P/REFERENCES OF DESIGN

INWARD A DEMONSTRATOR: EXPERIMENTAL STUDY TO REACH DESIGNER'S INNER CONVERSATIONS THROUGH INTERNAL FAMILY SYSTEMS.

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ABSTRACT | Design research is developing swiftly, adopting a lot from the scientific approach. However, rationalistic methods tend to limit their discoveries to ungeneralizable situated knowledge and lead to the separation of practice and theory, leaving unaddressed the tacit knowledge that design massively relies on. In this paper, an experimental tool is developed and tested that allows using design skills to explore their design decisions inward. During the design process, designers tend to adopt multiple perspectives of, for example, a client, a user, and a producer, and quickly switch between them looking for the best solution that suits everyone. We believe introspective methods are important for design researchers as they provide a better understanding of tacit principles guiding these shifts. The Internal Family Systems (IFS) approach suggests that as human beings, designers also have a set of personal perspectives, which might interfere with their design decisions and cause frustration. To reach them, an experimental card-sorting workshop was held with a designer who was still disturbed by one of the demonstrators he designed despite the time passed. Preliminary data was collected by interviewing the stakeholders and used to prepare the topics guiding the discussion. The workshop, guided by IFS techniques, revealed conflicts in the roles the designer plays as an executor, a company owner, and a private individual, which seem to be common in design practice. Further development of the tool might unfold a promising direction in design research towards bridging the gap between theory and practice, as well as design and research skills.

1. Introduction

Design research is developing swiftly, adopting a lot from the scientific approach. However, rationalistic methods tend to limit design research discoveries to ungeneralizable situated knowledge. This, in turn, leads to the separation of practice that is rapidly expanding into new domains and theory that is unable to follow it. Moreover, it leaves unaddressed tacit knowledge of design practice, that is often inseparable from the personality of a designer.

During the design process, decisions are often made by designers intuitively, even if they are based on solid ground of experience (Albers and Wiedner, 2011). Chow and Jonas noticed that keeping a distance from the studied object will never let the researcher fully comprehend the relationship between the designer and the design system (2008). Designers, however, have the necessary skills to position themselves inside it and obtain knowledge through practice. Furthermore, this perspective identifies a missing piece of design research — studying a finished project after being a part of it, or research AS design (or inward or inaccessible research) (
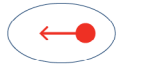Figure 1).

Observer position ● Observer looking ⟶	Outside the design system	Inside the design system
outwards (convergence)	research FOR design	research THROUGH design
inwards (divergence)	research ABOUT design	research AS design (inaccessible)

Figure 1. The concepts of research in design according to the observer position (see Chow and Jonas, 2008).

Moreover, the complexity and abstractness of design solutions are rapidly increasing. As opposed to the scientific approach that aims to reduce this complexity, design research thrives on it (Grand and Jonas, 2012). Therefore, to enhance the quality of the research skills of intuition and empathy inherent in designers should be mastered. Inaccessible otherwise, tacit bodies of knowledge can be accessed with the assistance of tools based on those skills. As a starting point of our study, we choose a demonstrator that has a richer soil for conducting such research (Sviridova *et al.*, 2022a).

In this paper, we develop and test an experimental tool allowing a designer to examine, report, and appraise their thoughts and experiences. The study is based on a case of a demonstrator, whose author claims to feel frustrated with it and still does not know why it was designed this way. To uncover usually tacit guiding principles, a series of interviews with all parties involved in the project-creating process were conducted. Based on the obtained knowledge, an experimental card-sorting workshop was held with the designer. According to the working hypothesis, during the design process, designers tend to adopt multiple perspectives of, for example, a client, a user, and a producer, and quickly switch between them looking for the best solution that fits everyone. To reach these perspectives of a completed process a combination of guided introspection methods with the Internal Family Systems approach elements was used. The researchers prepared cards with words that represented categories of possible reasoning based on the analysis of the interviews to guide the designer's inner conversations. The workshop revealed conflicts in the roles the designer plays as an executor, a company owner, and a private individual. These conflicts seem to be common in design practice and studying them might unfold a promising direction in design research towards bridging the between theory and practice. Moreover, a further development of the tool might help design research uncover guiding principles that are normally tacit such as designers' value

systems, enablers, drivers, or limitations.

