The Representational Imperative: Sketching and Design Creativity

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ABSTRACT

Design belongs to the compositional disciplines, which require a search at the front end of working on assignments. The end outcome is, in most cases, not the entity to be realized but a representation of it, in two or three dimensions. This is a complex process, as there are always many acceptable possible approaches and solutions. Creative design aspires to not only satisfy given requirements, but to surpass them, creating something that is both functional and pleasing to the senses, hopefully innovative and even surprising and exciting. To facilitate this complex practice, designers create intermediate representations that provide essential feedback, thus enabling actions that advance development of a solution. The fastest and most efficient representational device is a freehand sketch, manual of digital, which has many cognitive advantages, operating as a thinking tool as well as an external memory and communication device. Styles vary, and specific gains from sketching differ from one discipline to another.

Keywords: Creativity, Design, Representation

1 Introduction

The compositional disciplines aim to produce artefacts that satisfy predefined goals and surpass them in a creative, harmonious way that is comprehensible, innovative, and pleasing to the senses. In radical cases the artefact is expected to be surprising, even groundbreaking, a "game changer." Design in its different fields is considered a bona fide member of the compositional disciplines, but along it we find many others like music, literature, choreography. The visual arts, visual communication, and literature are cases apart; unlike the other disciplines, the final artefacts they produce are the definitive intended outcomes, like a painting, a poster, or a book. Crafts are somewhere in between; they may be practiced with or without prior sketches and in any event, there are no representational conventions or sketching rules in this case[1]. In all other cases, the artefacts are representations of the intended ultimate outcome, which is produced by separate parties such as construction or production workers and machines, dancers, or an orchestra.

Whether or not considered as problem-solving (of the ill-defined and ill-structured type), design is a process that requires a search at its front edge, in which ideas are generated, inspected, modified, and replaced. There are always various possible approaches, possibilities, and potential acceptable outcomes. Therefore, the designer (individual or team) advances step by step, isolates partial problems or issues, acquires additional information, determines priorities, tries out alternative paths to a solution, considers pros and cons of ideas, adjusts and readjusts initial concepts, before a preliminary conceptual design can be established. I claim that this complex process requires intermediate representations that serve as objects to ponder, react to, and evaluate[2]. Intermediate representations, partial, abstract and inaccurate as they may

[1] In exceptional cases notations are used for crats. An example is a coded pattern-guide used by shawl weavers in Kashmir, India, in the 19th century. Source: Collection of Vera Salomons, London. In the Exhibition 'Paisley, A Pricely Pattern,' Museum for Islamic Art, Jerusalem, 2022.

[2] Please note that an intermediary or intermediate representation is not a boundary object. These are two different concepts.

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be, provide valuable feedback and serve as sources for possible new discoveries and interpretations, which often spark creativity as they uncover unintended cues. When the designed entities are tangible, representations usually depict them, in two or three dimensions. In other cases, like music or dance, but also some engineering disciplines, more symbolic representations are used, mostly notations based on established conventions (e.g., Surasky & Goldschmidt, 2011). Disciplines vary in terms of the benefits of two- versus three-dimensional representation early on. For example, there is evidence that for mechanical engineering prototyping (3D) contributes to higher quality ideas than other representational means (Siti Salwa *et al.*, 2022, under review).

I focus on two-dimensional representations in design disciplines that yield tangible objects and maintain that free-hand sketches are the ultimate mode of representation, indispensable for design idea generation (Goldschmidt, 2014), whether produced manually or digitally. I argue that fruitful sketching, which enhances creativity, requires experience and familiarity with norms and conventions of the discipline in question. The paper centers on architecture, but also explores examples from other design and compositional disciplines, including fashion design, industrial design, and literature, and points out how each of the reviewed discipline utilizes sketching.

2 Architecture

Because of their size, buildings cannot be prototyped in full scale during the design process. Instead, architects produce scale models, but these are often delayed to late design phases. Today, they are supplemented and sometimes replaced by digital 3D views of the designed building, inside and outside; one can take virtual walks inside the building or experience it with virtual reality, augmented reality, or emersion techniques (Milovanovic *et al.*, 2017). However, none of these representational tools are useful during the early, idea generation phase of designing.

