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Demystifying the design process of demonstrators: contextual inquiry of two cases

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Abstract

Over years of practice, industrial designers have developed three steps that always lead to a design solution: inspiration, ideation, and implementation. Usually, the result is a product, but sometimes it is a demonstrator, a versatile concept, combining design, engineering, and art. However, designers usually are not aware of this notion. But if the result is different, how does it affect the design process? The analysis of the contextual inquiry study of two demonstrators shows that the transformation should happen during the ideation phase, where abstract concept becomes a story.

Keywords: demonstrator, contextual inquiry, design process, design knowledge, tacit knowledge

1. Introduction

The process of designing a commercial product is often seen as so highly dependent on intuition that it seems mysterious (Kahneman and Klein, 2009; Klein, 2017; Newman, n.d.). However, it can be generalized to three steps, leading to a design solution. With some variations, their design process consists of inspiration, ideation, evaluation, and implementation phases, preceded by conducting some research (Brown, 2008; Design Council, 2007; Dubberly, 2004). The result most likely is a commercial product that aims to solve a certain customer problem, to be manufactured and then distributed. However, sometimes the resulting object has uncommon characteristics: the design is final (not supposed to be reiterated) yet it doesn't mean to be produced, it is being exhibited instead of sold in retail, and it conveys a complex message. In other words, it shows what might work rather than what works (Brand, 1988; Sviridova *et al.*, 2022).

Such objects are demonstrators, tangible objects combining design, art, and engineering. Coming from innovative technology research, they communicate it to non-academic stakeholders (Bobbe *et al.*, 2023). Scientists use demonstrators to make their research visible and support bringing it from laboratory to market. However, due to the lack of expertise in user experience design, these projects often look very technical and can be mistaken for prototypes. If made in design studios, demonstrators delve deep into complex ideas and implement them as engaging interactive objects to let the visitors explore the topic at their own pace and depth (Sviridova and Verlinden, 2023). They usually rely on technology, but as a tool rather than a focus point. The message they convey is connected with a societal or philosophical problem, which doesn't have a solution yet (or cannot have one). Designers often define such projects as tangible design research or interactive installations as they don't know the notion, unlike technology labs, where the term 'demonstrator' is quite common. We assume that the design process that results in a demonstrator, is different from the one that results in a commercial product. If so, then in what step lies the transformation?

To answer this question, we conducted a contextual inquiry study with two design studios who intuitively came up with a demonstrator. In each case, we interviewed a main designer, a client (here, a person from outside the studio who initiated the project, if there was one), and observed how people interacted with the object.

2. Method

As the understanding of demonstrators is still in progress, a method of contextual inquiry was adapted for the study. Although it was initially designed to support engineers, we find it quite efficient to develop an understanding of domains with little prior knowledge. The method embraces the constraint of a small sample of users in this case and mitigates it by looking for participants with a maximum difference between them to gain a better comprehension (Beyer and Holtzblatt, 1997; Wixon *et al.*, 1990). It usually implies a series of two-hour one-to-one interviews, where a researcher watches a participant following their normal activities and asks to interpret them. Design demonstrators are made by using tacit knowledge as designers would often make decisions intuitively (Albers and Wiedner, 2011). Therefore, to elicit principles of designing them and possible influencers, participants were asked to draw a timeline for their project, mapping inspiration sources and parallel projects. They were also asked to reflect on the reaction of the audience to the projects, which was later compared to on-site observations conducted by the researchers.

2.1. Case selection

At first, we had to find demonstrators to study. The definition of a demonstrator is still quite vague, as well as the difference between them and the results of other design outcomes (Lim *et al.*, 2008; Malpass, 2017; Sviridova and Verlinden, 2023). Therefore, a checklist was developed and a project could only be selected if it met all the conditions. According to the checklist, an object is a demonstrator if: 1) the design does not imply any further iterations. It looks complete, refined, and aesthetically pleasing. It can partially mock the promoted functions, but it should look real to the audience; 2) it conveys a message about the research it was built upon and it is about the present or very near future. Demonstrators are suggestions, not speculations; 3) the technology used is not science fiction and the project can be realized at its fullest with the current level of technological development. However, demonstrators should be more creative than just a direct application of it to known products. Concept cars and fashion clothing often can be considered as demonstrators, but there are plenty of those so let's look at something less conventional; 4) it is designed for a non-expert audience and mediate communication between very different groups of people; 5) it is impossible to buy (several copies of) it right now.
The location was limited to Northern Europe and focused on projects accessible on-site to get first-hand experience. A list of ten projects for potential study was compiled, summarized below. They were validated by three independent experts with experience in designing and studying demonstrators, who filtered non-demonstrators out.