2. Background

The ideal tool for conducting inwards research should be suitable to be used by designers in their practice, helping them identify and locate design rationale and strategic reasoning. However, as it deals with extremely vague matters, developed skills of reflection and introspection are required. As this study only describes the first attempt at developing such a tool, it was designed to be used with a researcher as an assistant. Otherwise, the data obtained might have been too unreliable for the rigor analysis. To acquire the necessary skills, researchers are suggested to use methods of guided introspection and the Internal Family Systems (IFS) approach. As domains of sociology and psychology have great experience in studying how people think and behave, the adaption of their practices seems to be promising for helping designers reconnect with their work.

2.1 Guided Introspection

The skill of reflection allows experienced designers to form a dialogue with the design process of constantly growing complexity and take the potential unintended consequences of their actions into consideration (Schön, 1984). It helps guide the process toward the best possible result, however, it does not aim to investigate subjective experiences for insights or knowledge generation. Introspection, however, involves deeper examination with an intention to explore 'what' and 'why' of one's own thoughts. Although, the literature suggests seeing introspection as a process (Gould, 1995), in this study we mainly focus on its efficiency in studying a project that was made a long time ago.

Reflection is used to adjust rational decision-making steps on the way to the result (reflection-on-action and even more responsive reflection-in-action according to Schön), while introspection addresses individual experiences when the result is achieved (Figure 2). In addition, reflection works with memory that fades with time, while introspection addresses the mental images, feelings, and sensations that can be recreated vividly if using appropriate tools. Therefore, methods of introspection suit better if the question aims to uncover the reasons for made actions.

Xue and Desmet differentiate between two scopes of the conception: the researcher's self-introspection, characterized by the unity of the researcher and their subject, and guided introspection, when the researcher only guides the subject to introspect. The last method focuses on assisting the subject in examining and reporting their experience and does not involve the researcher's introspection (2019). In this study, we choose to assist the designer so that he would not need additional training and could focus better on the process of reconnecting with their work.
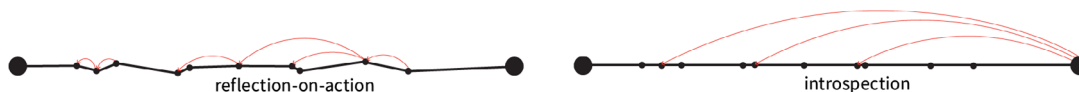

Figure 2. The difference between reflective and introspective approaches when studying the decisions made during the design process.

2.2 Application of Internal Family Systems (IFS) in Design

During the design process, a designer intuitively shifts between several roles to get a better perspective of each of the stakeholders. These roles can be simply a client, a user, or a manufacturer of the product, however, with the increasing complexity of challenges, they are becoming more complex. Marmo points out how contemporary designers communicating on contextual, communal, and organizational levels become more of 'translators' between making, researching, and facilitating modes (2017). Meehan notices the tension caused by the confusion between having different functions within specific roles and the growing expectations to fulfill them. Depending on which mode and in what context they are in, roles

define what tasks they need to perform, while functions are about the responsibility they take on a general level (Figure 3). The interplay between these entities demands constant adaptation, making designers flexible and quick learners (Meehan, 2018). However, the process of switching between the modes as well as choosing the current most relevant one remains unclear. We believe that if designers could consciously reconnect with these modes, they could discover a lot about their own design process.

To try to address them methods of Internal Family Systems (IFS) were used during the study. IFS is an integrative approach to individual psychotherapy developed in the 1980s by Richard Schwarz. The basic assumption of this transformative evidence-based model is that the human mind is subdivided into indeterminate inner parts that are united and led by Self. In balance, this 'family' develops a complex relationship, where each part adds something positive for the individual. However, as a reaction to stress, they might try to draw attention to the problem by destructive and counterproductive actions. For example, as a reaction to a childhood trauma, a part can turn into an exile and take over Self in a similar situation, causing the feeling of vulnerability and fragility to protect the individual's consciousness from pain. In practice, it might look like avoidance or denial, and even lead to self-harm (Schwartz, 1995). The goal of IFS is to reconnect with the parts and 'unburden' them, restoring the cooperative and trusting relationship. It is important to notice, that parts are not created by experiences but can be affected by them. There are no 'bad' parts and thus, no need to eliminate them, but instead help them return to their non-extreme roles (IFS Institute, n.d.). The approach is relatively new and not applied much in domains other than psychology, therefore its adaptation to the design research purposes happened intuitively and was not supported by the literature.

