Freehand Drawing
in the Architectural and Urban Design Process

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SUMMARY

The discussion on the use of freehand drawing in the architectural and urban design practice today – in the context of the digital development – is still ongoing. Numerous publications on this topic are based mainly on theoretical expertise, interviews or experiments. Nevertheless, there is a lack of investigation describing the actual use of freehand drawing in a real project.

Because of this research gap the author decided to undertake an empirical study usingparticipant observation. The investigation was possible mainly because of the design method (charrette workshop) used by an architectural and urban design office which agreed to have the work on the project in Chicago recorded. The charrette method, pioneered by this office, gathers all parties involved on the site of the project in order to facilitate the discussion, find a satisfactory solution for all parties and intensify the conceptual phase of the design.

The aim of the dissertation is to examine those features of freehand drawing which determine its current importance in architectural and urban design.

Charrette is a specific design method but in comparison to the conventional conceptual phase of designing taking place in an office the ongoing thinking and communication processes are similar. The drawings generated in Chicago were analysed and categorised. The categories show their different features: 1) enabling a quick record of information in the pre-phase (“sketchnote”), 2) transformation of an idea into form (“initial sketch”), 3) discussing ideas (“communicating sketch”) in order to evolve first thoughts into advanced concepts (“conceptual sketch”), finding mistakes and correcting them (“corrective sketch”) and, in the end, presenting “final conceptual drawings” to stakeholders and a wider audience.

The findings generally support the notion that, despite digital development, freehand drawing has valuable features, which are particularly visible in the education of architectural and urban design students, conceptual phase of the project and during design workshops. What is more, the dissertation demonstrated that while the use of drawing is being limited in certain aspects of design, it is being increased in others. The study helped establish the most important attribute of freehand drawing that determines the extent of its present use, namely its ambiguity, which stems from nothing other than the freehand nature of this tool.

ZUSAMMENFASSUNG

Im Kontext der Digitalisierung ist die Diskussion über den Nutzen des Freihandzeichnens in der architektonischen und städtebaulichen Entwurfspraxis immer noch im Gange. Unzählige Veröffentlichungen zu diesem Thema beruhen hauptsächlich auf theoretischem Fachwissen, Interviews und Experimenten. Nichtsdestoweniger fehlen Studien, die den eigentlichen Nutzen des Freihandzeichnens am Beispiel wirklicher Projekte beschreiben.

Vor dem Hintergrund dieser Forschungslücke wurde eine empirische Studie mittels der teilnehmenden Beobachtung durchgeführt. Machbar war die Untersuchung des Projekts in Chicago aufgrund der Entwurfsmethode (Charrette-Workshop) und durch die Zustimmung des Architektur- und Stadtplanungsbüros, das sich dieser Methode bedient. Bei der Charrette-Methode werden alle Interessengruppen am Ort des Bauvorhabens versammelt, um den Austausch zwischen ihnen zu vereinfachen, die konzeptionelle Arbeit am Entwurf zu intensivieren und zu einer für alle Beteiligten zufriedenstellenden Lösung zu kommen.

Das Ziel dieser Dissertation ist es, die Besonderheiten des Freihandzeichnens, die seine gegenwärtige Relevanz im Entwurfsprozess begründen, zu untersuchen.

Das Charrette ist zwar eine spezifische Entwurfsmethode, aber im Vergleich zur konzeptionellen Phase konventionellen Entwerfens im Büro sind die Denk- und Kommunikationsprozesse ähnlich. Die Zeichnungen vom Projekt in Chicago wurden analysiert und kategorisiert. Sie ermöglichen 1) das schnelle Speichern von Informationen vor dem Entwerfen („sketchnote“), 2) die Umsetzung von Ideen in Formen („initial sketch“), 3) die Diskussion von Ideen („communicating sketch“), um erste Gedanken in fortgeschrittene Konzepte weiterzuentwickeln („conceptual sketch“), Fehler zu finden und diese zu korrigieren („corrective sketch“) und schließlich die finalen Ideen („final conceptual drawings“) den Interessengruppen und der Öffentlichkeit zu präsentieren. Die Ergebnisse stützen die These, dass trotz der Digitalisierung das Freihandzeichnen über wertvolle Besonderheiten verfügt, die insbesondere im Studium der Architektur- und Stadtplanung, in der konzeptionellen Entwurfsphase sowie während der Werkstätten sichtbar werden. Die Dissertation hat auch gezeigt, dass dem Zeichnen in einigen Bereichen des Entwerfens Grenzen gesetzt sind, während seine Bedeutung in anderen wächst. Die Untersuchung half dabei, die wichtigste Eigenschaft des Freihandzeichnens herauszustellen, die seine gegenwärtige Nutzung bestimmt, nämlich seine Ambiguität, die von nichts anderem als der Natur dieses Werkzeugs herrührt.

STRESZCZENIE

Trwająca dyskusja na temat wykorzystania rysunku odręcznego w pracy architekta i urbanisty odbywa się w kontekście przemian technologicznych. Liczne publikacje w tym temacie stanowią przede wszystkim badania teoretyczne, bazują również na wywiadach i eksperymentach. Istnieje jednakże luka badawcza polegająca na braku opracowań opisujących aktualne wykorzystanie rysunku odręcznego na przykładzie rzeczywistego projektu.

