Jun 23rd, 9:00 AM - Jun 28th, 5:00 PM

A framework for the agency of sketching

Annemiek van der Wal
Delft University of Technology, Netherlands, The

JanWillem Hoftijzer
Delft University of Technology, Netherlands, The

Martijn Haans
Delft University of Technology, Netherlands, The

Citation

van der Wal, A., Hoftijzer, J., and Haans, M. (2024) A framework for the agency of sketching, in Gray, C., Ciliotta Chehade, E., Hekkert, P., Forlano, L., Ciuccarelli, P., Lloyd, P. (eds.), *DRS2024: Boston*, 23–28 June, Boston, USA. https://doi.org/10.21606/drs.2024.806

DRS BOSTON 2024 JUNE 24 — 28

A framework for the agency of sketching

Annemiek van der Wal*, JanWillem Hoftijzer*, Martijn Haans

Delft University of Technology, The Netherlands

*Corresponding e-mails: annemiekvanderwal@gmail.com, J.W.Hoftijzer@tudelft.nl

doi.org/10.21606/drs.2024.806

Abstract: Previous scholars have advocated the significant value of sketching in design processes. This paper first explores how design sketching functions as an agent for design, building on insights derived from both theory and practice. Interviews with professional designers in the field reaffirm the functions and importance of sketching. Not only for designers themselves, but also for their clients and consumers. Given the value of sketching and the variety of stakeholders involved, this paper then aims to structure the affordances of design sketching in a practical framework. Considering that affordances must be discoverable and perceivable in order to be effective, this paper subsequently proposes ideas for transforming the framework into a tool that will help designers to discover design sketching and unlock its benefits.

Keywords: design drawing; visualization; affordances; agency

1. Introduction: Exploring the agency of design sketching

1.1 The value of sketching, a brief review

Several scholars have advocated the significant value of sketching in design processes. Sketching is a way to (re-)organize and develop thoughts, arouse emotions, encourage action and cooperation and inform yourself or others (Tversky, 2010). Drawing is inextricably linked to design, as the original Italian word 'disegnare' actually means drawing. Results of a study by Corremans and Vaes et al. (2018) show that students with better sketch competences are more likely to score higher for their product design projects. Drawing during the design process could “maximize the conditions necessary for the reinterpretation of an image and the emergence of new ways of 'seeing it'”, according to Purcell and Gero (1998). Goldschmidt (1991) defines sketching: "(...) The dialectics of sketching is the oscillation of arguments which brings about gradual transformation of images, ending when the designer judges that sufficient coherence has been achieved."

The evidence in this paper suggests that there is a lot of interaction between drawings, the designer themselves and other stakeholders, such as clients and consumers. The relationships between the properties of both the different kinds of drawings and the interacting parties involved (which, according to Norman, can be called 'affordances') are defined by multiple aspects (e.g. design phase, stakeholders involved, industry field, function of the final design, use of materials). In this web of influencing factors, drawing can be seen as a major agent for design; providing the required affordances.

1.2 Study aim

"To be effective, affordances (and anti-affordances) have to be discoverable – perceivable", according to Norman (2013). Given the significant value of design sketching as was advocated by previous scholars, this paper proposes a framework and a tool to inspire and support designers, and make them aware of the value of sketching. The framework and tool should help designers to discover design sketching and unlock its benefits. In order to achieve this, this paper explores how design sketching functions as an agent for design, by building on insights derived from both theory and practice. This paper then aims to use the gained insights for the set-up of a practical framework.

1.3 Methodology

As the goal is to explore how sketching works as an agent for design, literature research is done as well as a qualitative interview study with five design professionals.

Firstly, this paper discusses insights about the affordances of design sketching gathered from studying literature. Subsequently, findings resulting from the interviews will be discussed. Knowledge and findings will be mapped and projected onto a common design process model (i.e. the double diamond) and design theory.

2. Design sketching in theory

In this section, the focus will lay on design sketches and the process of design sketching in particular. The section addresses various theories derived from a literature study that concerned design sketching. These theories concern the following facets: 1) The process of moving, seeing and imagining; 2) Discovering; 3) Ambiguity; 4) Convergence; 5) Interplay between designer and stakeholders.

2.1 The process of moving, seeing and imagining

When we sketch, we translate our mental images into visual representations, constantly bridging between thinking and seeing, which keeps determining our so-called movements. Goldschmidt (1991) schematizes the design drawing process by distinguishing between 'seeing as' (interpreting figural properties during sketching) and 'seeing that' (interpreting conceptual properties by sketching and examining) arguments during sketching. This creates a generative dialogue that aligns the design process with both abstract, conceptual ideas and concrete object specifics, turning into a final design (see figure 1).

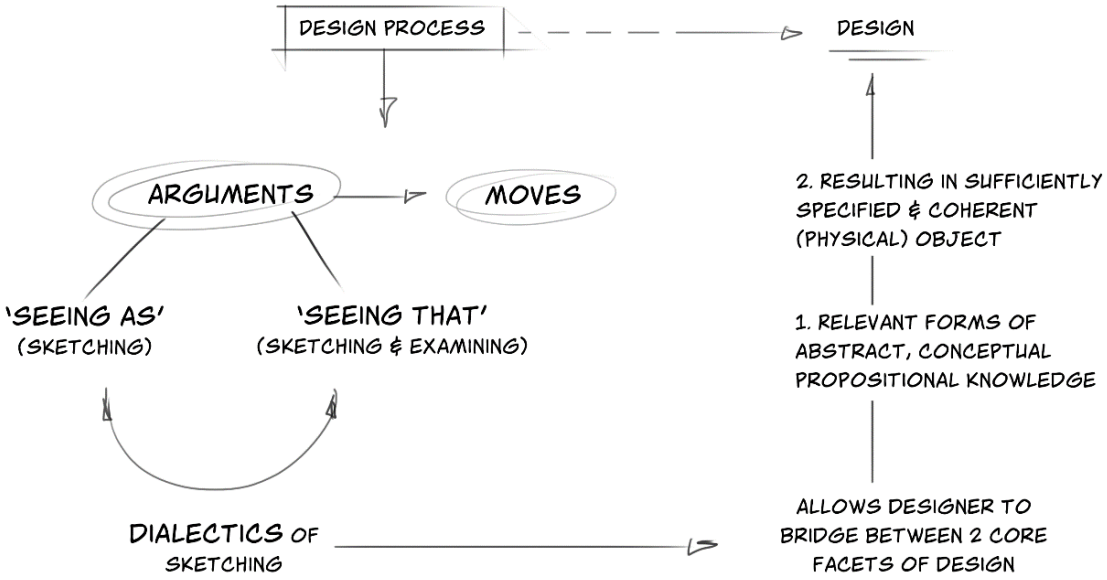

Figure 1 The 'dialectics of sketching' by Goldschmidt (1991): bridging between different kinds of arguments to determine our sketching moves and final design.

The described dialectics between 'seeing as' and 'seeing that' can be related to the four drawing purposes Cohen introduced in 1997: it trains one to observe (linked to 'seeing as'), make representational decisions and movements on the basis of motor skills, and to reflect (linked to 'seeing that'). According to Hoftijzer (2018), another step could be added, which is 'imagination': "Learning these four elements allows one to take the next step: imagining", he states. This ties in with the subsequent step Goldschmidt describes: observation of the imaginary will help to bridge between abstract knowledge and a specific outcome.

2.2 Discovering

During the sketching process of moving, seeing and imagining, unexpected and unintended moves are made. Schön and Wiggins (1992) stress that the consequences of these moves help to get more design knowledge into the consciousness of the designer. They contend that seeing unintended moves triggers the interconnectedness among different knowledge domains related to the design process and brings them into consciousness (see figure 2). This can result in the improvement of both quantitative and qualitative characteristics of idea development.