2.3 Case Selection: Of Instruments and Archetypes

Demonstrators can be described as tangible objects, combining engineering, design, and art to communicate a certain, usually abstract and complex, message to their audience (Sviridova *et al.*, 2021). Although the process of designing them has received some attention in the literature, it is mostly focused on scientific demonstrators intended to bring research from the laboratory to the market (Moultrie, 2015; Stelvaga and Fortin, 2022). This study focuses on a demonstrator made in a small design studio: it manifests the result of the research personal to the designers without the influence of a client, a manufacturer, or a customer (Sviridova *et al.*, 2022b). Therefore, we believe the approach we propose should be fruitful in this case as most of the decisions were made intuitively and could not be articulated by the designers or reached with analytical research methods.
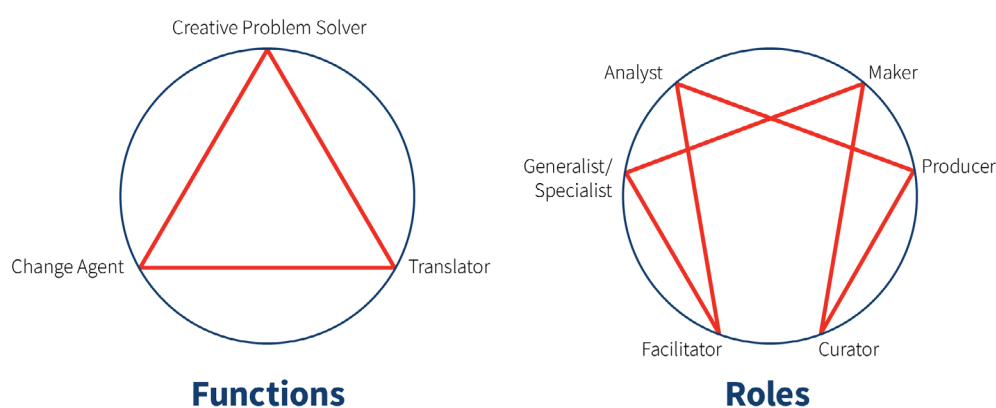

Functions   **Roles**

Figure 3. Visualization of probable functions and roles of a modern designer based on the visualization of an enneagram (see Meehan, 2018).

The selected project, 'Of Instruments and Archetypes' explores the relationship between physical and digital user interfaces by uniting measuring and making. It consists of a set of measuring tools and a screen displaying a 3D model. The user does the measurements and it immediately affects the parameters of the 3D model. When they are done the result can be printed. The project brings the making back to the maker, in the form of a physical embodiment of parametric CAD modeling (Figure 4). According to the designers,

the appearance of the tools is intentionally archaic to provoke people who are too used to digital interfaces (Unfold Design Studio, 2014).

Figure 4. Of Instruments and Archetypes by Studio Unfold (Unfold Design Studio, 2014).

This project was chosen for the study as it still causes frustration to one of its creators almost ten years later after it was built. The designer claims that this project is the most unusual in his practice because he still does not know why they did the project the way they did it and why they decided to do it in the first place. In the interview, he clearly states their intention to bring the digital functions of the 3D-modeling tools back to the physical world, however, the frustration stays. Thus, it correlates with our statement that the problem that initiated the design was so implicit to grasp, that the path to the solution was guided purely by the designer's intuition and hence, needs a special tool to be unraveled.

3. Method

To help the designer answer the question of why he did the project 'Of Instruments and Archetypes', a special tool was developed first. It was designed to help him locate the relevant tacit knowledge zones and introspect them looking for the reason for frustration. To identify these zones, methods of Internal Family Systems were used. The algorithm for guiding the discussion was provided by a psychologist with experience in using this technique. In a nutshell, it consists of preliminary focusing and work with unwanted behavior. First, inner parts need to be identified and described, then asked how they feel in general and regarding the project. The number of parts can be established by asking direct questions or noticing which words the person uses when talking about the problem. The introspection process was supported by the conceptual card-sorting technique as guidance for the participant during the sensitizing process (Sanders and Stappers, 2012).

To pinpoint the key concepts for the cards, the researchers interviewed the people involved in the design process. Additionally, the context of the project in the studio history was framed using the materials from their website. The concepts represented categories of possible reasoning derived from the analysis of the interviews and researchers' assumptions. They were supposed to act like anchors and guide the participant busy with interacting with his inner Self about abstract problems. IFS was used to help the participant identify his inner actors, while cards helped him describe them and their needs while exploring the structure of their relationship.