Mając na uwadze tę lukę postanowiono przeprowadzić badania z użyciem obserwacji uczestniczącej. Stało się to możliwe z uwagi na metodę projektową (warsztat charrette) wykorzystywaną przez biuro, które zgodziło się na opis zleconego mu projektu w Chicago. Charrette pozwala na zebranie członków procesu projektowego na obszarze opracowania, ułatwienie dialogu i dojścia do koncepcji satysfakcjonującej wszystkie strony.

Cel pracy stanowi zbadanie tych cech rysunku odręcznego, jakie decydują o jego obecnym znaczeniu w projektowaniu architektonicznym i urbanistycznym.

Charrette stanowi specyficzną metodę projektowania, lecz zachodzące w jego trakcie procesy myślowe i komunikacyjne są podobne do tych mających miejsce podczas konwencjonalnego projektowania koncepcyjnego w biurze projektowym. Rysunki z warsztatu w Chicago zostały przeanalizowane i skategoryzowane dla celów dysertacji. Nadane im kategorie wskazują na różne właściwości i funkcje: 1) szybki zapis informacji jeszcze przed projektowaniem („notatka szkicowa”), 2) nadanie idei materialnej formy („szkic ideowy”), 3) dyskusję nad rozwiązaniem projektowym („szkic komunikujący”) w celu przekształcenia pierwszych myśli w zaawansowane rozwiązanie („szkic koncepcyjny”), odnajdywanie błędów i ich korygowanie („szkic korygujący”) oraz prezentację „finalnych rysunków koncepcyjnych” interesariuszom i szerszemu gronu odbiorców.

Wyniki potwierdzają, iż pomimo przemian technologicznych rysunek odręczny posiada cenne właściwości, szczególnie widoczne w edukacji studentów architektury i urbanistyki, w fazie koncepcyjnej projektowania oraz podczas warsztatów projektowych. Rozprawa wykazała, iż wykorzystanie rysunku w niektórych aspektach projektowania ulega ograniczeniu, ale z kolei w innych – rozwinięciu. Badania pozwoliły na ustalenie najważniejszej cechy rysunku odręcznego, decydującej o wymiarze jego współczesnego wykorzystania. Jest nią wieloznaczność, wynikła właśnie z „odręczności” tego narzędzia.

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I. INTRODUCTION

I. 1 Justification for the topic selection

The choice of the topic of this PhD dissertation results from the need to place freehand drawing in the dynamically transforming working environment of architects and urban planners. Technological progress, which carries along new opportunities improving many aspects of designing, raises questions relating to the place of traditional design tools in a world where 'each generation will become more digital than the preceding one' (Negroponte 1996, 231).

The use of freehand drawing which, still at the end of the last century, was the basic tool sufficient to describe the entire design process, starting with conceptual sketches and ending with technical documentation, has become very limited in scope, if not abandoned altogether. Thanks to three-dimensional models simulating the designed object and replacing the traditional notation based on orthogonal projections, the architects' and urban planners' work is being transformed. The awareness of the advantages and disadvantages of freehand drawing in the work of architect and urban planner, the willingness to verify my own knowledge and opinions, and to confront drawing with the changes occurring in the design tool area have been the main motivation for the topic of the dissertation.

The topic was also selected because of the desire to verify the experiences gathered during 15 charrette workshops[1] in which I took part as an illustrator, organised by two architectural design studios: Berlin-based studio (DPZ Europe) and Warsaw-based studio (Mycielski Architecture & Urbanism). The findings from the selected workshops, and above all from the following design projects: Gdynia West (2012), roundhouse in Gniezno (2017) and Warsaw Uprising Square (2017) have been developed in Chapter V (mostly in Subchapter V. 3).

[1] The Warsaw Uprising Square in Warsaw (2017), the roundhouse in Gniezno (2017), Pole Mokotowskie, Warsaw (2016), Szałsza (2016), Zduńska Wola (2014), Gdynia West (2012), Konstancin Jeziorna – Old Paper Mill (2012), Wittenbeck, Germany (2012), Cement Plant in Grodziec (2010), Rogoźnik (2009), Bolshaya Izhora, Saint Petersburg (2008), Siewierz Eco-Town (2007), Buftea, Romania (2007), Berenice Bay, Egypt (2007), Parc d'Alliance, Braine l'Alleud, Belgium (2006)

In order to check the accuracy of these accumulated findings, I decided to use the participant observation research technique, when taking part in the workshop as a researcher. This enabled me to record, note and observe the phenomenon of using freehand drawing in a specific charrette environment. The results of my observations are presented in Chapter VI describing the project conducted in Chicago by the Duany Plater-Zyberk firm (DPZ Partners), a pioneer in the charrette method. The juxtaposition between my previous experiences and the subsequent written observations can be found in the conclusions from the charrette workshop (Subchapter VI. 6) and from the entire research work (Chapter VII).

I. 2 Dissertation's goal

The goal is to examine those universal features of freehand drawing which determine its importance in architectural and urban design in the light of the changes related to the development of computer techniques which currently take place. The aim is not, therefore, to compare the tools or to recognise the superiority of any of them, as the conscious use of the tools makes them complementary to each other.