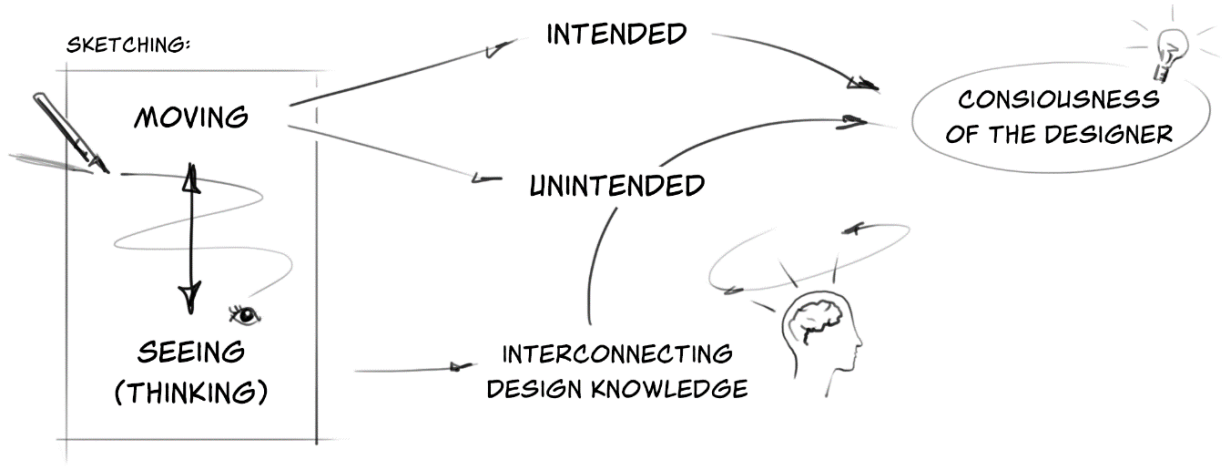

Figure 2 The consequences of unintended moves allow interconnected design knowledge domains to reach the consciousness of the designer, according to Schön and Wiggins (1992).

"Unexpected discoveries," as stated by Suwa, Gero and Purcell (1998), "are a form of perceptual interaction with one's own sketches. In other words, that is to detect hidden features of a visual/spatial representation." The discovery of so-called 'emerging parts', triggering one's design knowledge, happens apparently through an interplay between the designer and the sketch. Suwa, Gero and Purcell (1999) identified three types of unexpected discoveries in design: 'relation-type' (noticing proximity between elements), 'visual-feature-type' (attending to new visual features like size or shape), and 'implicit-type' (perceiving figure-ground reversal). They provided evidence that unexpected discoveries activate the generation of new design requirements, while in turn, new requirements encourage new discoveries. Additionally, the 'relation-type' can also be triggered by simultaneous attention to elements that were not connected before (Suwa, Gero and Purcell, 1998; see figure 3). This again increases the chance of coming up with creative inventions.

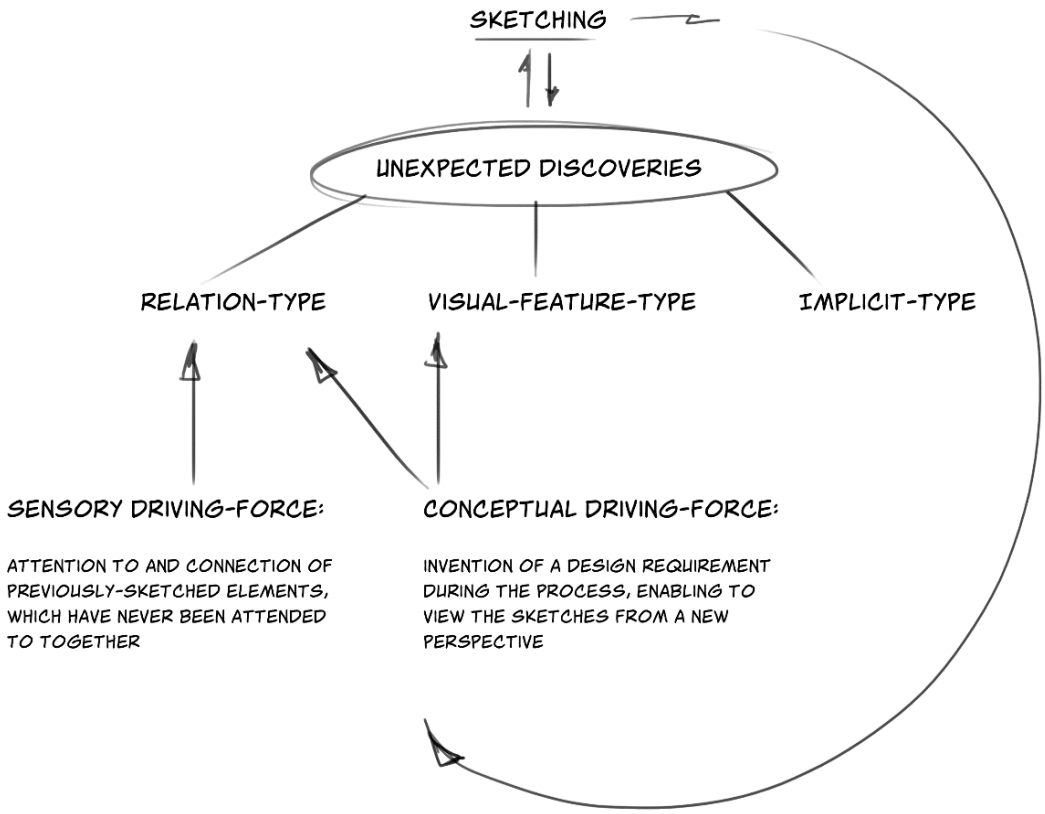

Figure 3 The interplay between the designer and the sketch can result in unexpected discoveries by emergence and connection of perceptual elements (Suwa, Gero and Purcell, 1998).

2.3 Ambiguity

The above mentioned are quite specific driving-forces within the process of sketching, that bring us to new ideas. However, this characteristic, immersive part of sketching goes further than that. According to Goel (1995), ambiguity created by unstructured sketches of varying ideas, referred to as lateral transformations, can be called essential for the design process. Considering the divergence and convergence stages clarified by the double diamond model of the design process (British Design Council, 2005), one could state that ambiguity in sketches, while encouraging lateral transformations to happen, positively influences the stages of divergence. Tversky (2010) aims that: “Ambiguity in sketches, just like ambiguity in poetry, encourages a multitude of interpretations and reinterpretations.” Seemingly, ambiguity in sketches increases the chance of the aforementioned discovery of emergent parts happening, bringing about new insights, new ideas and new sketches, subsequently causing a generative loop (see figure 4). This loop can be stimulated by the designer shifting focus between new perceptual figures and relations in specific and, by zooming out, new conceptual interpretations of the sketched subjects. These focus shifts, a phenomenon referred to as ‘constructive perception’ by Suwa and Tversky (2001, 2003), are allowed by the genera-

tive loop of ambiguous sketching and triggers thoughts about more complex visual and functional considerations. This relates to two reappearing occurrences in this section about design sketching: emergence and (re)interpretation during the sketching activity.

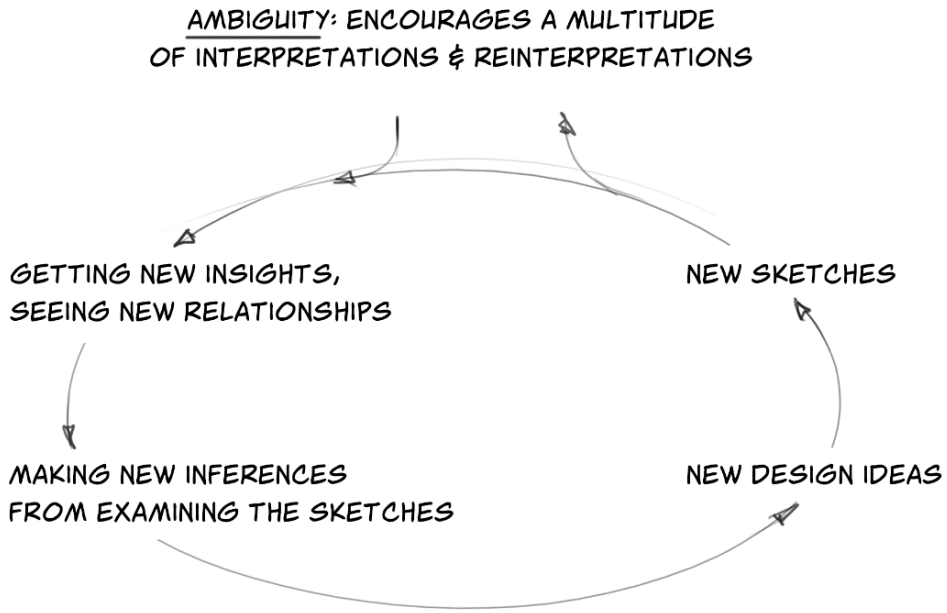

Figure 4 The positive role of ambiguity in design sketches, advocated by Tversky (2010).

