations of the instruments.

The development resulted in 20 designs of varying fidelity (Figure 1). Some theories had as much as five iterations, some only two.

Alongside these activities we also conducted research among students at a social work education. At this point we were discussing, if the success of the theory instruments in companies might be attributed to the fact that we had primarily involved designers, or if the idea of making theories tangible would apply to a wider group of professions.

This part of our research was conducted as four explorative 2-hour workshops, with social work students and their teachers. The students were asked to list theories they remember from their studies, select one and 'build it' with the available materials (clay, pipe cleaners, pompoms, toilet paper rolls, glue, string, and

rubber bands). Paper and pen were deliberately left out to investigate what a tangible representation would do to the perception of theory. Afterwards we challenged teachers to 'build' two of the theories the students had selected - Bronfenbrenner's Ecological Systems Theory (Bronfenbrenner, 1979) and Bourdieu's Forms of Capital (Bourdieu, 1986). The workshops were video recorded for later analysis.

In the analysis we look at the designs on three levels: (1) what roles do materials play, (2) how do various materials support theoretical perspectives, reflections and sense-making, and (3) how do (inter)actions encourage theoretical engagements. We investigate how participants interact with the instruments, and how they talk about it.

While we have tested the Theory Instruments in many different case studies, for this paper we focus mainly on one case that we can trace across several theory instruments: The charging of electric vehicles. The transition from gasoline to electric car, while an advantage to counter climate change, is not as easy as one might think: It needs different ways of thinking of distances and time; and new practices when 'filling up' the car. We were directed to this challenge by a company that develops charging service systems for private and commercial customers. In four 2-hour workshops each with 6-12 participants we explored the challenge. While some participants had personal experiences, we also provided video observations, field reports, and auto-ethnographic fieldnotes as a basis for their explorations and analysis. The Theory Instruments were employed to understand the situation deeper and potentially to discover opportunities for improvement.

## THEORY AS INSTRUMENT

When asked to define theory in their own words, the social work students suggested: *"Something that explains something"*, *"A way to understand something"* and *"A perspective on how something is, and why it is like it is"*. They focused on the theories' ability to explain. Somewhat differently, a collaborator from industry suggested that *"We see theories as tools"*, focusing on the idea that theories 'do' something for you, that *"you pick one that fits"*.

Our work is based in a pragmatic approach where theories *"...are not representations or copies of how the world is, but are tools, with which we transform, engage, and cope with the world..."* (Brinkmann 2012, 38).

Despite this pragmatic approach to theory as 'tools', we prefer to talk about the tangibles we design as 'instruments'. Like musical instruments they each have their own 'sound'. During analysis of field studies, the

instruments accentuate different perspectives, potentials, and challenges embedded in the empirical material.

The musical instrument metaphor helps us see theories as different ‘sounds’ that can be ‘played’ with the same (field)notes to gain new perspectives on the world and how we may engage with it from a design perspective.

**FROM REPRESENTATION TO ENGAGEMENT**

A core finding in our experiments is that materials need to do more than ‘represent’ theories. This is what visual models do well, but to entice designers to adopt new perspectives we found that the materials need to offer themselves for engagement with the theoretical concepts.

In what follows we look at tangible engagements with ecological systems theory in two different cases and contexts, one focused on educating social workers and the other on involving design researchers in the analysis of field material on electric car use.

**EGAGING WITH ECO THEORY IN EDUCATION**



Figure 3: Graphic model of Bronfenbrenner’s Ecological system theory

In social work Bronfenbrenner (1979) introduced his Ecological System Theory, breaking with the individualistic view of human development that was prevalent at the time by focusing on the surrounding environment and particularly the interaction between five interconnected systems. This theory is often

graphically illustrated as concentric circles (Figure 3) though Bronfenbrenner never visualised his theory this way but instead referred to Russian dolls as a metaphor. Most social work students are familiar with the concentric circles of the visual model and will often refer to exactly that model if asked to describe the theory.