The overall goal is indicated in the diagram below (Fig. 1), where the use of freehand drawing, which has changed over time, is marked in blue. The first three circles (1, 2 and 3) present freehand drawing slowly being replaced by the digital drawing at the stages where streamlining the production of technical documentation was set as the

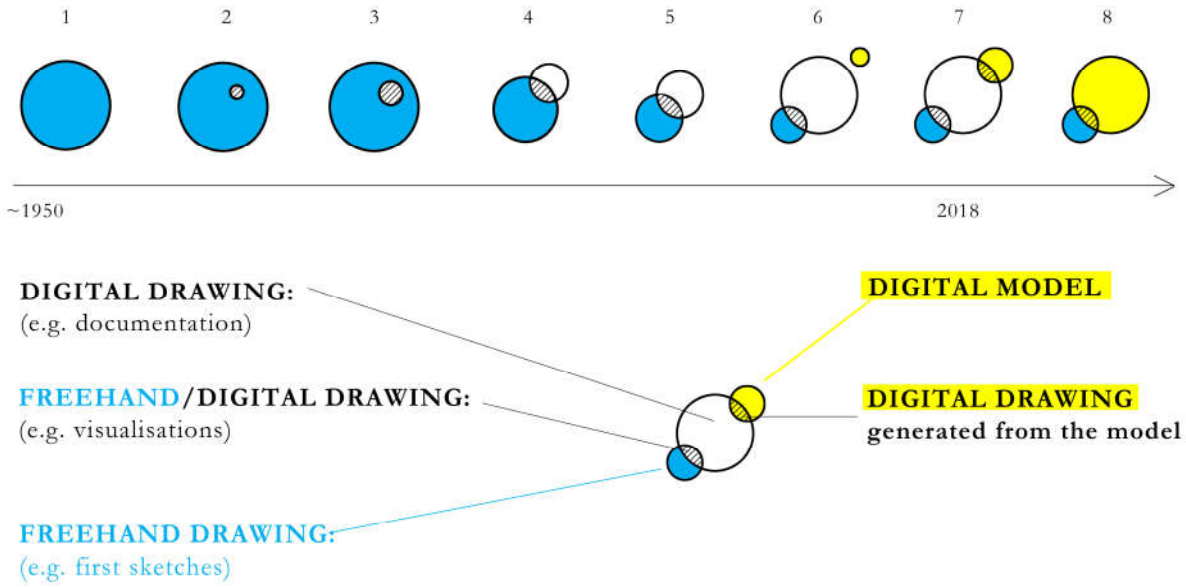


Fig. 1 Changes in the use of design tools since the 1950s until today

priority. The hatched area indicates drawings made on a computer which could still be delivered to the construction site if produced on the drawing board. The next stages (4 and 5) illustrate the increasing proportion of drawings marked with white – not drawn by hand, but produced digitally, due to the significant improvement of the design process and the applicable standards for design submission. The next stage (6) presents the design methods using a three-dimensional digital model (yellow circle). Over time, however, the majority of drawings were still made in two-dimensional form with the use of CAD software tools (white area). Currently (7), two-dimensional drawings (yellow hatched area) can be generated from the model if necessary. Probably in the future (8) 'flat' drawings will be created only this way, if there is a need to create them.

The dissertation is aimed at considering whether and why, despite the decreasing proportion of freehand drawing in the design process which has been observed for several decades, freehand drawing should still remain one of the tools serving the architect and urban planner. In other words, using the elements of the diagram, this inquiry can be presented as follows: will the blue area shown in the diagram disappear, diminish, or will it begin to grow (and if – why)?

I. 3 Scope of the dissertation

The considerations on freehand drawing can be enclosed within the area of its meaning in the architectural and urban design process.

According to Christian Gänshirt, the design process can be presented in a circular form (Fig. 2) containing four basic elements, including three cognitive processes (Gänshirt 2011, 79). The first of the above-mentioned elements – perception – focuses on the design situation and task. The second one concerns thinking which leads to mental images of the object being created. They are eventually expressed using gestures and words, and that constitutes the third element of the design cycle. Its fourth ingredient, complementary to the previous ones, are tools used to express thoughts (visual and verbal). The record of the designed object thus created is again subject to the process of perception, thinking and expression, creating a closed circuit.

Taking into account the mentioned design cycle, the dissertation in the theoretical part presents design tools (Chapter II), focuses on cognitive processes such as perception, memory and thinking (Chapter III), elaborates on the notion of design thinking