2.4 Convergence

Connected to this emergence and reinterpretation is de role of imagery and the connection of it all. Scholars have advocated that the use of imagery forms the basis of solving complex problems. According to C. Ware in *Visual thinking for design* (2010), “mental imagery can be thought of as an internalized active process; much as our inner dialogue is internalized speech, visual imagery is based on the internalized activities of seeing.” This evolves with visual thinking, by the ability to recognize patterns depending on the brain's network of pathways, enabling us to link visual information with our existing knowledge and understanding (Ware, 2010). Goldschmidt (2003) has proposed that design sketching functions as an extension of imagery, introducing the phenomenon of ‘interactive imagery’. This phenomenon concerns the activity of translating mental images into drawings that “express concepts in the visual-graphic modality using patterned schemas stored in a graphic lexicon that combine using ‘syntactic’ rules” (Cohn, 2012). Subsequently, within this lexicon there is the aforementioned emergence of unintended moves and unexpected discoveries, triggering new interpretations and mental images, which closes the loop of interactive imagery (see figure 5).

Taking this into consideration, one could state that design sketching also serves as an external memory aid. It allows us to access different types of knowledge in the long-term memory (Purcell & Gero, 1999). Sketches make (de)compositions of our mental images that can help

us processing, structuring and reflecting on the information we see in our head. It reduces the load on our working memory by mental synthesis.

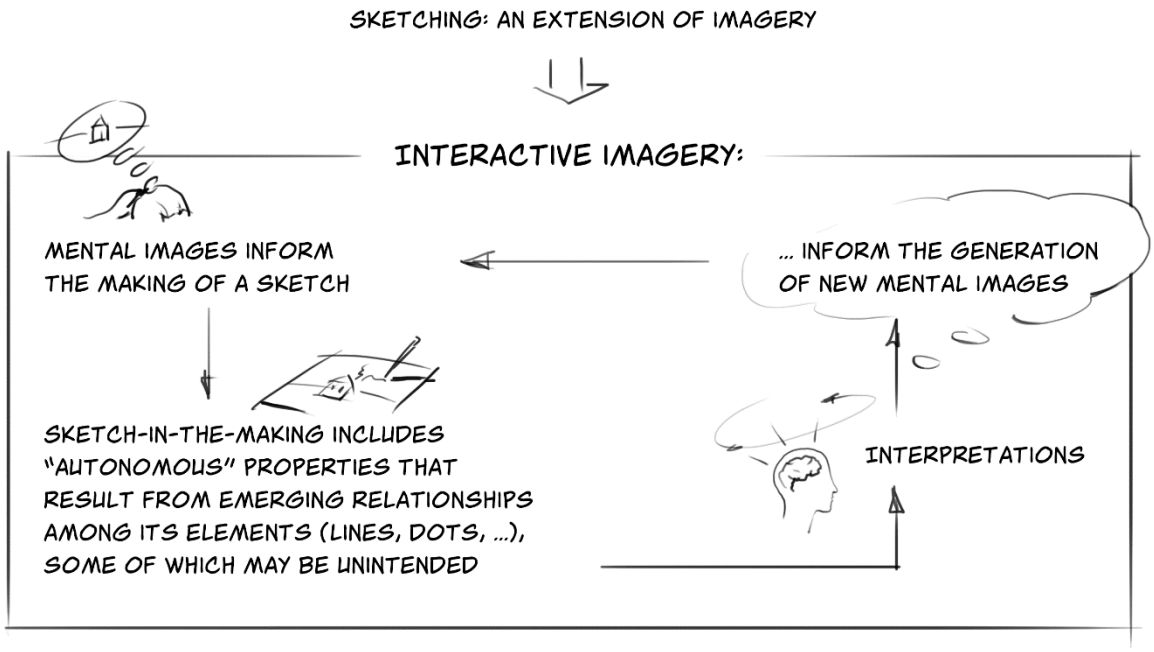

Figure 5 Design sketching triggers a generative loop of 'interactive imagery', according to Goldschmidt (2003).

2.5 Interplay between designer and stakeholders

Examining studies by Schütze, Sachse and Römer (2003), the role of design sketching in converging imagery by mental synthesis is confirmed: "The quality of solution concepts increases from entirely mental design problem solving without external support over partly supported to completely supported problem solving." As expected, subjects who solved a design problem supported by sketching achieved a significantly higher solution quality. Furthermore, Kudrowitz et al. (2012) found that the quality of sketches has a positive influence on the perception of the creativity of ideas, and Mulder-Nijkamp and Eggink (2016) found a significant correlation between the level of quality of drawings and the success of design outcomes in a brand extension industrial design project. Better sketchers are more likely to become better product designers, as proposed by Corremans and Vaes (2018). One could conclude that design drawing contributes to our 'visual literacy', meaning the ability to 'read, write and create visual images' (Harrison, 2022). This is apparently a valuable capability for designers themselves, but also a valuable aspect in the communication between designers and stakeholders.

For example, in his book *Engineering and the Mind's Eye*, Ferguson (1992) wrote about the value of non-verbal thoughts for engineers and how drawings play a significant role in the emergence of new inventions. Ferguson distinguishes three categories of sketches, as de-

scribed by Brun, Weil & Le Masson (2015): 1) 'thinking sketches' made by an engineer looking for new ideas; 2) 'talking sketches' made when two engineers communicate; 3) 'prescriptive sketches' that are meant to please and convince people outside of the design process. Emphasized by Brun et al. (2016), the different categories are in fact based on the distinction of the designer, stakeholders and other people outside of the design process. Tversky (2010) identifies four sketch purposes, three of which also involve interactions beyond the designer, with regard to communication, aesthetics and behaviour (see figure 6). In the communication with others, design sketches afford the designer to promote behavioural action and to convey literal information, e.g. measurements for manufacturing engineers, as well as to convey sensory information, e.g. by arousing emotions (Tversky, 2010).

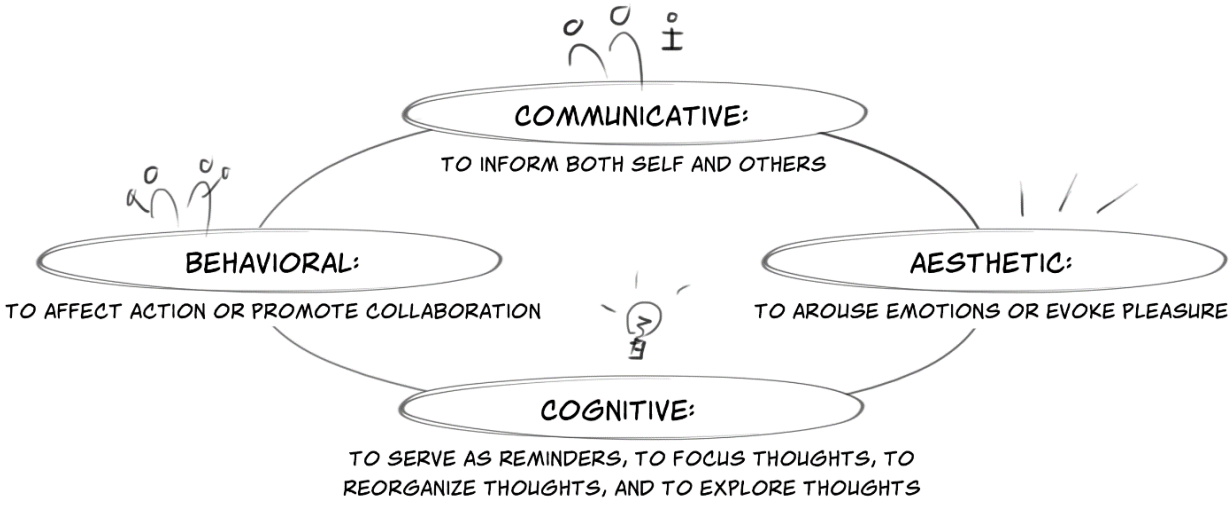

Figure 6 Four purposes of design sketching proposed by Tversky (2010), three of which concern the interaction with others.