When a social work student in a workshop was asked to build the theory in clay, it was indeed made up of concentric circles (Figure 4a). As documented by Fuhrmann et.al. (2018) modelling promotes the understanding of complex scientific concepts - but such models may also lead to a too narrow conception. The teachers had expressed dissatisfaction with the way the ecological systems theory is normally portrayed – as the concentric circles often leads to misconceptions among the students. In the teacher workshop, one of the participants subsequently turned Bronfenbrenner’s theory into a physical model (Figure 4b). Compared to the clay model, it invites for interaction: one can place pegs and tie them together with elastic bands to indicate different people and their relations.

One may recognise how the visual model continues to affect the attempt: It still looks like the graphic model with holes placed in concentric circles. A later attempt broke with the circle pattern entirely (Figure 4c). Here the systems levels are horizontal layers and the model now includes past, present and future in vertical columns. Having worked with this version, a student said: *“It’s only now that I actually think I really understand the theory – it suddenly makes sense”*

So, what is going on here? A way to understand how graphic models compare to tangible instruments is that graphic models tend to be seen as ‘done’. In the words of Ingold (2012) as ‘objects’ that stand before us as complete and final; any further changes it may undergo belongs to the phase of use or consumption (Ingold, 2012). Understanding the visual representation of the ecological theory as an ‘object’ (in Ingold’s sense of the term) makes us see it as “finished” and “true” and does not invite for further explorations but instead for application or use.



Figure 4: Bronfenbrenner’s Ecological System Theory in clay (a) as pegs in holes connected by elastic bands in a concentric pattern (b), and in line-clusters (c).

The student with the clay model of the ecological system theory (Figure 4a) *does* reach new insights she might not have achieved only by looking at the model because she can now rearrange the circles. This might relate to what Kirsch (2010) calls ‘the power of rearrangement’. The possibility to manipulate and rearrange something offers different ways of synthesising and connecting parts in a new way that a visual representation does not offer.

ENGAGING WITH ECO THEORY IN DESIGN RESEARCH

In Human Computer Interaction (HCI), Forlizzi (2008) suggests the concept of ‘Product Ecology’ to highlight the dynamic relations of products, people, and practices as they evolve over time. In the era of the Internet of Things, products seldom stand alone, they are connected to other products and services, often outside the control of single manufacturers. And new products need to find their way into complex human practices and social networks. The process of learning to use new technologies is characterised initially by a phase of adoption in which people try to integrate the technology in current practices. This is often followed by a phase of adaptation, in which things, people, spaces, and practices may need to change for new activities to take place (Forlizzi 2008).

Forlizzi’s visualization of Product Ecology shows how people interact with products (Figure 5).

Our attempts to engage design researchers in ecological systems theory were quite different from our explorations with the social workers. Whereas the social workers engaged through making tangible ‘representations’ of theories, design researchers were engaged through their interactions with theory instruments that we had built.

It took several iterations to develop a Theory Instrument for Product Ecology (Figure 6). Both people and products are represented by sand-filled balloons that can squeeze together and take shape after one another. Colourful pipe cleaners connect the balloons to indicate interactions. The sand in the box can be shaped to tell

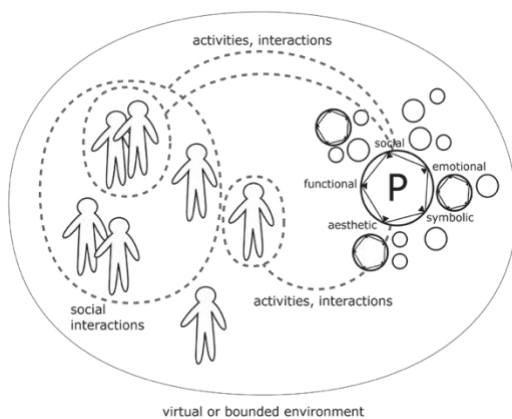


Figure 5 Graphic model of Forlizzi’s theory of Product Ecology.



Figure 6 The Product Ecology Balloons Theory Instrument consists of sand-filled balloons (products and people) with pipecleaners connecting them (interactions) in a sandbox (environment).

how products and people are interacting with the environment. The only inspiration transferred from Forlizzi’s graphic model in Figure 5 is likely the pentagon shape of the ‘product balloon’ heads.