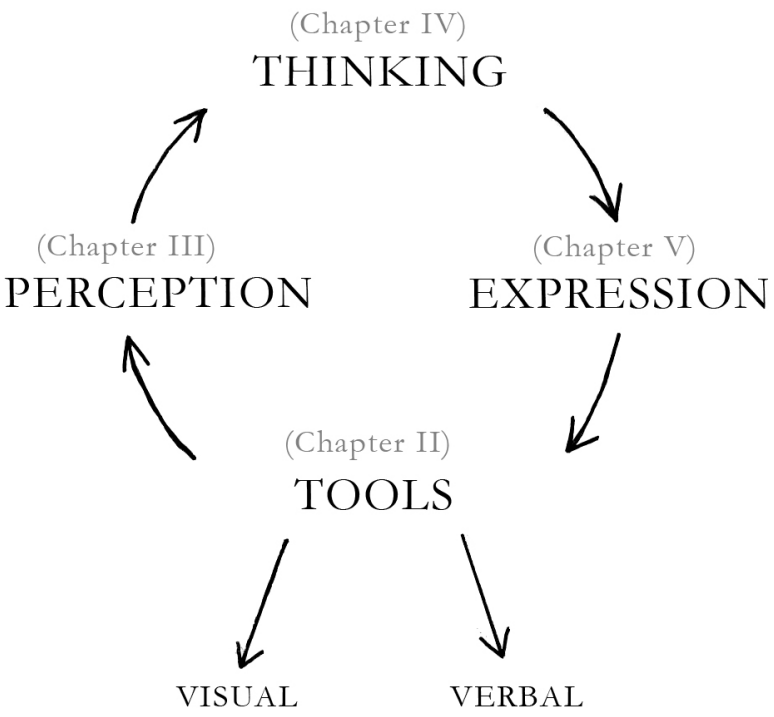


Fig. 2 Christian Gänshirt, design cycle;
the diagram contains references to the chapter of the dissertation devoted to the specific elements of the design cycle.

(Chapter IV) and discusses a visual way of expressing thoughts with the use of a special tool, i.e. freehand drawing (Chapter V) resulting from previous processes.

The empirical part (Chapter VI) describes a charrette workshop in Chicago, during which the use of freehand drawing in the design process is recounted. The charrette method itself, created in the United States, is not a direct topic of the dissertation. It has been briefly characterised in Subchapter VI. 1 for a better understanding of the case study.

According to Henryk Dąbrowski's definition, the essence of the drawing is the information contained in it (Dąbrowski 1983, 42–43). Chapters V and VI of the dissertation are aimed at demonstrating how this tool impacts the acquisition, notation, transmission and presentation of the information.

The timeframe is important here – the author is interested in the role of freehand drawing in the contemporary context of changes taking place in the area of digital technologies. They are, however, only the background for author's considerations, and not the essential topic of the dissertation.

The text also includes references to the history of architectural drawing and definitions of basic concepts which are necessary to understand the essence of the discussed topic.

I. 4 Literature review

The most important literature which do not exhaust, however, the entire bibliography of the dissertation, have been included in the subchapter below.

I. 4. 1 Cognition, perception, thinking, creativity

The main areas of psychology, including cognitive processes related to drawing (perception, thinking and remembering), have been described in a comprehensive publication titled *Psychology and Life* (Zimbardo 1992). Detailed studies elaborating on the topic of cognitive science relating to the dissertation are *Psychologia poznawcza* [Cognitive Psychology] (Nęcka, Orzechowski and Szymura 2006) and *Psychofizjologia widzenia* [Psychophysiology of Vision] (Mączynska-Frydryszek, Jaskólska-Klaus and Maruszewski 2001). The issue of creativity and imagination has been presented by Edward Nęcka in *Psychologia twórczości* [Psychology of Creativity] (Nęcka 2005). The specificity of design thinking has been developed by Donald Schön in *The Reflective Practitioner* (Schön 1983). The difference between vertical and lateral thinking and other important aspects of the creative process have been described by Edward de Bono (de Bono 1990).

The different functioning of the cerebral hemispheres, the understanding of which underlies, inter alia, the learning of drawing, has been delineated by Roger Sperry (Sperry 1968, 1974).

The above-mentioned cognitive aspects have been related to drawing in the book titled *Drawing and Cognition* (van Sommers 1984). Numerous publications by Barbara Tversky discuss the relationship between thinking and drawing (Tversky 1999; Tversky 2002; Tversky and Suwa 2009), similarly to the book titled *Thinking Visually* (McKim 1980) which contains many practical tips.

The work dealing with the relationship between psychology and the visual arts (mainly drawing, painting, and sculpture) is Rudolf Arnheim's *Art and Visual Perception*. In his book, Rudolf Arnheim discusses the issue of perception in relation to the questions of balance, shape, development, space, light, colour, movement, dynamics and expression (Arnheim 2004).

The publication dealing with the topic of perception is Juliusz Żórawski's work titled *O budowie formy architektonicznej* [On the Construction of Architectural Form]. Władysław Tatarkiewicz's introduction reads:

> The basic premise of both books – the American one [by R. Arnheim] and the Polish one [by Juliusz Żórawski] – is common, but the approach and factual material on which they are based – differ substantially. Both books complement each other, elucidating, each in its own way, the common idea.[2] (Żórawski 1973, 13)

The fundamental difference between both publications consists in Żórawski's narrower, architecture-oriented scope of interest.

Strzemiński's *Teoria widzenia* [Theory of Vision] describes, from a historical perspective, the relationship between art and the development of vision, understood in two different ways: as a biological evolution (the development of the eye) and as the ability to use vision – visual consciousness (Strzemiński 2016, 51–53).

I. 4. 2 Freehand drawing in design

The book titled *Werkzeuge für Ideen* [Tools for Ideas] (Gänshirt 2011) offers a broad view of the work of designers of various specialties in terms of the design tools they use. The inseparable connection between the tool and the hand, and in particular the importance of tactility in design, has been described by Juhani Pallasmaa who recalls the artisanal nature of this activity (Pallasmaa 2009).

The researcher specialising in studying the specificities of design is Nigel Cross (Cross 1982, 1999). One of his most important publications is *Design Thinking. Understanding How Designers Think and Work* (Cross 2011). He often raises the issue of the use of freehand drawing in design.