Although some architects prefer perspective or axonometric views of structures, a definitive majority of sketches in architecture use parallel projections, that is, plan, section and elevation. Paramount among these is the plan, which is the tool with which to think of the organization of floor areas, movement within a building, orientation, relationship to the surroundings, and more. Sections visualize spatial relationships among built elements and voids, and the volumetric dimensions of spaces, and enable exploration of light penetration and natural ventilation. Elevations are most useful for the study of openings in a building, as perceived from the outside. Therefore, familiarity and experience in the use of parallel projections is a must.

Experienced designers sketch very fast – there is no need, at the early stage, to be precise, or to worry about accurate scale, the amount of detailing, or even the completion of a sketch. The essence is to express ideas or concepts as they emerge, without having to think about any representational production aspects. Most importantly, rapid sketches, incomplete and inaccurate as they may be, give the designer who contemplates them on the fly an opportunity to make amendments but above all, to make new discoveries (Suwa & al., 2000; Suwa & Tversky, 1997), especially before a clear concept has emerged. It is precisely the incompleteness and inaccuracy that allow new interpretations of elements of a sketch and the relationships among them. In some cases, architects have been known to just doodle on paper when they feel stuck or devoid of ideas and then, with the help of mental imagery, see in them hinted shapes that are potentially relevant to the task in hand. A case in point is Alvar Aalto, who was a prolific sketcher (Fleig, 1971). The dialog between designer and sketch in the making has been well documented (Goldschmidt, 1991; 2003; Schön & Wiggins, 1992). The following example highlights the need for sketching knowledge and fluency in architectural design.

In a short experiment, participants who included architects and non-architects received a plan of a house on a small lot (Fig. 1a), with the following brief:

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You have inherited a small lot with a small house on it. The house is old and in poor condition and you can pull it down and build a new vacation house for yourself instead. As was the case in the past, building laws enable single-floor construction on 2/3 of the lot's area. When the house was built a one-meter clearance between the property line and any construction was required. The law has since been eased and today building right to the property line is allowed. Openings are allowed anywhere in the house's perimeter, provided the 3-meter-high party walls between your lot and adjoining lots remain intact.

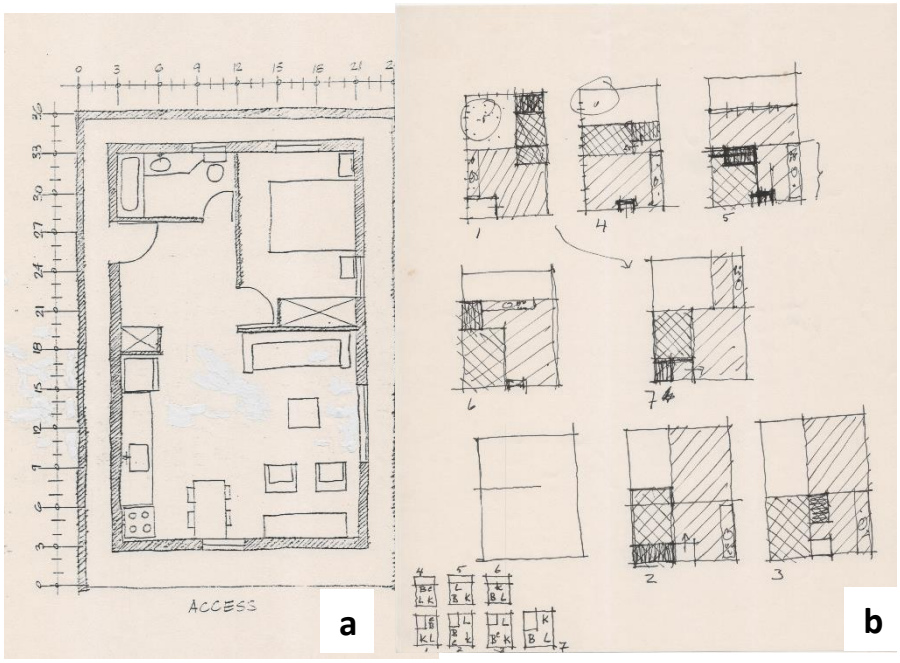

Figure 1: *a) Given plan of a house on a small lot (dimensions in feet). b) Analytic sketch by an architect*