While the students’ clay model (Figure 4a), was foremost a static, flat construct, the sand balloon model comes alive through participants’ interactions with it. In the trials with design researchers discussing the challenges of electric vehicle charging, the product balloons were selected as car, charger, app, and the people balloons were labelled driver, other drivers, family, customer service. Some picked home as the environment, others imagined public chargers: *“We are in a parking lot here [points to the sand box] in public space”*. This sets the context for social interactions: *“The driver experiences social relationships with other drivers, because there’s a line and they have to wait. A sense of community emerges, where they start sharing tips and suggestions.”* And interactions spread to the charge power provider: *“Sometimes there is a connection to the customer service, because things don’t always go as expected.”* Participants add pipe cleaners to indicate interactions. One group even saw different layers of relations, so added pipe cleaners at the base of the ‘balloons’: *“Family means that they are connected by themselves, not in the layer of technology.”*

Where a traditional HCI view on e-car charging might focus on the interactions between driver and charger, the Product Ecology Balloons challenge participants to take a broader view of other people, contexts, and the social environment.

Our studies suggest, that making theories ‘tangible’ is less about accurate representations and more about reflective engagement with material. Ingold (2010) quotes the painter Paul Klee who insisted that giving rise to forms is more important than the forms themselves. *“‘Form is the end, death’, he wrote. ‘Form-giving is movement, action. Form-giving is life’”* (2010, p.2). One



may say that a visual representation is “dead” as it is not a “becoming” whereas a physical engagement with theories can invite for transformation and further making provided it holds sufficient encouragement for manipulation, exploration and play. This is clearly visible in how participants engage with the Product Ecology Balloons - it is naming and rearranging the objects that fuel the inquiry into field observations and experiences.

### THEORY AS MATERIALS

In the Product Ecology Balloons instrument, the ready-made objects come to mean different theoretical terms: The balloons become ‘people’ or ‘products’, depending on the shape of their ‘head’, the pipe cleaners become ‘interactions’ between people and product, and the sand box becomes the environment (Figure 7).

The materials of the product ecology instrument were chosen to fit with the theoretical term adaptation. The elements of the product ecology instrument have pliable qualities, allowing participants to act out that products, people, context and connections may all change in response to each other’s presence. For example, the weighty sand-filled balloons change shape when squashed together, they may express affinity by bending their ‘heads’ towards others or stretch connections by not wanting to budge. The sand box allows for patterns to be drawn and erased, traces to be left and for ‘mountains’ and ‘valleys’ to interact with the placement of persons and products. The pipe cleaners too are pliable, allowing for connections that are smooth or jagged and straight or curved. From observation we noticed that participants loaded these physical, tangible qualities with meaning with the instrument inviting a perspective of ‘everything is connected’ and mutually constituted.

What guided us into picking specific materials and ascribing certain meanings to them might be seen as what Norman calls ‘signifiers’ (2008). Signifiers are indicators or signals in the physical or social world that can be interpreted meaningfully. Signifiers offer guidance to interpret a situation. We need the materials to quite unambiguously signify the most important theoretical concepts to scaffold tangible ‘theory work’.



Figure 7. The objects included in Product Ecology Balloons - sandfilled balloons with circular head (person) and pentangular head (product), pipecleaners (interactions), sandbox (environment).



Figure 8. In the Rites of Passage Tube instrument the half-tube (liminality phase) leads the ball (person) from one box (separation phase) to another (aggregation phase).

On the other hand, the materials must also allow the participants leeway to bring their own interpretations to bear. Schön (1992) observes that different designers often select different materials when presented with the same stock of available materials, and even appreciate the 'same' objects in different ways: *“Because each of them saw the materials in a different way, chose to use different items, singled out different features, and exploited different relationships between items and features, each student constructed a unique design world.”* (Schön, 1992).