2.6 Concluding

Overall, one could state that design sketching can work as an intervention that 1) triggers emergence and imagery; 2) supports (re)interpretation and convergence; 3) increases the value and quality of the process outcome; 4) serves roles in the interaction between designer and stakeholders. The agency of sketching triggered by the interplay between the designer and the sketched features, seems to affect the movements of the designer both during and between mental processing and physically acting.

Observing these conclusions, one could state that the agency of sketching is initiated by setting the designers' internal communication in motion. Additionally, the resulting sketches serve varying affordances in the communication towards stakeholders.

3. Design sketching in practice

In this section, the focus will lay on insights resulting from interviews with practitioners. The interviews were conducted with the following five designers:

1. Automotive Designer for an Italian design agency
2. Head of Product Design at a Dutch product design agency
3. Design Director at a Dutch product design agency
4. Independent Concept Designer in the Netherlands
5. Visual Communication Consultant & Designer in the Netherlands

All interviewees have been chosen in particular for their active involvement of at least ten years with design and sketching in practice, but each serves a different field (cars, products, visual strategies) and each has a different professional position (company/independent/manager/employee). They were asked about four topics: about the functions of sketching (the process) and of the sketches themselves, about the interaction with people involved, about their sketching style and about their vision and approaches towards the future. The interviews were recorded and lasted 30-45 minutes. Detailed transcripts of the interviews are available from the corresponding author, upon reasonable request.

To keep things succinct in this paper, the findings will be discussed in two parts: 'Purposes and functions of design sketching in practice' and 'Approaching the future of design sketching'. The first will provide a vision on the affordances of design sketching manifesting themselves in practice. The latter will provide a concise analysis on how contemporary trends might shape the future of design sketching and how the designers are anticipating on them. What are their approaches and their visions? Will future factors transform the affordances of sketching as an agency for design? This can be valuable information for the transformation of the proposed framework into a practical tool.

3.1 Purposes and functions of design sketching in practice

The designers' answers in this field have been clustered into six overarching goals of design sketching (see figure 7): 1) Communicating with ourselves; 2) Recording of the process: persuasion of content; 3) Call for attention, reflection and input; 4) As a work of art; 5) Common understanding; 6) Explanation.

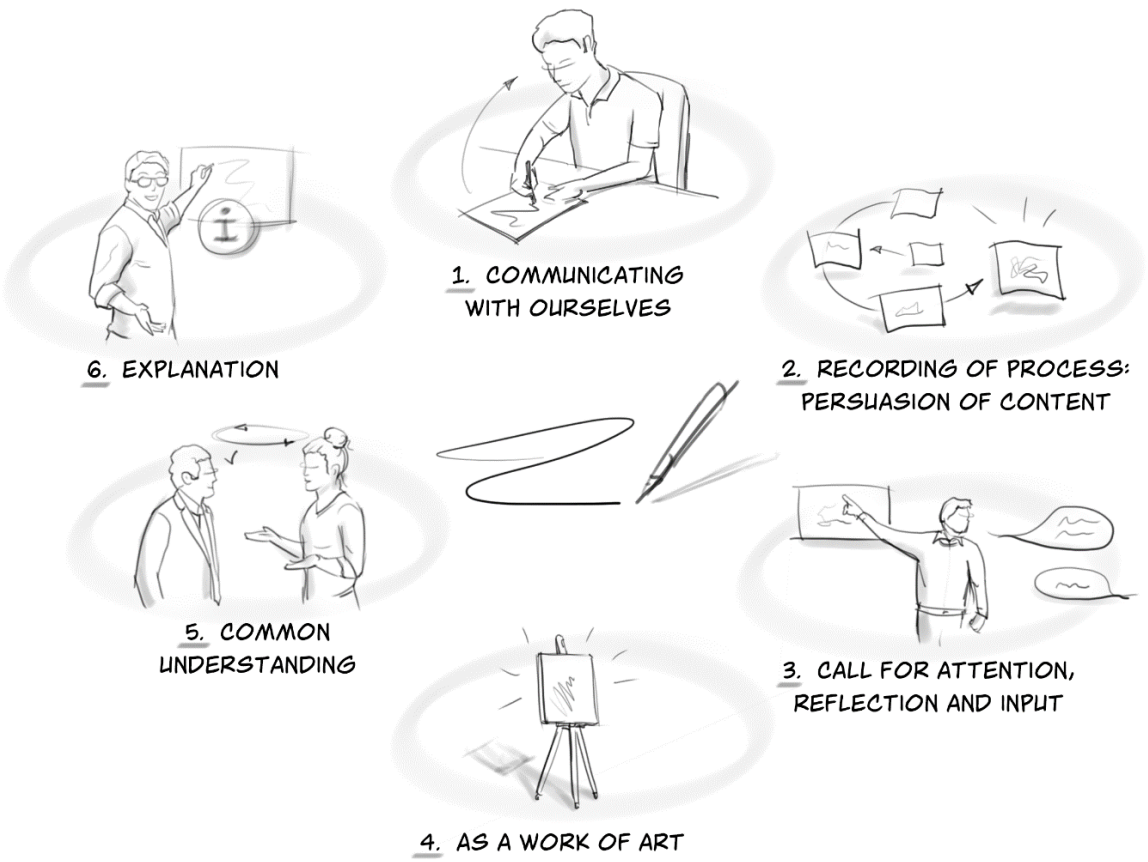

Figure 7 Six overarching purposes/functions of design sketching derived from the interviews.

First of all, the sketching process affords the designer to communicate with themselves; an affordance emphasized by experimenting with different tools. By continuously reflecting on the sketched lines, the designer tries to find new shapes, proportions and solutions while sketching: “I often already have the direction of an idea, but while sketching I react to my drawn lines. It is an interplay between the lines I see and the (re)attunement of them.” (participant 4). This resonates with the insights of section 2: ‘Design sketching in theory’. Furthermore, during the internal interplay between seeing the lines and (re)attuning them, the designer is apparently already client- and goal oriented: “Making all of these messy sketches helps me to continuously analyze what the client wants, what I want with that and how I can achieve that.” (participant 3).

Subsequently, the progress steps being (digitally) recorded by the drawings, can afford the designer to explain themselves and convince ideas towards the client. The interviewees unanimously indicated that they use sketches to present intermediate steps, so that their considerations and decisions become understandable. Hereby, the designers’ created content becomes more convincing.

Furthermore, also in relation to the interaction with the client, design sketches play a role in attention being drawn to certain elements, provoking reflection and inviting for input. This gives the designer the necessary information to adjust and continue the design activities in

the right direction. These affordances are emphasized when the design sketches contain a balance of shown fragments and do not look finished already: the sketchiness is an important signal to the client. It prevents miscommunication and, more importantly: anything that has not yet been fully established make it intuitively easier for people to provide input, as confirmed by experiences of the interviewees.

Moreover, practice showed that design sketches can function as a work of art, affording the designer to let a spark jump at stakeholders. This is particularly evident in the car design world: according participant 1, it is the emotionally attractive aspect of the design drawings that plays a major role. It is important that a spark jumps at the design director, for the reason that the drawing that sparks in him, for whatever reasons (little argument is given), is then chosen to continue with. “This means that the design and the drawing are one thing: the director does not distinguish those in this stage.” (participant 1). In this case, the design sketch affords persuasion of the design idea.