2.1.1. Smog free project

A series of projects that show the beauty of clean air. Consists of a tower, a concept of an urban vacuum cleaner using green electricity and positive ionization technology, a bicycle, that filters polluted air through a plug-in device on the steering wheel, and a souvenir ring, made out of compressed smog particles collected by the tower (Studio Roosegaarde, 2019)(Figure 1). All three experts agreed that this project was a nice demonstrator: innovative, makes an abstract concept of air pollution tangible and aesthetically pleasing, and engages the audience to rethink the way they see the world.

2.1.2. The energy collection

A series of tableware that collects solar energy from its surroundings. Each object is made of glass and contains a photovoltaic layer of a solar cell that collects currents based on the dye inside. It can release the collected energy to the cupboard through a conductive copper ring on the bottom when connected to the shelf. The gained electricity is stored and can be used to charge a phone or a USB lamp. The Energy Collection materializes the idea of harnessing solar power through everyday items (van Aubel,

2012) (Figure 1). The experts noted how nicely this project draws away from technology, drawing a new perspective on how solar energy can be domesticated aesthetically. All three agreed that it was a demonstrator.

2.1.3. Living with the Sun

A master thesis project by a Dutch student whose initial goal was to live a week using only the energy he could generate himself. During the experiment, the designer explored whether he could harness solar energy without having access to the rooftop. The result was a solar-powered kettle and coffee-bean roaster he created pursuing the comfort he lived in before the experiment. The appliances consist of a two-layer system of glass tubes allowing sunlight to be converted into heat, enough to boil water and roast coffee beans (Buitenhek, 2022)(Figure 1). All three experts agreed that this project was more of a prototype of a product idea, it didn't add much to the theory.

Figure 1. The smog free (left), the energy collection (middle), and the living with the sun (right) projects

2.1.4. The HY clutch

A fully 3D-printed clutch, including an integrated closure clasp, partial opening hinge, and interior pocket — all created by the same process and material. The design is inspired by natural fungi structures and can only be produced by using additive manufacturing (Figure 2). The clutch is available in the online store and can be customized by adding the customer's initials and monograms (Koerner, n.d.). According to the designer, the product demonstrates a new approach to disrupting traditional manufacturing techniques and questions environmental concerns. However, two out of three experts were not convinced and wouldn't call it a demonstrator as there were already too many projects executed similarly.

2.1.5. Balanced haptic biofeedback

This project combines everyday garments with the technology of using haptics for biofeedback to support stress reduction. A conductive wire and an embroidery thread form a circular motion pattern oriented to the inside. Together with an attached magnet, it creates a coil effect. Integrated into the garment, the wearer can start a breathing exercise by taking a certain sitting position. Hands movement back and forth on the pattern creates voltage that makes the magnet vibrate. As these vibrations occur with a certain frequency, the wearer can align their breath with them and slowly build it down to calming deep breathing (Van Der Lugt and Feijs, 2019)(Figure 2). Although the experts appreciated the idea, they believed it didn't answer the societal problem it raises. Meaning, by adding so much story to it, the designer lost the focus of what this product could be.

2.1.6. Quick fix

This machine allows the user to buy followers or likes on social media in just a few seconds. It is designed to be easily customizable for any platform and any currency (Depoorter, 2023)(Figure 2). The experts unanimously agreed that it had too little story and didn't add too much to theory to be called a demonstrator.

Figure 2. The hy clutch (left), the balanced haptic biofeedback (middle), and the quick fix (right) projects

2.1.7. Human cloud project

A series of experimental tools aim to inspire intimacy with the climate. A user breathes through the collector, which requires them to slow down their breathing. It decreases the heart rate and blood pressure and leads to a state of relaxation. The exhale then cools down in the chamber till it reaches a liquid state. When collected enough exhalations, the cloud generator delivers them to the sky in a weather balloon, where they get released, forming a cloud. Launched in the atmosphere, cloud formations reflect sun rays into space, thus slowing down the rate of global warming (Figure 3). The designers meant to suggest a temporal solution that can buy us some time, while geoengineering technology tackles the root causes (Stanislavskis, 2021). The opinions of experts had divided: while one appreciated the work of making things tangible, two others found this project to be too much about the story than a demonstrator should be.