We developed another Theory Instrument, the Rites of Passage Tube (Figure 8), to challenge participants to recognise that new technologies to users can mean quite fundamental transitions in practices, relations and identities not unlike rites of passages. Rites of Passage is a theory based on studies of how people in many cultures transition from one stage to another, e.g., from child to adult, from single to married. According to van Gennep (2013), such a transition, a rite of passage, progresses through stages: A stage of separation in which an individual detaches itself from a previous point in social structure; a stage of liminality and anti-structure in the margin (limen); and a stage of aggregation in which the individual is re-incorporated in a new social order, achieves a new sense of identity. The liminality stage is characterised by uncertainty: What must you do to depart from the familiar? What does your community consider necessary for you to fully transition?

The instrument consists of a ‘separation’ box, a ‘liminality’ tube, and an ‘aggregation’ box. Participants choose various haberdash objects to represent ‘signifiers’ and ‘rituals’, and wooden figurines to represent other people. To emphasise the theoretical meaning of all the various objects we spelled out the terms in printed signs saying what each box means or contains (Figure 8).



When discussing the electric vehicle charging case with this instrument, the participants investigated what characterises the transition towards becoming (acknowledged as) an electric car driver. Are there rituals involved? *“When you first get your keys, there is a moment when you go pick up your car and there is a sharing of knowledge about what the car is and what is going to happen (puts a key in the tube).”* One participant even told the story of her car being ‘unveiled’ from under a large cloth by the salesman at that occasion. Also, the first time you charge the car away-from-home might be considered a ritual, especially if there are other (experienced) drivers watching.

The term ‘liminality’ resonated well with the participants’ own experiences: *“...but even if you have that knowledge, there will be a couple of moments where you will be up-side down, stressing about what will work and what is not going to work”*. The drivers must develop new ways of understanding ‘driving’: *“The really interesting thing happens, when you are in the really unknown, where things are turned upside down is the concept of a battery, and the concept of the battery compared to the old sort of tank. Because the battery appears to you in many different ways, it appears as percentage, in terms of kilometres, in terms of kilowatts, in terms of maximum reach, and they are somehow all interconnected, and it is kind of confusing to navigate.”*

For decorating the Aggregation box participants chose objects as signifiers *“that tell people around you that you have an electric car: You have [your own] charger (metal pin with metal wire). You know how to use your iPhone with the charger (wooden pin with a small sign on it)”*. Once in the aggregation stage, drivers even display new driving practices: *“You are driving differently, slowing down to save power, hiding behind trucks to not have wind resistance... all of these things became part of how you navigate.”* The participants acknowledge that it does open a new perspective to look for rites of passage signs in the ethnographic research.

What works in this instrument is the variety of haberdash materials that challenge participants to think of stories and observations of different stages of becoming an electric car driver - and the theoretical terms that provide a language to talk about them. According to Ingold anything we come across can in principle be regarded as either objects or a sample of material:

*“To view it as an object is to take it for what it is: a complete and final form that confronts the viewer as a fait accompli. It is already made. Any further changes it may undergo, beyond the point of completion, consequently, belong to the phase of use or consumption...[..] To view the same thing as a sample of material, by contrast, is to see it as a potential—for further making, growth, and transformation. In a world*

*of materials, nothing is ever finished: “everything may be something but being something is always on the way to becoming something else”* (Ingold, 2012, p.435).

If the instrument in Ingold’s words is viewed as a collection of materials rather than an object it can be seen as *“a potential—for further making, growth, and transformation”* (Ingold, 2012). Ingold might have meant this metaphorically but perhaps the physical engagements with Theory Instruments show this potential.

## THEORY AS INTERACTION

In the Rites of Passage Tubes instrument, the theory is embodied in a particular *moving* of the ball (person) transitioning from the left box (separation) to the right box (aggregation) via the half-tube (passage). The material is used not just to lay out a particular arrangement, where each object has a particular theoretical meaning, but the movement itself is central in explaining the theory.



Figure 9. Two iterations of the rites of passage instrument, both with the idea of a ball moving - along train tracks (a) and through a vertical tube (b).

The idea of the rites of passage as a ball moving was central already in the first iterations of the design (Figure 9). In an early mock-up, the passage was symbolised with train tracks, on which participants would move a ball over objects that signify rituals. In the next mock-up, the ball would drop through a tube - but would be stopped by handwritten ‘ritual’ signs slotted into the tube. However, the fact that the ‘passage’ was invisible inside an opaque tube led to the idea of a transparent half-tube in the current design.