Lastly, there is the apparent affordance of design sketches for clarification: providing common understanding and explanation. The interviewees clarified that design sketches facilitate communication and streamline complex processes by ensuring everyone shares a common understanding. They clarify content and resolve misunderstandings, accelerating decision-making and guiding the design process in the right direction.

3.2 Approaching the future of design sketching

Contemporary trends (will) make alterations to the way designers will benefit from sketching as an agency for design. Conducting the interviews in combination with studying recent studies in this field, provide evidence for the following alterations.

To begin with, designers will probably focus more on the specific affordances of design sketching that concern good communication with stakeholders. Finding itself in the midst of the ‘fourth industrial revolution’, the industrial design field is shifting towards mass customization, personalization and digitization strategies (Pech and Vrchota, 2022). This causes a change in the interaction between consumer and selling company as well as in the interaction between the selling company and product designer: one is earlier involved in the process, which is influencing factors related to the agency of sketching (see figure 8). This observation ties in with the interviewed designers emphasizing that they are presenting drawings to the client that often look sketchy for a long time during the process; affording clients to keep on giving input. Furthermore, the shifting interaction contributes to the shift towards drawing digitally: affording designers to share them clearly and easily online, according to the interviewees. Moreover, the shift in interaction might increase the use of tools like VR and AR, because these new technologies make it possible for stakeholders to experience the ideas three-dimensionally and engagingly at an early stage of the design process, even from a distance.

That, however, could be at the expense of the quality of design sketching for the designer themselves, since multiple interviewees indicated disadvantages. In VR, e.g., the object has a

third dimension, which requires the designer to already have a more detailed idea of what it is going to look like. It can also cause an overemphasis on the perfection and visual appeal of the sketches. Participant 4 mentions: "(…) Still, it takes me longer than drawing in 2D, because you always keep that blockage of the third dimension, requesting me to already visualize more of the product. Sketching in 2D is clearer and faster." Participant 5 confirms this, by emphasizing that the drawings in a VR environment have to be more explicit and correct: "In drawings, we often deviate from reality in terms of perspective and depth. People quickly believe it, you can get away with a lot! With VR however, suddenly things must be worked out more truthfully." Interestingly, participant 3 has objectives the other way around, explaining: "We have tried 3D sketches with a VR set, but we are not very fond of that. It is quite rough, which makes it unusable for us. They are mainly organic shapes, while we want to define all of the dimensions quite quickly." Apparently, the fact that VR sketching bridges between hand sketching and CAD modeling, is not necessarily a positive characteristic for designers themselves. However, using technologies like these can still have the motive of the desire to present an immersive experience to others.

Related to the increasing interest in affordances for external communication, is the trend of the upcoming storytelling visuals. Concerning the agency of sketching, the emphasis will lay on being informative on various levels, involving products as well as visions, strategies, interactions and/or design stories (Hoftijzer, 2018). While human interaction is an increasing part of the content of design drawings, as is the human interaction with regard to the way the drawings are observed. Visuals on which one can zoom in and move through are increasingly popular, according to some of the interviewees, which is fitting with the contemporary digitalization times. Therefore, one could speak of a 'newly' emerging affordance of design drawings: providing an immersive experience of whatever is visualized.

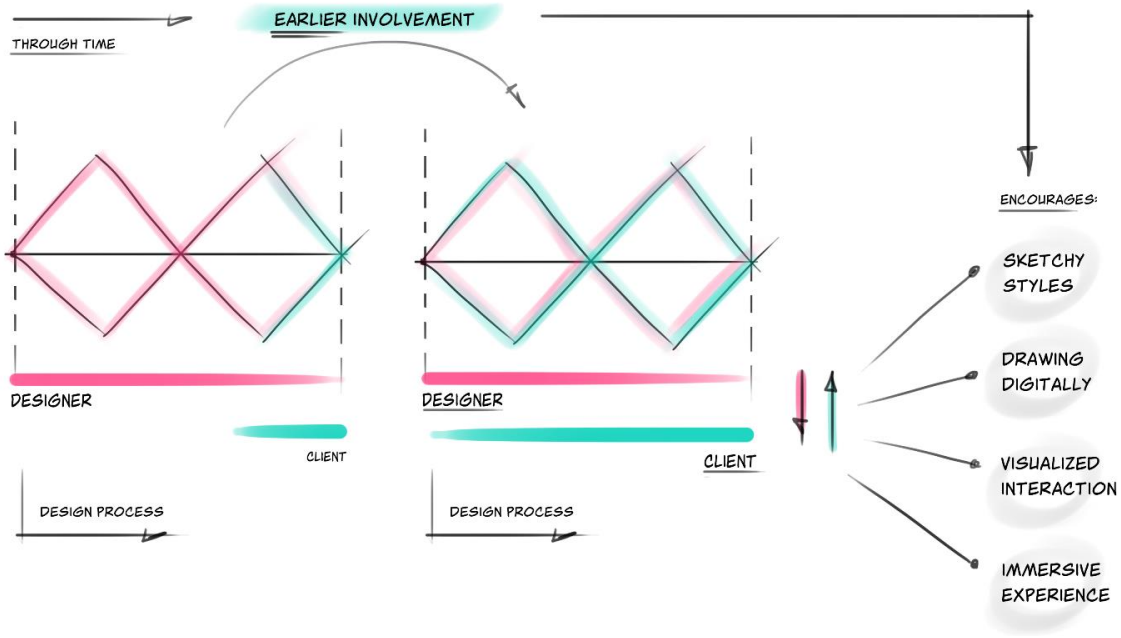

Figure 8 Earlier involvement of client encouraging design sketching-related factors.

3.3 Concluding

Six overarching goals of design sketching were derived from the interviews with designers in practice (see figure 7): 1) Communicating with ourselves; 2) Recording of the process: persuasion of content; 3) Call for attention, reflection and input; 4) As a work of art; 5) Common understanding; 6) Explanation. Comparing them with the discussed affordances of design sketching in theory (section 2), they show a larger focus on *external* communication instead of *internal* communication.

Earlier involvement of the client supposedly encourage the immersive and interactive experiences of visuals and the making of digital drawings. The latter can positively affect the affordances of sketching in design, for example looking at the ones derived from the interviews. It makes it possible to easily safe, show and share successive process steps, improving the recording function of sketches. Furthermore, according to the interviewees, the wide range of tools that are provided digitally lowers the threshold for the making of an expressive 'work of art', affording the designer to let sparks jump to stakeholders. This resonates with the aforementioned aesthetic function of sketches by Tversky (2010), evoking feelings of pleasure. Additionally, digital 'interactive' drawings, with their immersive characteristics, encourage the drawings' call for attention.

In contrast to the 'Design sketching in theory' section providing evidence for the 'internal' value of sketching, in practice the focus seems to shift towards the outsiders' perspective (figure 9). Besides the client being earlier involved, so that the designer focuses on the presentation of ideas throughout the whole process, the use of digital media also stimulates this shift. It asks for more explicit information in an early stage of the process (the third dimension), decreasing the amount of the aforementioned ambiguous sketches. Furthermore,

the interviewees confirmed that AI technology is already incorporated into the earliest stage of ideation, supposing that the affordance of 'communicating with ourselves' will be partly taken over by newly developed technologies.