2.1.8. Love letter generator

This project explores how generative AI can influence society. To generate a love letter, a visitor should first answer a few questions. After the piece is done, the AI will ask some more questions, and then even more (Figure 3). The designers invite their audience to ponder on the costs and risks generative technologies can bring to our lives (Bedrijf de Liefde, 2022). However, the experts found the message too vague and not quite graspable by interacting with the installation. They also didn't find the execution convincing enough to be considered a demonstrator.

Figure 3. The human cloud (left) and the love letter generator (right) projects

2.1.9. Plural

This kinetic object visualizes interconnectivity within social environments. The audience interacts with a complex woven network, which is a great metaphor for our society, by passing their hands over it. The impact immediately becomes visible and it depends on the time of the interaction (Figure 4). It also embeds specific terms, such as equality, dominance, empowerment, and so forth, shown after pressing

a designated button. The installation consists of motors that move elastic strings and thus influence the threads connecting them (Mischer & Traxler, 2019). All three experts agreed it was a demonstrator as it materializes an abstract concept in an aesthetically pleasing way, while the interaction engages the audience to learn more about it.

Figure 4. An interaction with Plural (left, middle) and its location in the museum (right)

2.1.10. Narcissus

This kinetic art project consists of eight moveable hexagon mirrors, connected to actuators. When a visitor comes closer, they will move one by one to focus on them and track their movement. Thus, the visitor will see eight reflections of themselves. However, if there are two or more people in front of the object, the mirrors will divide into parts and the visitors will see each other (Figure 5). The designer meant to explore how the behavior of people reflects their nature: they noticed that some people feel awkward when eight mirrors show them their faces, while others, on the contrary, enjoy it (Blok, 2022). The experts found the implementation of such an abstract concept into a tangible interactive object solid enough to consider it a demonstrator.

Figure 5. Narcissus while catching multiple faces (left) and how visitors see it (right)

The last two projects were selected for further study due to the limitations of timeline and logistics: Narcissus, developed by an independent designer, and Plural, commissioned to a small design studio by a design museum. The interview with the former took place in person, at the designer's studio and took around two hours. For the latter, one of the studio founders was interviewed online. In total two meetings around an hour each were held. Interviews were semi-structured with questions intended to frame the studied project in the context of the designers' values and to explore the process of designing it in detail. In each case, the aim was to if there were particular events leading or influencing the decisions made by all the stakeholders during the design process and to learn their perspectives. To understand how demonstrator is perceived by their target audience, observations were made in addition to indications from the stakeholders.

2.2. Contextual inquiry of Narcissus

Origins and development

The inspiration for Narcissus came from the idea of making a kinetic machine with mirrors that is interactive. For the designer, who has a background in engineering and describes his values as technical,

personal, and experimental, it started as a mechanical challenge. After dozens of prototypes, the construction was set, yet some more time took the refinement of the interaction. However, when he showed his first prototype to his friends, they noticed that the result was more than just a technical gimmick. One of them recalled a legend of Narcissus, a pretty young boy who was turned by a goddess into a flower for being too self-affected. After this, the designer studied the mythology around this story to better understand the reasons why people might react differently.
The whole process from the idea to presenting Narcissus at a large exhibition took less than a year. Implementation and evaluation took the most, while the inspiration and ideation phases were the shortest. The conceptualization was mainly about choosing and designing the components, however, it took quite a while. The finetuning phase was relatively long as it took a while to ensure smooth operation, but also to test if people reacted as planned. (Figure 6).