Figure 1b is by an architect who chose an analytic approach and produced seven different alternative plan diagrams, based on the location and shape of the open space, or garden, which is to occupy one third of the lot, in relation to the other elements of the plan: Living(room), Kitchen (with dining), and bedroom with bathroom. He left it at that and did not choose one of the alternatives for further development.

Figure 2a shows a preliminary sketch by an architect participant, which was then developed into a final sketch, shown in Figure 2b. Like other participants the architect used tracing paper over the original give plan, and therefore did not have to deal with any measurements. We can see that the first sketch served to fix the position of all plan elements, which were then finalized in the second sketch.

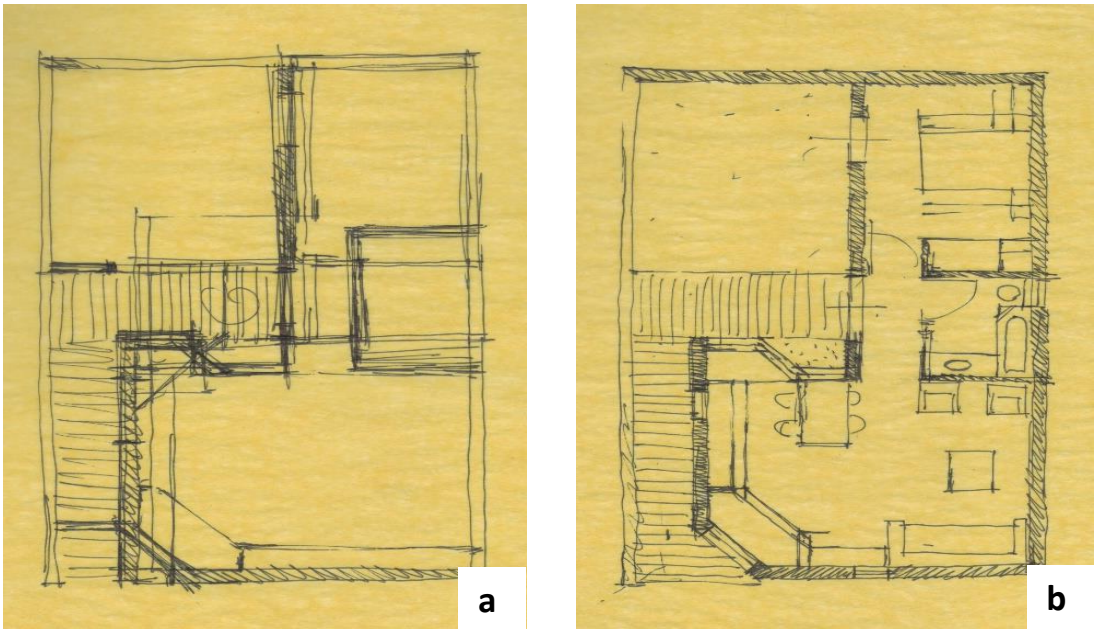

Figure 2: *Preliminary and final sketches by an architect. a) First sketch. b) Second sketch.*

Figures 3a and 3b are sketches by non-designers who participated in the experiment. They reported feeling at a loss to produce a design proposal, as is evident from their sketches. Both participants could understand plans drawn by others when explained, but this did not help them produce plans of their own.