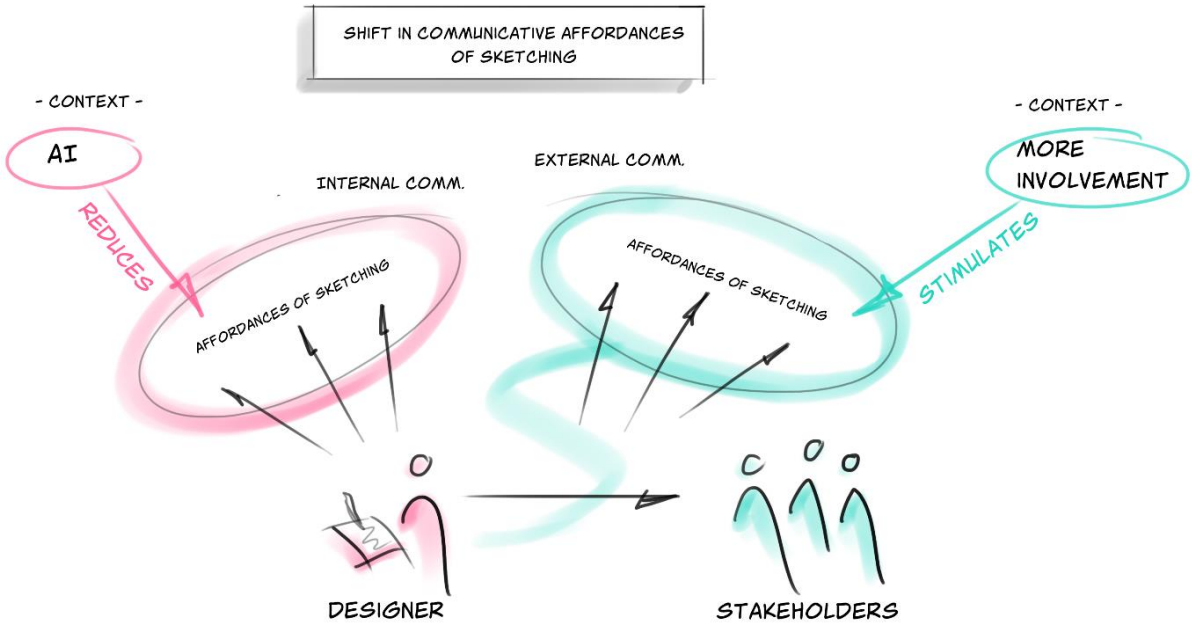

Figure 9 Decreasing focus on internal communication and increasing focus on external communication towards stakeholders.

4. A framework for the agency of sketching

In order to make perceivable how design sketching functions as an agent for design, the insights derived from both theory and practice are structured in a framework. The foundation of the framework is based on the evidence in this paper suggesting that the agency of design sketching is initiated by generative internal processes. It is proposed to function as an agent that makes an essential contribution to the design process. Therefore, in the created framework (see figure 11), sketching is visualized as something that reminds us of an aorta: functioning as an (internally) valuable contribution to a whole. The ability to design by sketching is running through the blood of designers.

4.1 The set-up

The 'double diamond model' (Design Council, 2005) illustrates the design process through which the vein runs. The choice to utilize this representation of the design process is based on its incorporation of both diverging and converging processes. As outlined in section 2.3, during problem-solving the act of sketching and its purposes are evolving, by transitioning laterally between less structured, varying ideas and vertically by transforming one concept

into a more detailed form (Goel, 1995). Relating this to the process of diverging and converging, the transformative properties of sketching as an agency make a good match with the double diamond model.

As can be seen, the 'pillars' of the aorta are representing four generative, internal processes set in motion by sketching (figure 10). They are based on the insights of theoretical research (see section 2). These pillars illustrate initial processes, which are followed up by the six overarching functions of design sketching derived from the interviews. The latter are not directly visible in the proposed framework, since the focus has been placed on the core affordances of design sketching.

The core of the aorta concerns the two pillars of emergence and imagery. These form the generative loops of (un)intended moves, seeing, imagining, discovering and the interactive state of imagery, due to which differing ideas are appearing. Ambiguity is the key value here, encouraging the generative characteristic of these action loops. Subsequently, the sketched features stimulate interim reflection, bringing about (re-)interpretations and, by closer inspection, (re-)connection of the elements. Consequently, these are the surrounding, 'embracing' pillars, achieving convergence. Here, the key value is mental synthesis.

Following the double diamond model, the designer can go through these processes twice to achieve the end result. However, considering that all of the constructive loops of 'pillars' are generative, the framework has no fixed end: it is only ending when, citing Goldschmidt (1991), "the designer judges that sufficient coherence has been achieved".

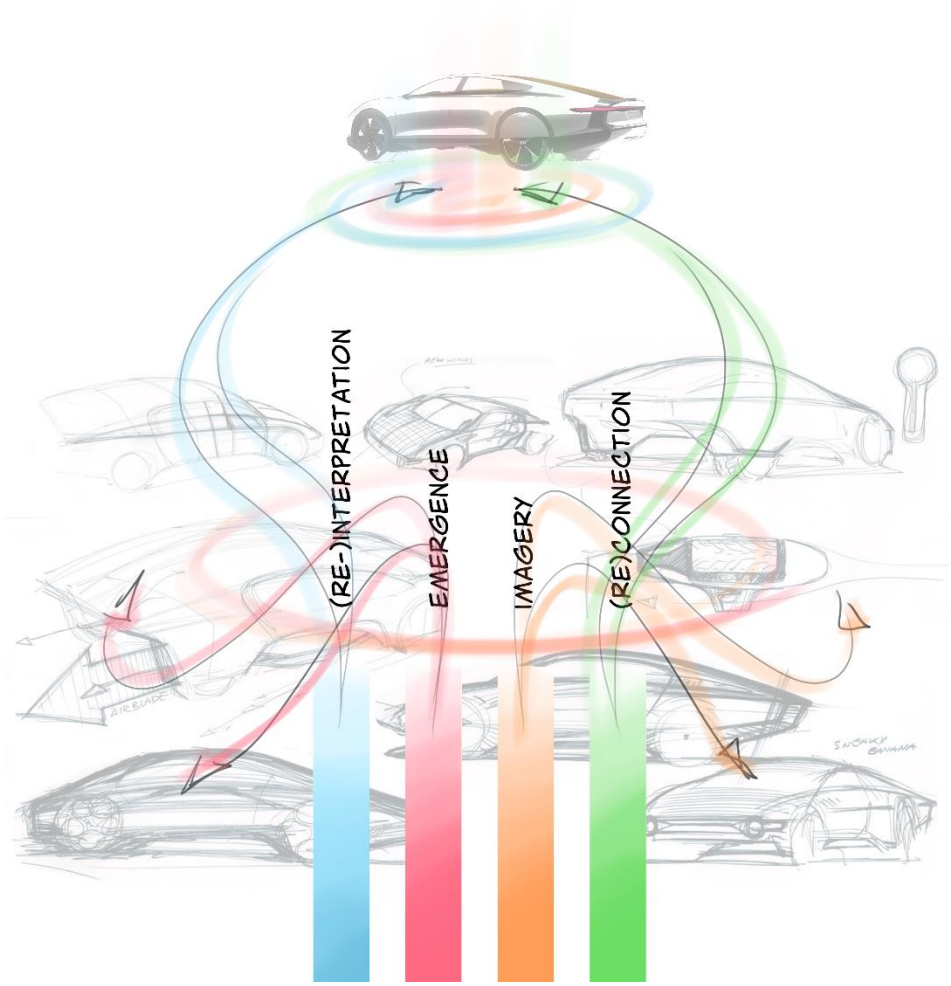

Figure 10 The pillars of the Framework for the Agency of Sketching projected onto process sketches of Lightyear, Granstudio.