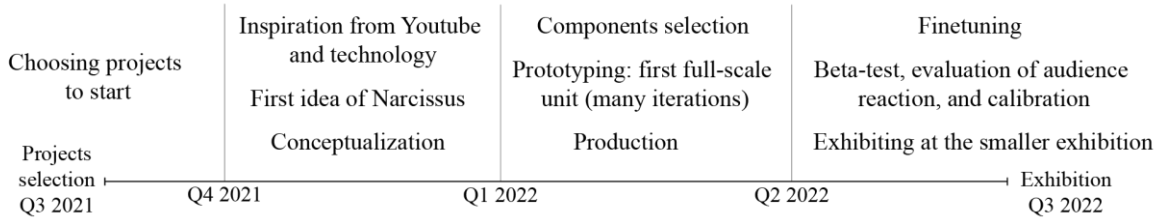

Figure 6. Timeline of the development of Narcissus

Design qualities and audience response

The designer wanted to make sure the result was beautiful. Before attending a large exhibition, several versions of Narcissus were exhibited in different environments, like a barbershop as a beta test and a smaller maker space exhibition. In the former, it barely drew attention: people were not ready to meet an interactive installation at the place they visited with the specific purpose of getting their hair done. At both exhibitions, the audience reacted as planned: those who stopped in front of it for at least 10 seconds to give the automatics time to focus found out that all mirrors were showing them their face and following them wherever they went. The designer asked several visitors about their impression and they said the feeling was quite intense, as if somebody was staring at them. Some people would find it uncomfortable and immediately step out, some would stay much longer, looking back at their reflections. There were lots of laughs when people would come in groups and see how the mirrors show each other. Nobody confirmed they were narcissistic, but people agreed with the name. This is how the designer knew his project worked. Although the installation was quite satisfying and well-working, he believed it could be more exciting so probably the design is not final yet.

Observations

The observations were made during a conference on topics of design and art that hosted around three hundred people, mostly from academia, with backgrounds in design, art, or engineering. Narcissus was exhibited at the main common space and observed during lunch and coffee breaks, that were served there. The object was not so popular during lunch as people were busy with their food and didn't have much time to browse the surroundings. During coffee breaks, more people were attracted by Narcissus. In between these two periods, the designer gave a short presentation about the project, which might have piqued the interest of people to find it and try to interact. Given that, most of the people noted in the graph, engaged with Narcissus, they took their time to figure out how it works, took pictures with it, and had conversations with the designer who was around (Figure 7). A few people passed by not interested, but just as few read the additional materials explaining the concept deeper. Most people spent less than a minute to interact with the object, but several people stayed for longer than two minutes.

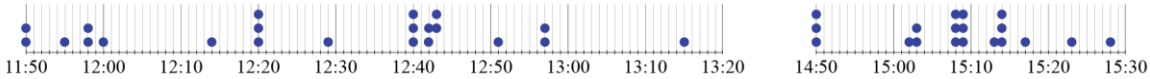

Figure 7. Observations of Narcissus

It seems that a demonstrator should be exhibited for an audience that is perceptive and open to discover new things. Moreover, at the exhibition people are willing to be surprised and entertained, so it doesn't

hurt if the project's appearance is catchy, while at the conference people expect networking, so they enjoy talking to the designer in person and exchanging contacts. It also means that no matter how well the demonstrator is designed, it wouldn't work in a place where people would go for another reason, such as a shopping center or a train station unless it was designed for such a place specifically.

2.3. Contextual inquiry of Plural

Origins and development

Plural was made by a small design studio, which currently consists of four people. Each project is a group effort with a constant dialog between all the members, however, final decisions are made by two founders. In three words, they would describe themselves as curious, versatile, and without handwriting, meaning a distinctive style. The latter is important for the studio that their clients commission them projects with quite open briefings and never know exactly what they get at the end.

The main interest of the studio lies in the area of interconnected relationships between a human and nature and that there is so much that can't be separated. They see themselves as 3D communication designers, who want to talk not just about the object, but about the topic and have a lot of interest in the translation of scientific data or studies into tangible outcomes.

When they design a project that should work in a certain way or evaluate if it worked as planned, the knowledge comes from the feeling point of view and experience. They learn not only things that are working but also which things to consider more carefully in future projects. Thus, each project is an experiment in a way, as soon as something new is developed for a context they find a different solution.

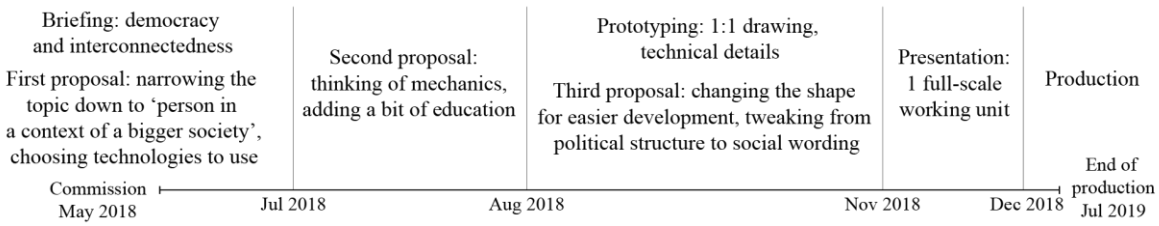

Figure 8. Timeline of the development of Plural

A curator of the project from the museum side corroborated the timeline described by the designers. They commissioned Plural because they already knew about their kinetic sculptures. She points out that, unlike other museums, their topic is usually bigger and more abstract, so it was important to find a way to convey this message to the visitor. They developed the patterns together with the designers, trying to figure out what social notions could look like. She said you need to trust in art when trying to show such complex things in a simple way. Experience reduces the percentage of surprises, also they organize interviews with visitors from time to time, but the result can be unpredictable.