An instrument that even more clearly banks on the explanatory power of interaction is the Reciprocity Balance instrument (see Figure 10). We designed this to focus attention on the way companies/organisations build relations with customers and users through various forms of exchange – tangible and intangible, in the digital as well as in the physical realm.

Twentieth-century social and cultural anthropologists developed theories of exchange and reciprocity to



Figure 10. Reciprocity Balance instrument

explain how relationships are formed through cyclical patterns of gift giving: Mauss (2002) divides these cycles into obligations to give, to receive, and to reciprocate. With new or casual relationships, we give gifts of equal value and we reciprocate in short, frequent intervals, like paying for lunch. The period from “I’ll get you next time” until you return the favour, is what establishes trust and good will. As Levi-Strauss (1996, p.59) said: *“There is much more in the exchange itself than in the things exchanged”*. With deep or family relationships, the reciprocation intervals are longer, and the gift value varies.

The balancing rod of the instrument can tip to one side or the other, depending on how many clothespins you attach to it –and how far along the rod they are placed (Figure 11). Each pin represents a gift or gesture towards the other that must then be received and reciprocated with a pin on the other side of the balance point. In our workshops, players assigned additional meaning to the colours, material, and number of pins.

In the electric vehicle charging case, the instrument triggered the participants to think of how drivers build relations with the charging service company - beyond a simple idea of ‘buying electricity’: *“In this model, the ongoing relationship between the car owners and the infrastructure that is provided by the company is always going back and forward (rocking the balancer) because it is dynamic. It is always in change - unbalanced and balanced again.”*

The instrument encourages the participants to play roles as driver at one side and (e.g.) service provider on the other: *“we (points to the ‘driver’) plan our charging activity, and you (points to the ‘service provider’) help us plan the charging activity, and when to do it. But you (‘service provider’) gain a lot with it, because the net will not get overloaded” [...]“...in the end we made a relationship that was more than just the money”*

The balancing of the reciprocity instrument invited participants to think in terms of value exchange, often between user and company. It triggered discussions on the fairness of the exchange (is the user putting in more than the company?) and what each side is investing into

the relationship (is the company’s offering really that valuable from the user’s point of view?). The rocking movement and tipping action of the balance embodies the ongoing discussion as participants hang clothes pegs on either side.

Kirsch stresses that thinking and sensemaking very often is interactive. Interactive meaning: *“a back and forth process: a person alters the outside world, the changed world alters the person, and the dynamic continues”* (p.441). The interactive process of projecting structure and materialising it is according to Kirsch one of the most fundamental processes of thought:

*“When we interact with our environment for epistemic reasons, we often interact to create scaffolds for thought, thought supports we can lean on. But we also create external elements that can actually serve as vehicles for thoughts. We use them as things to think with”*. (p.445).

Our last example, the Actor Network Rings instrument, has a particular focus on moving objects (Figure 11). Actor-Network Theory (ANT) was developed by Latour and colleagues (1992) to describe the interactions between human ‘actors’ and nonhuman ‘actants’ to achieve something together, a ‘programme of action’. *“We have been able to delegate to nonhumans not only force as we have known it for centuries but also values, duties and ethics”* (1992, p.157). Rather than seeing ‘the social’ as completely separate from ‘the material’, Latour suggests that things have agency comparable to that of humans. He uses the term ‘disciplining’ to describe how actants influence the practices of agents. To make explicit the agency of things, he introduces the idea of ‘imaginary substitution’: *“...every time you want to know what a nonhuman does, simply imagine what other humans or other non-humans would have to do were this character not present. This imaginary substitution exactly sizes up the role, or function, of this little character”* (1992, p.155).

The Actor-Network Rings instrument consists of wooden rings, wooden and colourful clothespins, coloured magnets, and wooden balls (Figure 11). The wooden clothespins are actors, the colourful (black, white, or



Figure 11. The Actor Network Rings instrument

orange) plastic pins are actants. They attach to a ring to form a network that ‘upholds’ a wooden ball, visualising a programme of action. Imaginary substitution is mimicked by removing or replacing single pins. Disciplining is shown with magnets.