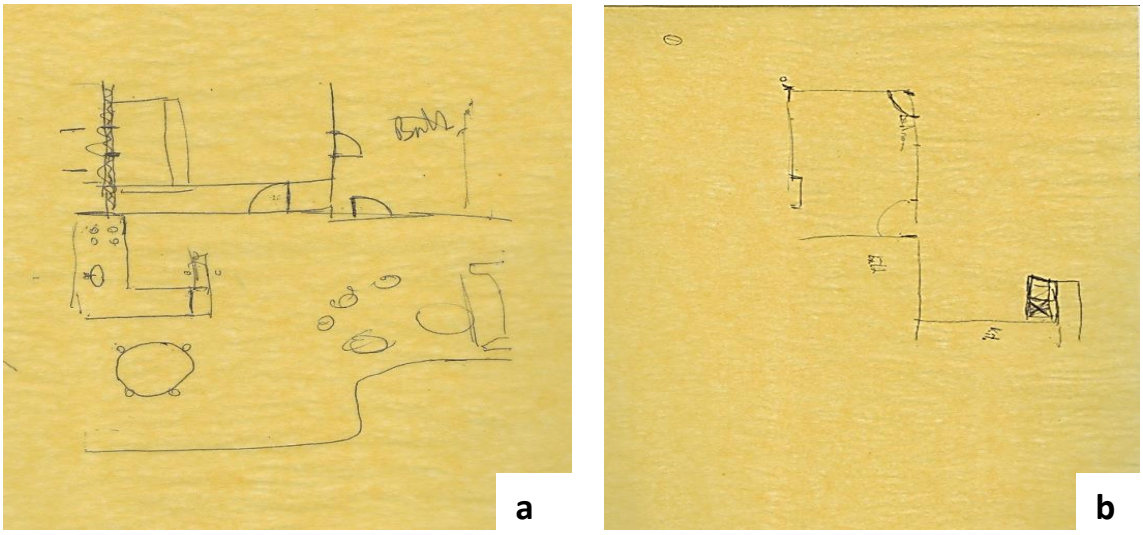

Figure 3: *a & b) Sketches by non-designers.*

This assortment of rapid ideation sketches illustrates two important points. First, the importance of sketching fluency that comes with familiarity and experience. Second, the diversity of approaches to a design problem or task, which yields different search directions.

3 Fashion design

In 2001 Eckert and Stacy made the following statement: "We argue that creativity in garment design resides in finding innovative understandings of the spaces of acceptable garments and perceptual evaluations of acceptability as much as in idea generation." (p. 1). In the two decades since that statement was made the focus of creativity in fashion, or garment design has shifted quite considerably and now focuses on what

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some call 'conceptual fashion design' which is tightly connected to fabric design (Au & Au, 2018). Fabric design has made enormous strides forward with the introduction of new technologies that are adapted to the fabric industry. Over a decade ago Issey Miyake started using fabrics in which permanent pleats and folds were implanted (see for example his famous 'origami dress' (Demetrious, 2010). The latest cry is the use of 3D Printing on fabrics, used by a score of top fashion designers to create extravagant sculptural cloths (see for example work in conjunction with Stratasys, a manufacturer of industrial 3D printers (Stratasys, 2021). It is conceivable that in the not very distant future this technology will be commonplace and available even to lay persons who will print their garments. Today, however, 3D printed fashion is still quite futuristic, and most fashion designers use traditional techniques, which start with making sketches. These sketches are then used by a pattern maker, who interprets the sketches to make an initial "draft", or prototype, of the garment, actually using fabric.

The preliminary sketches of a fashion designer look very different from fashion illustrations, just as initial architectural sketches differ from later renderings. In the following, we look at the work process of one fashion designer: Sasson Kedem, based in Tel Aviv.

Kedem is a collector of tribal art, and he is fond of over-sized garments that appear to complement the art pieces that are abundant in his stores. His garments follow geometric and "architectural" concepts – they are wearable constructions, always with a twist, never "common." He uses big black notebooks in which he sketches his creations – one page per garment. If satisfied, he passes a sketch to his long-time pattern maker, who translates the sketch into a pattern on paper at a 1:1 scale. Kedem states that the pattern maker has worked with him for a long time and "he knows my whims." When the pattern is ready the two discuss it; on many occasions they have disagreements and Kedem says the pattern maker usually has the upper hand. "He knows better", he says. Once the pattern is cut and sawn in fabric, the studio staff serve as models and Kedem decides on modifications. This step is repeated util he is satisfied. Figure 4 shows a sketch and the ensuing garment that was subsequently hung in the store. Describing his creative process, Kedem stresses the sketch which is the beginning of everything. He says that although he has an initial idea and an image in his mind, once he puts pencil to paper, he can much better visualize the garment and the first modifications are made on the sketch itself, before it reaches the pattern maker. He also adds annotations. The sketch "talks back to him", similar to what architects say about sketching in their idea generation processes. However, the prototyping process with the actual garment being produced as a first draft is unparalleled in other design disciplines discussed in this paper.