4. Results

4.1 Interviews

Three people worked on "Of Instruments and Archetypes": the designer, the second founder of the studio, and the intern. At the moment there was also the second intern, but all the parties agreed, that her contribution was mostly the details, as the core decisions about the idea, concept, software, and funding were made by the aforementioned people. Thus, the study consists of three interviews with them, an analysis of the project in the context of the studio history, and the results of a workshop with the designer.

The interviews were semi-structured and took around an hour. Two of them were held online, the one with the designer — in person. Questions focused on the timeline of working on the project and on the reasons for making it. The main parts of the project were elicited from the transcripts of the interviews' recordings and explained the distribution of work (Figure 5). To find out what caused the designer's frustration about the project, decisions that were made during the process and reasons for making them were coded and analyzed. Cards for the card sorting part of the workshop were made based on this data. The further analysis focused on contradictions in the participants' words.
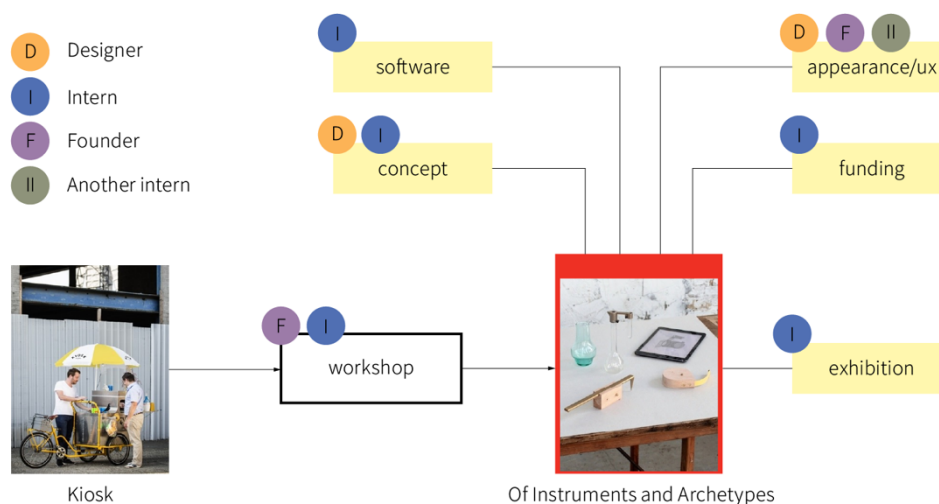

Figure 5. Roles on the project according to the interviews.

All three participants corroborated the roles they (together with another intern) played during the work on the project. The founder and the intern came up with the initial idea while conducting a workshop related to their previously done project, Kiosk — a mobile stall where people could print a custom detail. During the workshop, a discussion started with the participants about digital copying, and the idea of a tool that could take measurements directly on the screen arose. The intern was the main driver of the idea, and eventually, he obtained a grant that allowed finalizing the work after the concept development. He also organized the exhibiting of the project.

The founder said she did not feel any frustration regarding 'Of Instruments and Archetypes' and that according to her vision, the project showed well what the studio does. She explained that especially in the earlier days they liked to envision scenarios of the near future and illustrate them with tangible interactive objects. They were never interested in bringing them to the market and, therefore, she never felt any frustration about this project, nor questioned why they did it in the first place. However, two other participants still feel it and we believe, the reason lies in the aspect of commercialization.

The intern said during his interview that he started this project as a development of democratic design ideas.

By that, he understands the approach when designers provide customers with the possibility to make a product instead of the product itself. According to this, 'Of Instruments and Archetypes' should have become part of the easily accessible production facility, and the tools should be able to be bought in a hardware store or found on the street and used to create a chair, a table, or anything. Soon he realized, that this idea was impossible to materialize and he could only reach the demonstrator stage. However, he believed that the designer pushed the project to become a real product, something that could be produced and sold.

On the contrary, according to the designer's interview, the problem was that "if you want to make an impact, you have to complete the project instead of making it a kind of inspirational thing". He claimed that during his studies he was taught to work with concepts and museum installations, never considering the potential business model or the way how to commercialize his design. To him, 'Of Instruments and Archetypes' was more of a reflection point of what it was supposed to be and what it should be, where lies the fine line between a materialization of a concept to inspire others and a prototype for potential production.