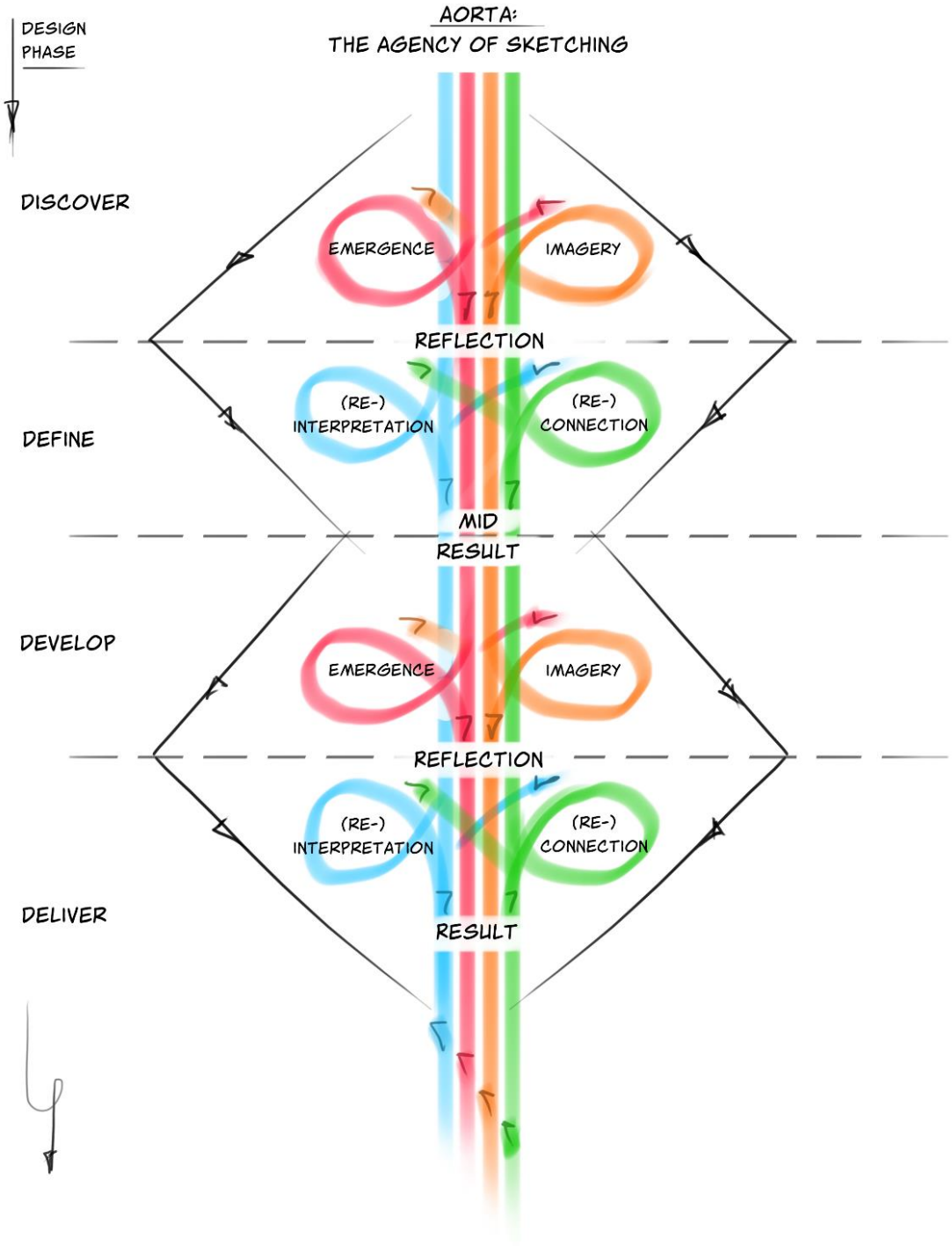

Figure 11 The proposed Framework for the Agency of Sketching.

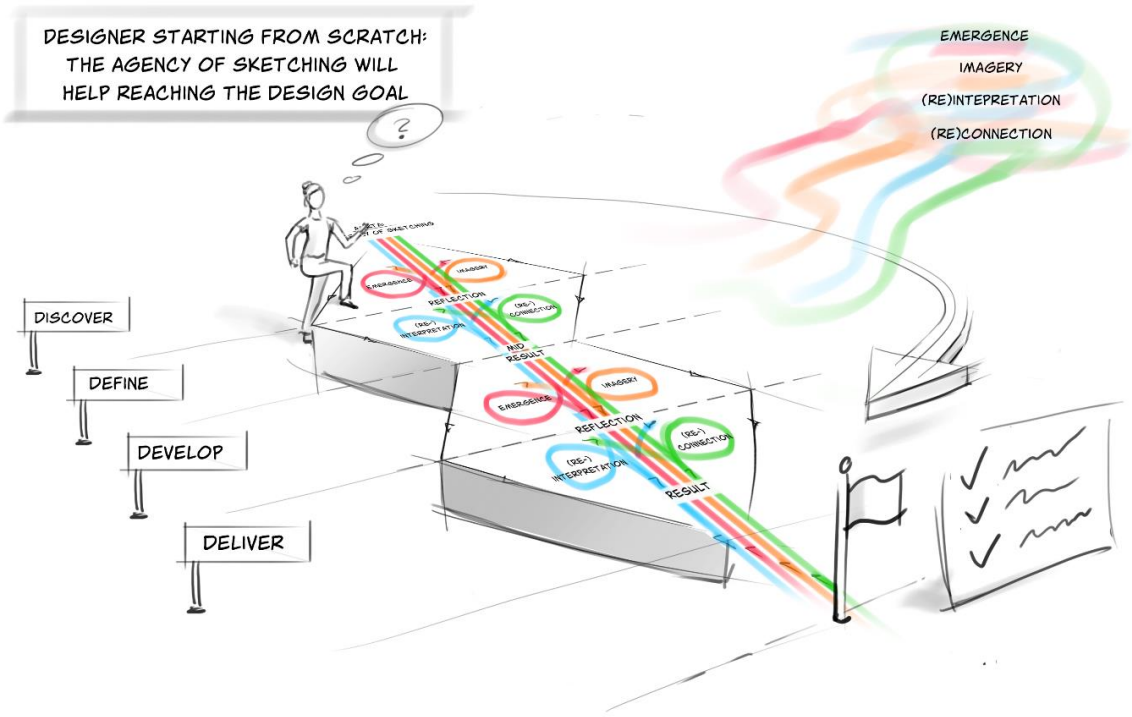

Figure 12 The framework visualizing how the designer will reach the design goal with help from the agency of sketching.

4.2 Reasoning for practical application of the framework

The framework captures the essential theoretical affordances that reveal the agency of design sketching. Now, the question can be raised: could it also be relevant in a practical sense? Considering that affordances must be discoverable and perceivable in order to be effective (Norman, 2013), the framework could be used to reach designers with the following goal: to let them discover design sketching as an agency and unlock its benefits. This can be achieved by transforming the framework into a tool applicable in the current work domain of designers. A tool aligned with the stated objective must adhere to some essential values, such as the following (proposed by the authors):

- It should be inviting
- It should be accessible with a low threshold (intuitive usage)
- It should have an inspiring effect on the user
- It should be valuable during multiple stages of the design process
- The content should be renewable

To elaborate on this, further design research is needed. Nevertheless, to illustrate this suggested applicability of the framework, two possible concept directions for a tool within the designers' practical context will concisely be described, using the proposed framework as a

basis; distinguishing an analog direction (figure 13) and a digital direction (figure 14), both with their own advantages.

Concept direction 1

This direction (figure 13) is a response to the fact that a physical object can lower the threshold of using the framework-tool during interactive sessions. Collaborative use is expected to enhance the feeling of inspiration. During brainstorming sessions, students or colleagues can take out cards and have a look at examples of process sketches made in the same stage of designing. The boxes with cards can be 'open source', meaning that one can add their own sketches. Observing sketches of colleagues or student buddies can stimulate to start sketching too.

The boxes with cards not only distinguish sketches corresponding to different design stages, but also corresponding to the varying internal processes (the four pillars). Interacting with the product, e.g. adding your own sketches, therefore stimulates a deeper understanding of the agency of sketching and, in the case of using it together, elicits conversations about it. Moreover, the designer can showcase their design processes to potential clients, making them more confident about your competence, creativity and problem-solving skills.

Furthermore, the tool will remain useful for client meetings throughout the entire design process. Before meetings, the designer can categorize the recorded design sketches and put them in the boxes. During the meeting, it can help the designer to involve clients in his or her steps, inviting the clients to provide useful feedback. The tool, prominently present on the desk of the designer, helps clients understand and value the time the designers spends on the creative process.