Figure 4: *Preliminary sketch and final garment by Sasson Kedem.*

4 Industrial Design

Unlike architectural sketches, industrial design sketches are almost always three dimensional. Oftentimes we find sketch sheets in which different alternative designs of an object are portrayed. In most cases an industrial designer is charged with designing a new version, or a re-design, of existing object types: consumer products, medical instruments, tools of all kinds, vehicles, electronic devices, and so on – anything humans (and other species) use. Designing a completely new artefact type is rare, but of course it provides an opportunity to make a highly regarded creative breakthrough; the first laptop and the first cell phone are familiar examples. To be creative and innovate, designers of subsequent designs of such products must think of many alternatives in order to arrive at something that performs a similar function but is still surprising. When technology is involved, a new version may build on its advances. When a classic and non-technological object is involved, form is the major creativity agent, along with color, material, and texture. A recent book by Pei and Self (2022) spells out the many kinds of two- and three-dimension representations used by product designers, many of which are, or can be, produced manually.

Figure 5 shows two examples of sketches for a low-tech object. One is a coffee pot by the architect and designer Charles Gwathmey (other known architects have also practiced industrial and product design in parallel to their architectural career), and the other is an electric kettle by the designer Uji Terkuma. The differences between the two sketches are noticeable. Gwathmey draws mainly two-dimensional projections, while Terkuma uses mainly three-dimensional views. He also shows his object in use – in one of the views a hand is holding the handle and pouring water out of the kettle. Another view represents a tilted kettle, something Gwathmey would probably never consider. Gwathmey's sketches are very geometrical; Terkuma's are not. We do not compare the two design disciplines here, but only wish to demonstrate differences in sketching practices, and figure 5 is a good example.

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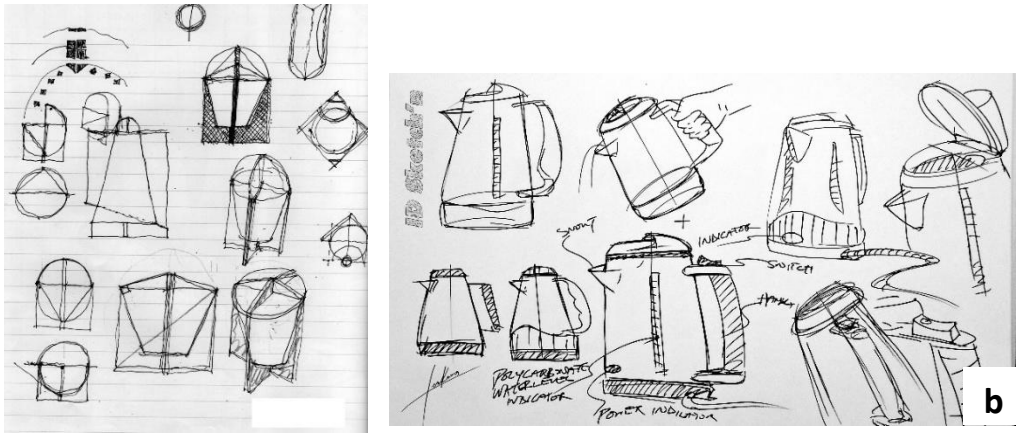

Figure 5: *a) Coffee pot, Charles Gwathmey, 1990. b) Kettle, Uji Terkuma, 2018*

Engineering sketches are different from both architectural and industrial design sketches. But engineering is by and large less of a compositional discipline, and in some of its varieties, like electrical engineering, it relies mostly on notations. Therefore, it is left out of the current discussion.