Therefore, we concluded that the reason for the designer's frustration lies in his attempts to define what he as a designer should do: pursue commercialization like what a product designer is supposed to do or stop at the conceptual phase like he was taught at the design academy and what he prefers better. This version seems even more plausible if look at the studio projects' timeline: before 'Of Instruments and Archetypes' their work looked like prototypes of products that only needed one more step to be brought to the market, while afterward, they switched to demonstrators illustrating their ideas and research, and later, even to movies as a medium that communicates their stories more clear (Figure 6).
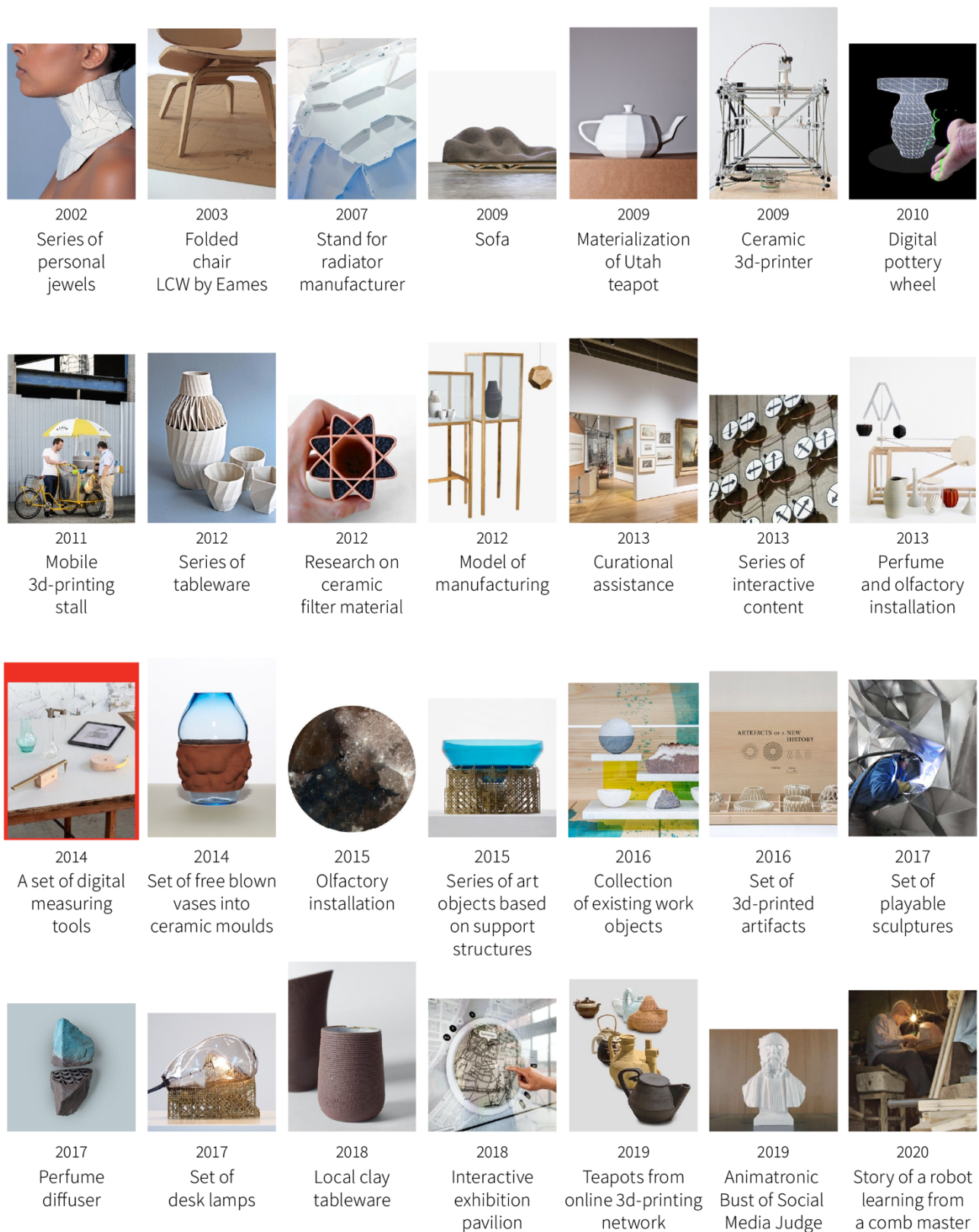
Figure 6. Timeline of all the projects done by the studio so far. In the top part, projects have the potential to be brought to the market, in the bottom — the focus is switched to the stories that the objects represent or even the videos.