When the Actor Network Rings instrument was introduced in the case of electric vehicle charging, participants carefully analyse the combined system of human and non-human actors, and how they support the goal: “... you have got the car, the technology, the app, the screen in the car. All sorts of things that are kind of working against charging the car. So it is the willpower of the person who kind of lifts the main goal (points to the ball)...”

The option to move the pins up or down to support the ball takes on meaning: “We noticed that maybe there was too much technology (P1 turns the black pin downwards and the ball falls to the table) so that eventually the task it not supported (imitates to put the ball back on top)...but then we also figured that the technology is there for a reason and in some cases it is actually beneficial (turns the black pin back to its original position)”. And as the activity unfolds, the participants come to think of even more actors and actants: “You cannot disconnect the cable when the car door is open...so there is reasons for that (adds technology pin)...” “This other problem is also potential criminals” (adds a wooden pin) — if there wouldn't be any criminals, this app would not be needed at all...a lot of the things that make the use difficult are because the engineers thought: Oh otherwise other things will go wrong”

Both the Reciprocity Balance and the Actor Network Rings instruments build dynamic behaviours with the materials. The rod contraption prompts participants to achieve a balance of ‘gifts’ over time by adjusting how many clothespins might sit on the rod and how far from the balance point. To tip the balance is fun, but also triggers reflections on real-world relation building. To make actors and actant pins ‘uphold’ (balance) the heavy ‘programme of action’ ball with the Actor Network Rings is precarious. What is it actors and actants achieve together, and what happens, if one of the coloured clothespins is removed?

Schönian *backtalk* is at play: The material behaves in unexpected ways, it responds to the moves participants make (Schön 1992). The dynamic challenges embedded in the instruments’ forms clearly stimulate the conversation between participants. This is a phenomenon also described by Mitchell et al (2013) as ‘Oops! Moments’: “Kinetic materials offer different ways to do so, and with their dynamic behaviour, generate ‘surprises’ and unexpected events that challenge participants to relate those behaviours to something that

makes sense in the [business model] context.” (Mitchell et al 2013).

One feel obliged to translate what happens with the physical instrument to what it might mean in terms of theory concepts.

## DISCUSSION

Do the new perspectives brought about by the Theory Instruments help uncover observations that were previously invisible to the designers? Do they also open new design opportunities? In the electric vehicle charging case it is comparatively easy to see how the perspectives brought about with the Theory Instruments scaffold new discoveries and might also inspire ideas for improving the situation, for instance mentioned in the workshops:

- Support social relations between drivers in the family, among neighbours etc. (Product Ecology Balloons).
- Make the ‘key ritual’ an event for the entire family (Rites of Passage Tube)
- Reconsider value creation towards a symbiotic relationship in which the needs of both consumers and service company are addressed (Reciprocity Balance)
- Make clear, why the technologies seem to counter-act easy charging (Actor Network Rings)

Our engagements with the instruments in the field provide an opportunity to reflect on materialization. Finding ways of conveying theory in material form is a challenge. With each theory instrument, the specific materials chosen highlight and de-emphasize particular aspects of the theory. Our intention was that the instruments themselves simplify understanding of the theories. The design process, hence, was also a process of boiling each theory down to its core and deciding which core qualities needed to be embodied in its corresponding instrument.

Is the design of the theory instrument dependent on the backgrounds and orientations of our design team? Most likely. Our approach has been as best as we could to ensure a cross-disciplinary effort to diminish biases. Our team brought together two design-anthropologists, two industrial (artistic) designers, one design engineer and one interaction design student. We approached theories as schemes for organizing ideas and making sense of the world. We were less concerned with how faithful the theories were interpreted in the instruments and more interested in how the collection of instruments offer participants the opportunity to adopt multiple perspectives. A theory’s utility is in its relevance to the thinker and the subject at hand. In this way, we argue



that the Theory Instruments create new ways of thinking with materials allowing designers to see ‘the invisible’.

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