5 Literature

Literature differs from the other design disciplines we refer to in this text, in that the intended final product is not a tangible product. However, we consider it to be a bone fide compositional discipline: texts are composed, and this includes literary as well as other texts. A writer usually has a general idea about the topic of the text, its components, a story and its characters (in case of a novel), a research question (in case of an academic research text), etc. But all of these are preliminary and develop only in the process of writing, in which the writer may add, distract, and revise most of the initial intentions and decisions. Even poetry, which is written without any pre-plan, is subject to later revisions. Most writers produce draft after draft, the draft being an equivalent of a sketch. Figure 6 presents drafts with revisions by two master writers, poet Walt Whitman and writer George Orwell. With the advent of word processing, we lose records of many revisions made on the fly, leaving no trace of what was there earlier. However, the ease with which versions can be produced actually cause many authors to revise more than was reasonably possible before computation.

Needless to say, some writers revise more than others, just as some designers re-sketch more than others. Tolstoy is said to have re-written War and Peace several times: His wife Sonya, who was the only one able to decipher his handwriting, copied it seven times, each time after Tolstoy revised the previous version. Tolstoy was a notorious reviser who also disfigured proof sheets, once the versions his wife copied reached the printer, with endless changes and corrections (Troyat, 1967).

Another notorious reviser, closer to our time, was Raymond Carver, an American writer well-known especially for his short stories. In a 1983 interview with Nadine Gordimer about his writing processes, he said:

> "I put in a lot of hours at the desk. . . Much of this work time, understand, is given over to revising and rewriting . . . doing this or that to it, taking this out and putting this in. It doesn't take that long to do the first draft of the story. I've done as many as twenty or thirty drafts of a story. Never less than ten or twelve drafts." (Carver, 1984, pp. 202-203).

The practice of revising a text repeatedly many times is akin to what I call serial sketching, which some architects engage in, and did so especially in the era of using tracing paper which enabled multiple overlays on the same sketch. Rewriting is essential to the quality of a text. In the words of William Zinsser (1976/2016): "…rewriting is the essence of writing… professional writers rewrite their sentences over and over and then rewrite what they have rewritten." (p. 4), see example below (Fig 6).