Figure 13 Concept direction 1 (analog).

Concept direction 2

This direction (figure 14) is a response to the fact that using a digital medium can draw attention of users and can effectively facilitate renewable content. A touch screen will be placed next to the coffee machine in a design agency. Here, the user can upload your sketches by scanning them easily on the spot.

Additionally, the device draws the attention of designers who have a break from work; the perfect moment to get inspired by colleagues. This will encourage usage of the tool. Within the framework that is projected on the screen, small pictures of the user and their colleagues will be visible, including corresponding design sketches. This way, one can see where the others are in their design processes. By clicking on the picture, their current sketches will be presented. In this manner, users not only gain inspiration from diverse sketch examples, but also have the opportunity to engage in collaborative thinking with their colleagues. In the case they meet over a cup of coffee, the framework-tool will make it possible to, in a low-key way, visually demonstrate to each other what they are currently working on.

The digital framework-tool aims to trigger sketching inspiration, involvement with colleagues and collaboration. More importantly, it elicits a direct understanding of the benefits of creative steps. It also helps structuring the design process, allowing the user to visualize one's progress and gain inspiration for the next stages.

Figure 14 Concept direction 2 (digital).

5. Discussion and conclusions

Some suggestions are worth mentioning. Firstly, this research is conducted from a designers' point of view. However, exploring both designers' and stakeholders' perspectives, e.g. by adding client interviews, can enhance the understanding of perceptions on sketching and sketches (although note that the shift towards earlier client involvement fosters realistic viewpoints from the designer). Secondly, the interviews were conducted with participants each of whom serves a different field (cars, products, visual strategies) and has a different professional position (company/independent/manager/employee). However, this variety increases the effect of discrepancies, wherefore future research should involve more interviewees per design field to mitigate these. Lastly, in order to develop an effective tool based on the framework, interviewing designers who do not use sketching (anymore) as a (commonly used) medium could provide valuable insights. Understanding their motives helps in finding ways to resurrect their interest in sketching, aligning with the goal of letting them rediscover its benefits.

Overall, by clarifying the agency of sketching for design, the created framework provides an overview that can be used to understand and to communicate the wide range of different

affordances. The framework should be concise and schematic. At the same time, projecting the gained knowledge onto current design process models , brings nuance to the recognition of different kinds of sketching, sketches and corresponding affordances. For example, in addition to the function of the ID Cards by Loughborough University (Evans et al., 2020), introduced to provide understanding based on the representation of chronologically categorized kinds of design visualizations, the framework is able to allow for process-related nuances per design stage. These process-related nuances are based on *emergence*, *imagery*, *(re-)interpretation* and *(re-)connection*, referred two as the four pillars of design sketching. They emphasize that the role of sketching in not only communicating with others, but also in communicating with ourselves.

Contemporary trends seem to change to the way designers will benefit from sketching and suggest that a focus shift is appearing. Designers tend to increasingly pay attention to the affordances of drawing with regard to communication towards others, while other factors decrease the tendency of benefitting from the affordances taking place internally (see section 3). This might decrease one's ability to link visual information with existing design knowledge and understanding and to train the brain in connecting different knowledge domains during sketching. Given the advocated value of the internal affordances in particular (see section 2), and given the emphasis on these in the proposed framework (provided by the four pillars), one could state that the consultation and utilization of the proposed Framework for the Agency of Sketching, and the awareness created along with it, could become increasingly valuable.

6. References

British Design Council (2005). The Design Process: The 'double diamond' design process model. https://www.designcouncil.org.uk/our-resources/the-double-diamond/

Brun, J., Le Masson, P., & Weil, B. (2015). Analyzing the generative effects of sketches with design theory: sketching to foster knowledge reordering. In DS 80-10 Proceedings of the 20th International Conference on Engineering Design (ICED 15) Vol 10: Design Information and Knowledge Management Milan, Italy, 27-30.07. 15 (pp. 041-050).

Cohen, D. J., & Bennett, S. (1997). Why can't most people draw what they see?. Journal of Experimental Psychology: Human Perception and Performance, 23(3), 609.

Cohn, N. (2012). Explaining 'I can't draw': Parallels between the structure and development of language and drawing. Human Development, 55(4), 167-192.

Corremans, J. A., Vaes, K. R., & Coppieters, W. (2018). Do better sketchers become better product designers?. In DS 92: Proceedings of the DESIGN 2018 15th International Design Conference (pp. 2411-2420).

Evans, M., Campbell, I., & Pei, E. (2020). Making the tacit explicit: Developing tools to support collaboration during industrial design and engineering design practice. Loughborough University. http://handle.net/2134/12284078.v1.

Ferguson, E. S. (1992). Engineering and the Mind's Eye. MIT press.

Goel, V. (1995). Sketches of thought. MIT press.

Goldschmidt, G. (1991). The dialectics of sketching. Creativity research journal, 4(2), 123-143.

Goldschmidt, G. (2003). The backtalk of self-generated sketches. Design issues, 19(1), 72-88.

Harrison, K. (2022). What is Visual Literacy?. 2022, from https://visualliteracytoday.org/.

Hoftijzer, J. W. (2018). If you don't draw it, you will not see it. Design para acessibilidade e inclusão. [Design for accessibility and inclusivity]. L. M. Fadel, V. R. Ulbricht and C. Batista. Sao Paulo, Brazil, Blucher: 59-73.

Kudrowitz, B., Te, P., & Wallace, D. (2012). The influence of sketch quality on perception of product-idea creativity. AI EDAM, 26(3), 267-279.

Mulder-Nijkamp, M., & Eggink, W. (2016, April). Innovating from inside the brand:(Re) searching the optimum design strategy for brands a new product innovations. In Global Brand Conference.

Norman 2013: Norman, D. (2013). The design of everyday things: Revised and expanded edition. Basic books.

Pech, M., & Vrchota, J. (2022). The product customization process in relation to industry 4.0 and digitalization. Processes, 10(3), 539.

Purcell, A. T., & Gero, J. S. (1998). Drawings and the design process: A review of protocol studies in design and other disciplines and related research in cognitive psychology. Design studies, 19(4), 389-430.

Schon, D. A., & Wiggins, G. (1992). Kinds of seeing and their functions in designing. Design studies, 13(2), 135-156.

Schütze, M., Sachse, P., & Römer, A. (2003). Support value of sketching in the design process. Research in Engineering Design, 14, 89-97.

Suwa, M., Gero, J. S., & Purcell, T. (1999). Unexpected discoveries and s-inventions of design requirements: A key to creative designs. Computational Models of Creative Design IV, Key Centre of Design Computing and Cognition, University of Sydney, Sydney, Australia, 297-320.

Suwa, M., Gero, J., & Purcell, T. E. R. R. Y. (1999). Unexpected discoveries: How designers discover hidden features in sketches. In Visual and spatial reasoning in design (pp. 145-162). Key Centre of Design Computing and Cognition, University of Sydney, Sydney.

Tversky, B. (2001). Spatial schemas in depictions. In Spatial schemas and abstract thought (Vol. 79, p. 111).

Tversky, B. (2003). Navigating by mind and by body. In International Conference on Spatial Cognition (pp. 1-10). Berlin, Heidelberg: Springer Berlin Heidelberg.

Tversky, B. (2010). Visualizing thought. Topics in Cognitive Science, 3(3), 499–535. https://doi.org/10.1111/j.1756-8765.2010.01113.x

Ware, C. (2010). Visual thinking for design. Elsevier.

About the Authors:

Annemiek van der Wal has a Master's degree in Design for Interaction at Delft University of Technology. Her areas of expertise include design sketching and human-centered design.

JanWillem Hoftijzer worked as a product designer for various agencies. Today he is coordinator and senior lecturer covering the field of design sketching and visualisation at Delft University of Technology. He is co-chair of the Design Society's SIG 'Design Sketching'.

Martijn Haans works in product design and visual communication. As a visual communication expert he has collaborated successfully with consortiums applying for NWO and EU grants. He also lectures Bachelor and Master visualisation courses at Delft University of Technology.