A similar scope of interest is the research domain of Bryan Lawson. His two books: *How Designers Think* and *What Designers Know* complement each other. The first one describes the thinking processes occurring during the designing stage and how the training programme, tools and design techniques should be adapted to them (Lawson 2005). The second publication reveals where designers draw their design knowledge from, focusing on the meaning of drawing in knowledge acquisition (Lawson 2004).

[2] 'Myśl podstawowa obu książek – amerykańskiej [R. Arnheima] i polskiej [J. Żórawskiego] – jest wspólna, ale ujęcie inne i inny materiał faktyczny, na którym są oparte. Obie książki podpierają się wzajemnie, oświetlając każda na swój sposób wspólną myśl.' (translation into English: Monika Fryszkowska)

In the book titled *Sketches of Thought*, Vinod Goel demonstrates that computer operations have an impact on cognitive processes, as they require precise and literal thinking. At the same time, there are various symbol systems in the modern environment, based on vagueness and ambiguity underpinning them: sketching, painting, poetry and even everyday interpersonal relations. They occupy a nontrivial place in cognitive processes (Goel 1995).

The collection of information on the meaning of drawing in the psychology of development, art education, philosophy, art history and design has been published in the book titled *Wozu zeichnen?* [What is the Point of Drawing?] by Béatrice Gysin. The author, in search of an answer to the title question, includes in her book her own thoughts, texts of researchers associated with the science of drawing, as well as short interviews with artists, graphic designers, as well as furniture and jewellery designers, architects and illustrators (Gysin 2012).

The results of experiments, involving engineers from areas other than architecture and urban planning, showing sketching as a supportive but not indispensable activity in design (Schütze, Sachse and Römer 2003), seem also valuable. Ullman's study has also some valuable references to the direction in which CAD tools should go (Ullman 1990).

I. 4. 3 Freehand drawing in architectural and urban design

The publication *The Force Is in the Mind. The Making of Architecture* enables the reader to view the work of well-known architects. It also includes a collective lexicon of the architect's tools with photos (Krasny 2008). Peter Lorenz's book also provides an opportunity to get to know the architects (mainly from German-speaking countries) along with their sketches, implementations and answers to questions posed by the author, identical for each designer (Lorenz 2004). The Polish perspective has been presented in *Rysunek – zmysł architektury* [Drawing – the Sense of Architecture] which is a set of essays written by Polish architects and collected by Mirosław Orzechowski (Orzechowski 2013).

A similar publication to the three aforementioned is *Why Architects Draw* by Edward Robbins who opted for the form of interviews with architects, complemented by their design sketches. The introductory part of the book, containing reflections of the author himself (Robbins 1997), also deserves close attention. Paolo Belardi's short publication *Why Architects Still Draw* refers to the title of Edward Robbins' publication. Two lectures

included in the book describe – in a poetic and allusive manner, full of references to many fields of science, culture and art – the current meaning of the drawing in the work of an architect (Belardi 2014).

Przestrzeń w autorskich zapisach graficznych [Space in Author's Graphical Records] by Marian Fikus focuses not so much on the creation of the drawings themselves, but 'defines the specificity, the rank and the role that it [drawing] plays in the [architecture and urban planning] design process'[3] (Fikus 1991, 10). Similarly to the publication by Fikus, the PhD thesis titled *Rysunek strukturalny w prezentacji przestrzeni architektonicznej* [Structural Drawing in the Presentation of Architectural Space] contains original examples of graphic materials, where the history of architectural drawing has been described together with its modern application and an emphasis on handwritten visualisation (Suffczyński 2008). The PhD dissertation by Władysław Fuchs from 1994, thematically close to Suffczyński's dissertation, focuses on the contemporary design methods, both traditional (mainly drawing) and digital ones (Fuchs 1994).

The specific perception of space by 'the eye of the architect' and the visualisation of the non-existent space of the design are the topic of Tom Porter's book which compares, similarly to Fuchs' work, the features of a traditional drawing presentation with digital techniques (Porter 1997).

Leszek Maluga describes 'autonomic architectural drawing', i.e. visionary drawings created by architects. Even if the original intention behind the visionary drawings was not to construct a building, they constitute an important element of the architects' creative output (Maluga 2006).

The articles depicting the historical perspective of design tools, their new version, and the critical reflection were collected in *From Models to Drawings* (Frascari, Hale and Starkey 2013). A similar form can be observed in the collection of essays in the *Architectural Design* journal whose entire edition has been devoted to architectural drawing: its history, contemporary practical use, drawing experiments, as well as predictions about its future (Spiller 2013).

[3] 'określa specyfikę, rangę i rolę jaką pełni [rysunek] w procesie projektowania [architektury i urbanistyki]' (translation into English: Monika Fryszkowska)

The historical approach, which also encompasses the most recent digital revolution and predictions about the form of architect's work in the future, includes *The Alphabet and the Algorithm* (Carpo 2011).

The collection of essays titled *Schreiben und Zeichnen als Erkenntniswege im Städtebau* [Writing and Drawing as Cognitive Methods in Urban Design] associates designing space with visual arts and writing, which allow to share everyday experiences related to the environment with others and become aware of them (van Haaren and Schmidt-Kallert 2015).