4.2   Workshop

To test the hypothesis about the conflict between a concept-maker and a commercial product designer, and to see if there were other conflicts, a workshop with the designer was conducted. It was held in person and took around 90 minutes. The participant was briefly introduced to the procedure, the timeline, and the concepts written on the cards. The first half was based on techniques of IFS, while the second was the work with two sets of cards. The concepts written in the first one are meant to guide the discussion and help the participant describe his inner parts together with some blank pages left to add something if needed. The second set had potential frustration reasons based on the analysis of the interviews and the researchers' assumptions (Figure 7, left). During the first half, two main inner parts of the participant were identified: a curios challenge-seeking part enjoying problem-solving and making things, and a sustainable business-oriented part, who seems to have a conflict regarding earning money/sustaining the studio and exploration of design/envisioning the future. We assume that the discussed project was the one where the conflict took place for the first time.

To guide the discussion, questions from a list provided by the IFS expert were asked in an appropriate order (Table 1). The parts were directly asked what makes them happy or frustrated (Table 2). Then they were asked to focus on the 'Of Instruments and Archetypes' project and describe how they feel. Surprisingly, the sustainable part was happy about the project because "that story works". Being pragmatic, it enjoyed developing the concept of how consumers work together with designers in the future. At the same time, these aspects caused the frustration of the curios part — it did not have "a lot of plays" as the concept was quite specific. However, if the curious part gets its freedom, the sustainable one faces eternal questions of how to fit the project into their studio's strategic evolution. The designer notices that "the desirable situation would be that companies pay you to be the curious hacker and the future envisioning", yet he admits that it is a dreamland, and other studios he knows have the same struggles balancing between the need to produce things that can be sold and aspirations to research and explore.

Table 1. Questions to identify the inner parts and work with specific ones adapted from the IFS approach.

Focusing Self on one of the inner parts:
- At which part would you like to first pay attention? Which part would you like to talk to first? What does it look like?
- What thoughts can you notice when focusing on this part? What feelings do you have towards this part?
- Are there other parts? What other parts can you notice/observe/hear?

Work with a specific part:
- What story does this part want to tell us about itself? What is important for this part to tell us? When did it appear for the first time? How old is it?
- What does this part do for you? What does it take care of? What are its intentions towards you?
- When did it start doing it?
- What did it feel when it started taking care of it? Does it like this job and the way it does it?
- If it did not need to do it, could it give this job to Self? What would it prefer to do instead?
- What is the attitude of Self towards this part? What does <another part> think about this part?

Changing focus to a specific part:
- Do I understand it right that one of the parts is now reacting to this? Who is talking right now?
- Could you please ask it to step aside for a bit? Does it agree? If not, what reasons does it have? What can we do for it to step aside for a moment?
- When you hear the voice of//observe this part, what else do you notice?
- Could I please speak to <another part>?

These perspectives are quite contradicting, nevertheless, the designer believes the parts understand that they are "two sides of the same coin" and that having the sustainable one is "a necessary evil" for the curious one. It is confirmed by the card-sorting exercise: the participant arranged the concepts so that they better represent these parts, however, with time they blended (Figure 7, right). He admits that although each of the parts finds much fun in the other's activities (for example, the curious part is interested in learning how business works), it is the sustainable one that bears the most frustration as it has "to think about efficiency and the bank account" when the curious part does not worry about these things and can cut the frustration loose. Meaning, that keeping one part happy causes the frustration of another:

> "They are mutual. You can switch them because without one there's no other and without the other, there is no one. So you cannot pinpoint which of the two is frustrating you. … But the frustration is universal. That is a lack of having the means to do what you like to do or having a lot of means to do something that's different than what you want to do".
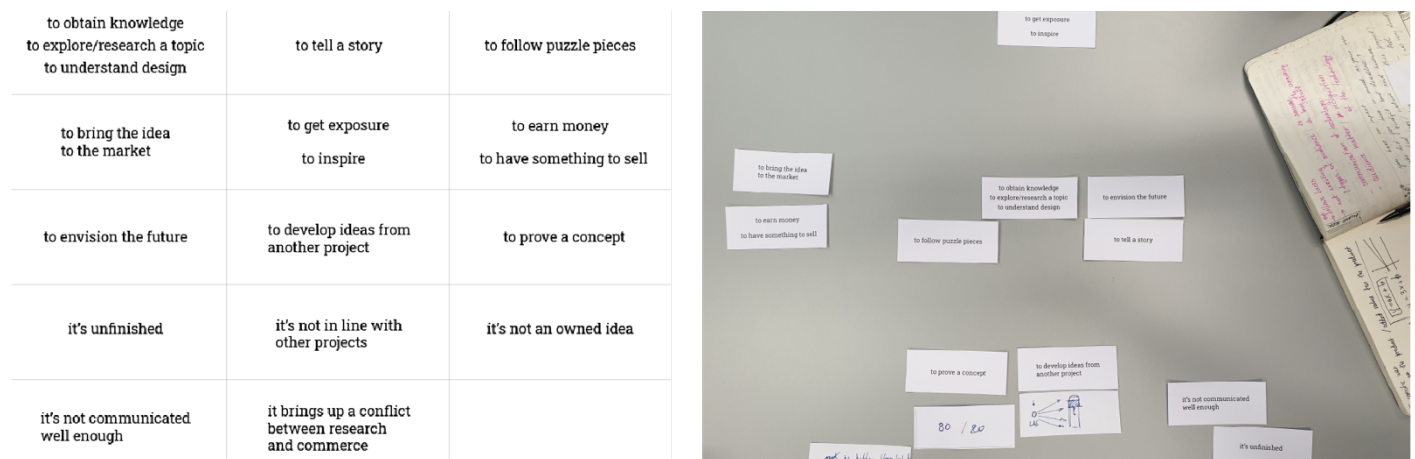

Figure 7. Premade concept and possible frustration reasons cards (left) and the results of card-sorting exercise supported by methods of guiding introspection clustering the concepts as more inherent to one or another inner parts (right).

The two inner parts of the designer were in constant conflict as they also represent his rational studio owner part opposing his irrational designerly one. Although he admitted the reasons for his frustration became clearer, the designer could not find a connection to why this particular project caused this emotion. The analysis, however, showed that 'Of Instrument and Archetypes' was the key project that changed the direction of the studio from potentially producible products to demonstrators, significantly shifting the emphasis to the research part, and later even abandoning the presentation of its results in a tangible form. The frustration arose as the intern who initiated this project represented the opposing views, in other words, the process of working on this project coincided with the designer's inner conflicts. The designer did not come up with this interpretation during the discussion, however, he did not contradict it either. Although the participant denied the reason for doing the project came clear to him during the study, he agreed with the researchers' version brought to his evaluation at the end of the workshop:

> "Honestly, I think I understand very well, but I'm just not comfortable, really. So maybe … that's also why I brought this project up, because I know that it's kind of … the end of something and the start of something else".

The proposed tools worked as planned, however, the efficiency could be better: the participant could not always distinguish between the parts, and sometimes the guidance from the researcher was more confusing than helpful. Additionally, they focused on personal inner parts and could not locate the designerly inner parts. However, they might be tightly connected, especially in small independent design studios where designers have more authorship of their work. The collected data can be useful to refine the tool but it also highlights the potential direction of further research, which is a conflict of inner parts of a designer. The potency of it is proved by the participant claiming that many of his peers are experiencing the same.

Table 2. Reasons when two parts identified by the designer are feeling frustrated or happy.

	Curious challenge seeker/ creative problem solver/ explorer and maker of new things	Strategic future thinker/ business-oriented/ sustainable
Frustrated	- The longer you have your own studio, the more you involve people, the less you can get involved in that fun part (making things) - It's frustrating that I'm teaching here, while people in the studio are playing with stuff and making things - If you only try to be efficient and solve the problem, then you stop at the point where you start to be curious. - I think the core frustration where you feel like (the other part) is really happy - (this part) wonders how can I earn a sustainable income without having to make this vision as a startup	- The frustration is that it doesn't know what it can be or what is the format of that - It worries about how to get resources - from the outside it looks like (other studios) can finance kind of the curious, inquisitive meta story design work. But then later you talk to them, … and there is no magical solution - How can such activity sustain itself? How does it make an impact?
Happy	- I like to understand things - Two parts … are not meant to go together, but let's see what happens when we put that together. I think that's the fun of creating hacking	- It would want that he can fund the work properly: from a client, or public or private funding, or from limited edition objects

5. Limitations

It was the first time when the researchers used the Internal Family Systems technique and the lack of experience led to sometimes redundant guidance that, in turn, caused the participant to go in circles. Nonetheless, the result can be considered positive based on the participant's reactions: he managed to distinguish and switch between the parts and referred to them separately when answering questions. Sometimes, unwanted parts joined the conversation, it was clear as the participant's voice and even mimics changed. With guidance, however, they were properly addressed and asked to wait, while giving the space to the parts that were of the study's interest. Additionally, this approach deals with one individual, and no matter how complex one human being could be, a designer might have several personalities intertwined, such as user, client, or manufacturer whose opinion they take into consideration. It might decrease the accuracy of the tool; however, we believe it can be mitigated with the level of its development.