Observations

Observations were made at the museum, that commissioned Plural, located in Berlin, Germany. Several timeslots were chosen, in the morning and the afternoon, the period was close to Christmas, so to mitigate the possible increase of visitors, the observations happened partially during a work day and a weekend day. However, after the first half of an hour, the researchers noticed that Plural did not react to the visitors' movements even if they spent quite some interacting with it. A museum worker said that it was bad luck, and the installation worked earlier that week. Unfortunately, it wasn't repaired during the time the researchers were there for the study, so results are not very valid and therefore only one timeslot is presented below (Figure 9). The behavior and the number of visitors were pretty much the same during the other timeslots. Nevertheless, Plural attracted people, only a few passed by it without stopping, while most spent a minute on average to read the description, push the buttons, and wave their hands above the network. Even being out of order, the object can tell a lot about notions of political structure thanks to the comprehensive description on the wall and the simplicity of a visual metaphor. Plural is located in a hallway together with another object (Figure 4, right), however, visitors would choose to approach Plural rather than that other installation regardless of the direction of their movement.

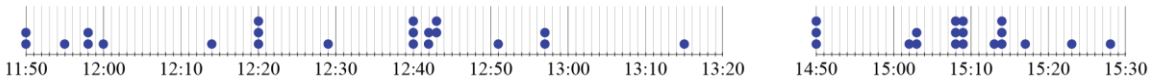

Figure 9. Observations of Plural

3. Cross-case analysis

Due to the different backgrounds, the participants have a very different approach to designing. The designer of Narcissus started his career only a few years ago. He came from engineering and, in his own words, did it "the other way around": he started from a technical challenge, realized that it became something more than just a technical gimmick, revealed a hidden message about human behavior, and then did research discovering references to it in history, mythology, and science. The designers of Plural have more experience and this is why they are more confident in evaluating the result. Despite the high technical level of their works, both participants indicated that they only use technology as a tool, to draw attention and engage the audience, but never to be the core.

The designer of Plural identifies three layers of a project: a visual one, where people see it, make it their own, and judge it; an educational layer, where they easily and quickly pick the basic message of the project without reading any text; finally, a deep layer, where people can dive into the research that is behind the project if they want to know more. A visitor, thus, is a key part, who comes into a dialogue with a project, that doesn't give any concrete answers. Instead, it asks questions, but by coming up with their conclusions, a visitor gets the experience that stays with them.

The designer of Narcissus wants its audience to be emotionally engaged and amazed with his project and believes that it will encourage them to also learn more about the technology behind it. Despite all differences, both of them completed all steps of the design process with similar results (Figure 10).

In both cases, the designers couldn't explicitly explain how they knew that the object would work the way they wanted it to work and apparently, most of the decisions were made intuitively. They often refer to their inner understanding: they knew if 'it felt right' or 'the outcome is not right'. From the positivist point of view, which is quite common in academia, it is probably some sort of mysticism. Pepper (1942) describes mystical experience as revelatory, immediate, indubitable, ecstatic, unified, comprehensive, and negating other modes of cognition. Indeed, "Any sufficiently advanced technology is indistinguishable from magic" according to Clarke (1973). Nevertheless, it is reckless to mistake demonstrators for magic devices even with their advanced use of technology. The analysis shows that there is no difference from the usual design process in the inspiration (research) and implementation phases. However, during the case selection process, the experts often mentioned 'too much' or 'too little' story projects had. Therefore, we believe the 'magical transformation' happens during the ideation phase and it should be related to the 'amount' and 'quality' of story the project has. Probably it is about the intention: designers of demonstrators want to make a topic visible, not a product. Demonstrators rarely start as client projects. Usually they are a result of a collaboration or commissioned by museums or art-centres. In both ways, it is crucial for designers to keep the freedom of topic interpretation, which might lead them to find new ways of transforming them to stories. However, during the ideation and the implementation phases, both participants also find important considering different perspectives and adjust the concept accordingly. Both participants evaluated the effect by observing and talking to people interacting with the objects.