The PhD thesis titled *The Right Tool at the Right Time* analyses the use of freehand drawing in the architect's work and attempts to create the prototype based on computer software that would be able to recognise sketch elements and convert them to digital elements, thus streamlining the design process (Do 1998).

The suggestions for new design tools have also been included in the article by Masaki Suwa and Barbara Tversky (Suwa and Tversky 1997), which is one of many experimental research studies on the thinking process which takes place in the designer's mind during architectural design (Bilda, Gero and Purcell 2006; Do, Gross and Zimring 1999).

One of the most important publications on the role of sketching, also based on an experiment involving architects, is *The Dialectics of Sketching* by Gabriela Goldschmidt. According to the author, designers' conceptual sketches do not convey images written in their minds, as in the case of sketches made by 'laymen', but they are a visual demonstration helping to evoke the design's non-existent images (Goldschmidt 1991).

In spite of the above-mentioned attempts, many researchers involved in design thinking remain sceptical when it comes to the possibility of a complete, comprehensive description of the thinking processes which take place during the design phase, due to the unique specificity of the problem, i.e. the design (Cross 2011; Goel 1995; Lawson 2004). Already in the publication from 1984, Ömer Akin noted that the phenomenon of reaching a design solution can be included only when the process is divided into sections, during which reasoning takes on a predictable and descriptive character (Akin 1986).

Many books provide an insight into the work of architects by presenting their sketches (Benedik 2017; Bingham 2013; Jones 2011; Schank Smith 2005); Moleskine illustrated monographs are worth mentioning: a series of sketchbooks of the world's leading

architects, featuring e.g. Zaha Hadid's sketches (Serrazanetti and Schubert 2012) or the exhibition catalogue (Moleskine 2009).

Worth noting is the activity of the world's only Museum for Architectural Drawing founded by Sergei Tchoban in Berlin, which is an excellent source of knowledge – not only in the form of exhibitions, but also its publications (e.g. Bartels 2017).

I. 4. 4 Freehand drawing and digital techniques

The impact of the rapid development of digital tools on the use of drawing spurred the need to organise in 2011 a symposium at the Yale School of Architecture (YSoA) under the suggestive title 'Is Drawing Dead?' with the following speakers who took part in the event: Peter Cook, Mario Carpo, Michael Graves and Patrik Schumacher. The history of drawing was presented, together with contemporary architectural practice and critical reflection on the changes taking place, as well as hopes associated with them (YSoA 2011).

A follow-up event to the above symposium was the conference, attended by the author, held in London in 2016 organised by The Bartlett School of Architecture under the title 'Drawing Futures'. The post-conference publication, as well as the event itself, was divided into four thematic parts: 1) referring to the expansion of the capabilities and definitions of drawing using digital tools ('Augmentations'), 2) historical ('Deviated Histories'), 3) showing the drawing visions ('Future Fantasticals') and 4) variable information recording methods ('Protocols') (Allen and Pearson 2015). Some interesting possibilities of traditional and digital techniques integration were presented, and the importance of drawing as a creative inspiration in the era of development of digital technologies was emphasised.

The title and issues similar to those raised at the YSoA conference can be found in the David Scheer's publication titled *The Death of Drawing*. The author describes a momentous event, i.e. the ongoing transformation from design based on two-dimensional drawings to the process taking place directly on a three-dimensional model which simulates an object (Scheer 2014).

The practical use of digital and traditional techniques juxtaposes experiments giving insight into the time and manner of performing particular activities related to the stages of reaching a solution set in the research study of a design problem (Bilda and Demirkan 2003; Goel 1995; Jonson 2005).

The context of changes taking place in the working environment of architects, based on the increasingly common access to information, its processing and management, has been included in the publication titled *Źródła architektury informacyjnej* [Sources of Information Architecture] (Słyk 2012) and *Digital Culture in Architecture* (Picon 2010).

A similar presentation of CAD techniques, geared towards demonstrating the possibility of the design idea expression, easier management of data about the object and implemented examples of objects constructed with the use of CAD techniques can be found in the book by Peter Szalapaj (Szalapaj 2005).

I. 4. 5 Charrette Method

The most important publication, gathering information about the specific method itself and its practical implementation, is *The Charrette Handbook* (Lennertz and Lutzenhiser 2014). A lot of information can also be found in the DPZ (Duany Plater-Zyberk) brochure containing a large number of richly illustrated examples of implementations (DPZ & Company 2013).

The charrette workshop was first organised on the Polish market by the urbanist Maciej Mycielski, the author of the article titled ‘Warsztat planistyczny "charrette" a Nowy Urbanizm’ [The Charrette Planning Workshop and New Urbanism] (Mycielski 2005).

I. 4. 6 Teaching freehand drawing

Practical tips and exercises supported by knowledge in the field of psychology and cognitive neurobiology are contained in the book by Betty Edwards *Drawing on the Right Side of the Brain.* The author’s ideas are based upon the use of the dual nature of the human brain in the science of drawing (Edwards 1999).

Mirosław Orzechowski writes about visual perception, the functioning of the senses and their connection with mental reception in the book titled *Rysunek – metoda edukacji kreatywnej* [Drawing – the Method of Creative Education]. He describes the cognitive aspects that evolve with the child’s age in relation to the development of the intellect, emotions and motor skills (Orzechowski 2015).