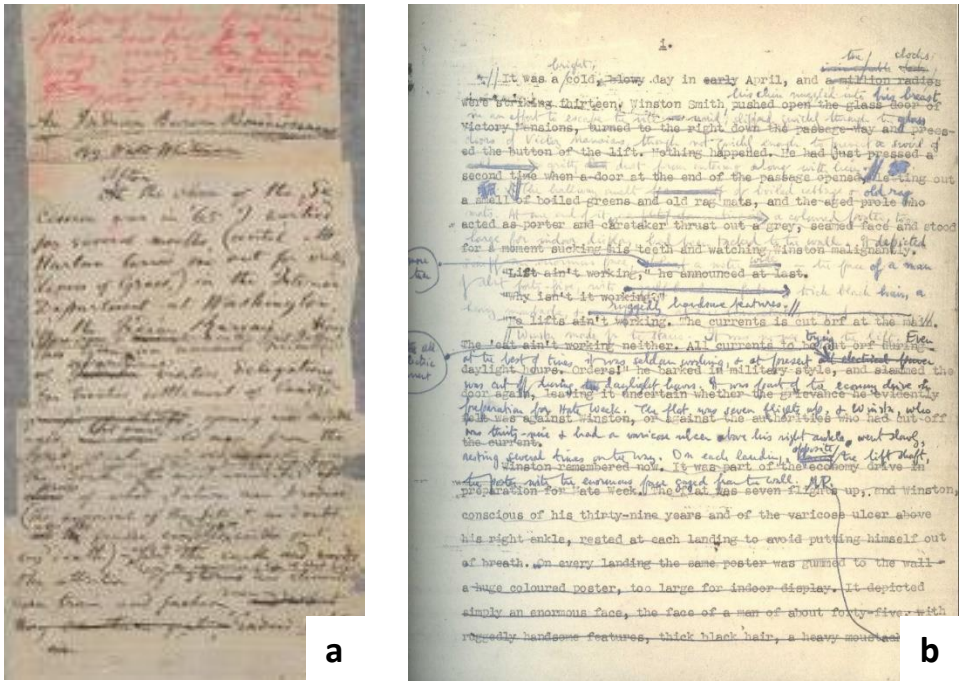

Figure 6: *Examples writing and rewriting*

6 Discussion and conclusions

We may ask how the writing of text is different from writing music. Music uses a standard notation system, which is not to say that composers do not revise and rewrite, just like writers. Dance, too, can be written down, and there are a number of movement notations in use today, notably Labanotation (Hutchinson-Guest, 2005) and the Eshkol-Wachman movement notation (Eshkol & Wachman, 1958). In both cases the composition is made of a limited number of components with a large number of possible combinations among them. The words writers employ, in endless combinations, use a much larger repertoire of components and are more reminiscent of the shapes and forms used in architectural drawings, where although they are usually regular and geometrical, they can come in countless sizes, proportions and combinations. But unlike written words, shapes and forms can also be irregular and incomplete, and in industrial design those are the rule rather than an exception. But in all disciplines, creativity stems from the arrangements of such components – words, shapes and forms, musical notes, etc. – to create a unique outcome that we recognize as creative and appreciate as such. Where materials are involved, as in architecture, industrial design, jewelry and certainly fashion design, other properties also come into play – color, texture, tactile experience. But those are secondary; many exemplars of products in these disciplines come in several alternative colors and textures which, we must stress, are of no compositional significance (unlike the case of visual art).

We can see, then, that there are languages of design representation, and we find that although they are used for similar goals – as an aid in the search for creative design outcomes – they have developed disciplinary

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distinctness in line with the nature and substance of each discipline. In industrial design, representations analogically depict the intended object, usually in three dimensions, often in perspective, and objects are drawn from several angles. Details are attended to from the very beginning and serve as the basis for design alternatives. In architecture most preliminary representations are abstract- plans and sections do not portray building elements but serve to understand the positioning of spaces in a structure. Fashion design sketches are closer to the flat patterns that are later drawn by the pattern maker: the designer automatically translates his or her vision of a garment into a flat pattern, just as the architect automatically translates a volumetric image of a building into plans and sections. However, in architecture the opposite is also true: explorations in plans and sections can then become 3D structures. These mental translations from 3D to 2D and vice versa require the cognitive ability to envision the result of the transformation, which takes place in visual mental imagery. In the case of architecture, a good command of the rules of parallel (orthogonal) projections is necessary, and in industrial design a basic drawing ability is a must.

Writers' output of words and sentences requires great sensitivity to the semantic nuances of words as well as to their sounds. Composers are said to hear tunes in auditory imagery and then lay them out as scores. Writers usually do not compose sentences in imagery; words flow to the writing medium concurrently with their emergence in the mind.

In all cases, though, the representation on paper or screen talks back to the designer who amends and changes it as many times as necessary until he or she or they are satisfied. Of great interest is also the ability to discover new and unforeseen opportunities in very early sketches. Therefore, vague and incomplete sketches that mean nothing to others can be of great value to their makers, and some architects are known to just jot lines on paper in order to create an image they can then explore for useful clues. Without a representation, one's ability to evaluate and assess is rather limited. To some degree it can be done in imagery (Athavankar, 1997; Bilda & Gero, 2008), but the capacity of mental imagery to deal with large and complex entities is quite limited. What makes design entities creative is their perfect match with the purpose for which they are created, pleasing features and of course novelty and innovativeness. We could add later stage advantages like low production costs, ease of use/comprehensibility, environmental robustness and more – but we may just as well stop here, as we focus on the idea generation phase. To achieve all of this is no minor feat, and it requires cycle after cycle of idea generation and refinement. This is where representations come into play to assist the designer, and to keep up with one's thinking speed they must be created very fast with minimum effort and no restrictive production rules (Goldschmidt, 2014). Because manual sketches are so well suited for the task, they are not passé, despite the rich digital means we have at our disposal. The sketch, I believe, is here to stay, because the representational imperative favors it over other modes of exploration.

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