4. Discussion and conclusions

To find out how the process of designing demonstrators is different from the process of designing commercial products two projects of design demonstrators were selected for a contextual inquiry. This method allows building understandings even with a small sample of participants due to their diversity. Interviews with the stakeholders showed that the phases of evaluation and implementation are the same for designing a commercial product and demonstrators. On-site observations of the objects confirmed that both projects work as intended, although the participants could not explicitly describe what that 'intended' meant at the start of their project. Together with remarks from the experts about the 'amount' of story in the projects during the project selection process, this led us to conclude that the difference lies in the research or ideation phases.

The designers of this study could not evoke how exactly they came up with an initial idea after the research phase. Neither could they explain how they knew if the result worked as planned, let alone if it was 'entertaining' or 'educating' enough. Given the difference in complexity of initial challenges for commercial products and demonstrators, it seems that during the ideation phase an abstract concept (research results or new technology) transforms into a story that eventually becomes a tangible object. This process might be the key to understanding the nature of demonstrators. This demystification continues with identifying and describing that process.

	Narcissus	Plural
Inspiration (research)	[I was inspired by] Mainly YouTube, [videos] about kinetic machines, [about] projects that do interactivity. But then you also add for example history study here. What is the history of this subject? ... But here (Narcissus) also there was the mythology. It's just still started from experiments and it's personal. How does this work? From reading about science? ...So these things bring also ideas, and ... they spark something. Wait a minute, maybe I can do something with that. That's how narcissus came to me. I saw things and then they came together.	I think it was based ... a lot of this balance and this interconnectedness and that everything is connected also on a society level. This was the briefing. It's important when we also have the time for the project and ... a little bit of budget, we ... want to make this research accessible. For the [previous] project, we made five books which were more like five different topics which were mentioned by the scientists. It was not super clear. It was more like this topic. Then we actually defined it, Okay, the impact of a single person in this society context.
Ideation	That's what's got me interested. Can you do something with mirors that is interactive? Because that is what a mirror is about it's about looking at yourself, not just making nice shapes. I wanted to go for a prototype quickly and for me the real difficult aspects. Where this motor, face recognition and the algorithm to get those three together. And then I thought about the shape.	Okay, how could bigger systems and singularity be combined? It had to be with different dots which are all connected, but then still the possibility to put the person in focus or to visualize this person over a little bit to abstract this impact. These were the three directions. The one was more about mixed lights and the other one was more about magnetic spheres... Here it was more, okay, the single person in single light dots which was then disappearing in the bigger RGB work. This was more like how people move in a certain way, but this was a bit too weird anyway. Then the third one was this one that was actually planned to have this network From the wording change from political wording to social wording ... because we all had the feeling that it then fits, you feel more attached to it
Implementation	I came up with this is how I'm going to do it? But then I made I think many proto[type]s... [It] went through countless of iterations. I think I made dozens of them to get how to make a ball joints correctly and have them printed. I think I had this calibration... It is way too complicated so I need to... I think I worked on it... two months.	[after many adjustments] ...in the end, we developed actually the whole mechanics as well in the studio We actually used the motor, made these adaptations and made all this technical knowledge we had at that time.
Evaluation	[beta-test at a barbershop] I think people liked it. But I don't think it attracted a lot of attention. ... People walk in, go to their, do their thing and leave. [at the exhibition] they [visitors] agreed to the name. That's a good name. That's what I heard a lot. ...that's how I think my conclusion is that it works What I'm now doing is doing technical engineering stuff to make something that is not practical. Oh, it's about looking in mirrors, and the thing needs a little bit of time. Seconds to catch you and to start turning to you. So sometimes [visitors] ... moved on too quickly and then they completely missed it. But most of them didn't and then they stood there for a second and ... [they started] to realize what's actually going on ... They grasp it and then ...there's this shock of intensity... Basically someone like somebody staring at you.	I find this project super beautiful. I think also with this aspect of visualizing actually something super complex like self-centeredness or democracy or connectedness, I think it works very well. Also with these buttons, I'm very happy also with the choreographies, how they move, I think. I think the project is, in my personal view, very beautiful and also from a conceptual point of view, it has a very nice storytelling quality. You don't need to... It's very intuitive and so on. One of the most emotional experience for us last was .... when we were setting up [another project] an it's also programmed its own choreography on the table when no one is there and it's moving ... two minutes... And then there was this guy who was painting all the booths. He was standing there and watching it and watching it... And when it was over, he applauded... it was one of our most unexpected and remarkable reactions because it shows that it is touching people.

Figure 10. Excerpts from the interviews with the designers of Narcissus (left) and Plural (right) illustrating their approach to steps of the design process and how they evaluate if the result works

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