The same author in the book titled *Poszukiwanie architektury* [Searching for Architecture] (Orzechowski 2010) gives the reader numerous answers to questions related to the sense of teaching architectural drawing and its specificity.

The academic teaching of freehand drawing at selected faculties of architecture in Poland and in Europe was presented by Andrzej Białkiewicz. The achievements of the Cracow School of Architecture were supplemented with a historical view of the architect's drawing practice (Białkiewicz 2004).

A comparison of the use of traditional and digital techniques in teaching design can be found in publications describing experiments with the participation of art and engineering students (Kvan et al. 2004; Lu 2009).

I. 5 Research gap

The state of research presented above shows that the use of freehand drawing in the work of architects and urban planners has been widely described. Particularly worthy of note are publications such as *The Death of Drawing* (Scheer 2014), *Werkzeuge für Ideen* (Gänshirt 2011), *The Alphabet and the Algorithm* (Carpo 2011) and *The Thinking Hand* (Pallasmaa 2009) that present the current context of the advances in this field.

A number of articles describe the practical use of freehand drawing by architects or a group composed of architects and other designers which were presented with a fictional design problem (Bilda, Gero and Purcell 2006; Do, Gross and Zimring 1999; Goldschmidt 1991; Lu 2009; Suwa and Tversky 1997). There are also a number of publications which compare the use of traditional drawing techniques by architects with their use of digital techniques, again based on a conducted experiment (Bilda, Demirkan 2003; Jonson 2005; Goel 1995). A task of structuring the actual process of developing architectural design based on the graphic materials created in the process was undertaken by Marian Fikus (Fikus 1991). Finally, the psychological dimension of architectural design was studied and described in depth by Ömer Akin, once again based on the developed graphic materials (Akin 1986).

However, none of the above-mentioned publications have studied the use of freehand drawing based on a description of the process of developing an authentic architectural or urban design over its entire conceptual phase with the use of participant observation method. Closing the research gap consists of considering the entire spectrum of hand-drawn graphic representation in a chronological manner, including not only the selected drawings used strictly for finding the design solution but also working and informal

drawings such as drawing notes, sketches correcting other sketches or used for communication between participants.

Such approach is appropriate since it allows to verify to what extent designers make use of freehand drawing in their actual working environment (described in II. 4) and in the available time. This contemporary, ever-changing context, carrying with it, among others, new design tools, causes many of the above-mentioned research studies to be outdated, resulting in additional widening of the research gap, which this PhD thesis attempts to fill.

The charrette method offers a good opportunity to conduct such study, because it is a condensed conceptual design process organised in form of a several-day workshop open to the participation of all interested parties, which brings together the majority of the participants of the design process, including the investor and the residents of the developed area.

It needs to be borne in mind, however, that a charrette workshop is a specific design environment based on strictly defined rules (see also VI. 1). Therefore, the conclusions from the case study may be referred directly to conceptual design with the use of workshop methods including the participation of the public, and indirectly to conceptual design in a broader context, taking into account especially the team work aspect.

I. 6 Research question

The main research problem in this dissertation is the question: what is the role of freehand drawing at present in the architectural and urban design process?

The context of the dissertation are technological changes in the field of new design tools and the charrette workshop method.

I. 7 Hypotheses

General hypothesis:

H. Freehand drawing has attributes that render it useful in the design process[4] and it is therefore used in the process.

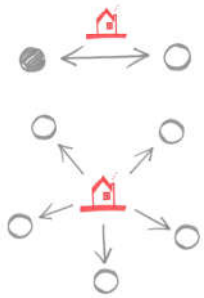
[4] The term ‘design process’ used in the dissertation refers to the process of architectural and urban design.

Detailed hypotheses:

H1. Freehand drawing enables the designer[5] to record and understand space and therefore constitutes an element of the phase that precedes the design process.

H2. Freehand drawing enables the designer to translate thought into form and therefore constitutes an element of the conceptual phase of the design process.

H3. The role of freehand drawing is to communicate within and outside the design team, which is why it is an element of all phases of the design process that require communication.

			(SUB)CHAPTER
	RECORD OF 'PRE-THOUGHTS'	HYPOTHESIS 1 (H1)	V.1 V.4 VI
	RECORD OF THOUGHTS	HYPOTHESIS 2 (H2)	V.2 V.4 V.5 VI
	TRANSFER OF THOUGHTS PRESENTATION OF THOUGHTS	HYPOTHESIS 3 (H3)	V.3 V.5 VI

Tab. 1 Detailed hypotheses presented alongside the milestones describing the trajectory of the designer's thoughts and the chapters and subchapters of the dissertation analysing a given issue in order to verify the hypotheses.

[5] The word 'designer' used in the hypotheses refers mainly to architects and urban planners, although in the case of the charrette workshop, a lay person (who is not a member of the team of designers employed to carry out the workshops) coming to the workshop can be a designer. This is in line with the basic charrette principle of co-design and cooperation of as many stakeholders as possible (see VI. 1).

I. 8 Methodology

To verify the hypotheses and to find the answer to the research question, the following research methodologies were selected.

I. 8. 1 Literature review

The basic method which enables scientific cognition is literature review, used mainly at the preliminary stage of work on a doctoral thesis. It consists of studying any existing scientific literature which is directly or indirectly relevant to the topic of the thesis. It aims at 'demonstrating the usefulness, the originality and the novelty of an approach to the research problem to be addressed'[6] (Apanowicz 2002, 72).