As both methods used in the study are based on subjective experiences, the tool might be limited to projects where the researchers have access to the involved parties. Meaning, that it could be less effective to use with secondary data. Although the tool is capable of being used for projects designed decades ago, and the feelings and emotions can be recovered almost as vividly as they are, the memory fade might still be a reason for concern.

6. Discussion and Conclusions

An experimental workshop was designed as a first attempt to develop a tool to reach tacit knowledge that designers produce when working on demonstrators. To identify and reconnect with his designerly inner parts, a designer who claimed he still does not know why he did one of his projects ten years ago was asked to introspect on his experience while sorting cards. The process was guided by questions based on the

Internal Family Systems (IFS) approach when the concepts on the cards were based on the analysis of the interviews of all involved parties together with the context in which the project was carried out. The direction of the tool design has proved to be successful as it allowed the participant to reconnect with the project he worked on more than ten years ago. Two inner parts of the designer were elicited: a curious problem-solver and a sustainable strategic future thinker. In a conversation with them the designer identified what aspects of his work make them happy or frustrated and realized that they contradict each other: if one inner part is happy, the other one is frustrated. The 'Of Instruments and Archetypes' project apparently coincided with the designer's realization of the fact that he will always have to invent new ways how to sustain his studio if he wants to work only with conceptual design. It means prioritizing the well-being of one inner part at the expense of another.

As the use of IFS is expanding to other domains such as marketing and branding, the proposed tool can be potentially adapted for multidisciplinary use. The method to locate the inner parts was based on the one that therapists use in their practice so it was not pre-adapted to the design context. However, if a person with no prior experience managed to use it (it could be seen by changes of voice and vocabulary selection of the participant when an inner part that did not want to talk interfered with the conversation), the efficiency of the method can be enhanced in the future. It might be used in research of design rationale and strategic reasoning of designers given the necessary modifications (that are also to be discovered).

In his essay 'The Author as Producer', Benjamin discusses the necessary changes in the political and economic environment that can grant the author the freedom to write what he pleases (2018). The social situation, however, is not inclined to give him such autonomy and will inevitably force him "to decide in whose service he wishes to place his activity". Benjamin talks about the potential impact of technological advancements and their ability to redefine both authorship and labor and gives an example of Brecht's theatre, where he alters "the functional relationship between stage and audience, text and production, producer and actor". Almost a hundred years later we witness his predictions come true. Today it is barely possible for intellectual workers to not be involved in their actual production process: designers must learn how to design, develop, and market their content to be sustainable. The Author has become much more multidimensional — yet, this advancement has also brought conflicts. The increasing number of roles and functions designers have to perform today might result in a lack of *design* in their practice and cause psychological frustration. For design research, it means that studying design is inseparable from the personality of the designer and to advance they also need to expand their palette of tools, functions, and roles.

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About the Authors:

Aleksandra Sviridova has an extensive track record and network in the field of digital design, 3D printing, and prototyping. In her working life of more than 5 years of industry, her interest in the overlap between the arts and technology grew, as well as a passion to learn more, after which she followed the training for integrated design with summa cum laude in Dessau. She is currently pursuing her PhD at the Antwerp Design Factory, part of the research group of Product Development, University of Antwerp. Promotor is Prof. Jouke Verlinden.

Jouke Verlinden is the spokesperson of the research group of Product Development at the Faculty of Design Sciences. His research focuses on Augmented Fabrication: cyber-physical manufacturing and mixed reality and digital fabrication for improving (augmenting) human-centred design. He has published >120 scientific articles and several patents. He is editor-inchief of the Journal of Design Research (JDR). Furthermore, he acted as guest editor for CAD journal, International Journal of Interactive Design, Engineering, and Manufacturing, International Journal on Automation Technology, while he co-founded a magazine series on Augmented Reality and Art. Recently, one of his co-authored works received the European Heritage Award for the Scanning for Syria project (2020), the best paper award at the ASME DETC conference (2017), while he received the 2016 Purmundus Award for the 3D printed bicycle.

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