I. 8. 2 Case study (individual cases method)

A case study belongs to qualitative research methods and its goal is to illustrate a certain process, phenomenon, behaviour or event (op. cit., 70). It contains an in-depth analysis of a case as an overall process (in the present dissertation a charrette workshop in Chicago and a specific design task within the workshop) and of a detailed phenomenon occurring within the process (using freehand drawing in creating a design concept). Along the case study method the observational method was used, as well as the following research techniques (subordinate to research methods): participant observation (I. 8. 3), interviews (I. 8. 4), questionnaires (I. 8. 5), and the analysis of graphic materials (I. 8. 6).

I. 8. 3 Observational method

The most significant research method used by the author to describe the Chicago workshop was observation, conducted using the participant observation technique. Observation in a research study must be a well-thought-out process which can be reported and explained. The observation criteria were therefore selected from among the criteria proposed in *Encyklopedia Socjologii* [Encyclopædia of Sociology] (Boczkowski 2000, 9–10):

– the research problem includes the question on the extent of use of the freehand drawing during the charrette workshop: how, by whom, to what extent, when and for what purpose it was used; if the use of any other design tools was noted, and the same questions were repeated with regard to their usage;

[6] 'wykazaniu celowości, oryginalności i nowego ujęcia wyłonionego i podjętego do badań problemu' (translation into English: Monika Fryszkowska)

– the observation site was the building of a ward of the Presence St. Mary's Hospital in Chicago where the rooms used during the charrette were located: the room used as a design studio, a gym and a conference room;
– the fragment of reality selected for observation was the entire process of developing a design concept during the workshop; the organisational aspects were omitted;
– the set of tools used for recording and storing the fragments of reality included: a text note, a scanner for recording the created drawings, a voice recorder, a photo camera for image recording and a camera for filming;
– the observational procedures used were based on the assumption of a single-person study directed at a group composed of designers, representatives of the investor and residents;
– the method of data description consisted of a written report including the graphic material, interviews, questionnaires and a transcription of statements selected from the sound and the film recordings; the data underwent analytical procedures appropriate for the research problem and the acquired observational material.

Participant observation, used during the charrette in Chicago, is a research technique, subordinate to the research method (Apanowicz 2002, 81). It may be defined as a

> research process in which the observer becomes a functional element of a given social environment for the purpose of a scientific study and remains in direct close relations with the observed persons, taking part in their everyday life. (…) Therefore the observer has a double role – that of the researcher and of a research subject.[7] (Boczkowski 2000, 13)

Danny Jorgensen describes the two-fold role of personal experiences collected by the researcher in participant observation (Jorgensen 1989, 93–94). On one hand, being in the centre of the action and being a part of the studied group enables the researcher to gain a valuable perspective, difficult to obtain from the outside. On the other hand, it should be noted that it can be accompanied by a lack of critical reflection. The observation must meet the criteria of objectivism and may not influence the studied object, process or phenomenon (Apanowicz 2002, 63). Danny Jorgensen notes several research techniques for acquiring information (Jorgensen 1989, 22–23), among which the interview, the questionnaire and the graphic materials analysis were used during the charrette.

[7] 'proces badawczy w którym obserwator dla celów badania naukowego staje się funkcjonalnym elementem danego środowiska społecznego pozostając w bezpośrednich, bliskich stosunkach z obserwowanymi i biorąc udział w ich codziennym życiu. (…) obserwator występuje więc w podwójnej roli – badacza i badanego.' (translation into English: Monika Fryszkowska)

I. 8. 4 Interviews

Interviews are a research technique used both in a case study and observational methods (Apanowicz 2002, 85–86). The technique used for obtaining information, both in the case study in Chicago and independent of it, were interviews with architects and urban planners, which had qualitative and informal nature. The list of interviews which were carried out can be found on page 250, and their sound recording is included on the CD-ROM. The interviews contained four basic questions, subject to minor modification in the course of the conversation, depending on the profile of the interviewed person:

1. What is a definition of freehand drawing?
2. What is a role of freehand drawing in the design process?
3. Is it possible to develop a design without the use of freehand drawing?
4. What is the future of freehand drawing in the context of today's technological advances (BIM technology, parametric design etc.)?

The open nature of questions and the freedom of the interviewees to express their views were of importance. The questions were drafted based on the instructions contained in the publications of Earl Babbie and Danny Jorgensen (Babbie 2004, 270–276; Jorgensen 1989, 85–88). The interviews were conducted in accordance with the stages indicated by Steinar Kvale, but excluding transcription. These stages are: a) thematising (defining the purpose of the interview and the studied notions), b) designing (the ethical dimension of the interview and the manners of achieving the purpose), c) interviewing, d) transcribing, e) analysing, f) verifying (checking the reliability and validity of the material), g) reporting (communicating the findings) (Kvale 1996, 88).

I. 8. 5 Questionnaires

The questionnaire is a research technique used both in a case study and in observational method (Apanowicz 2002, 86–88). In this doctoral dissertation two questionnaires handed out during the workshop in Chicago were used; the questionnaires were addressed to 1) the team of employed designers (Tab. 7) and 2) to students – interested parties (mainly residents) invited to participate and co-design during the workshops (Tab. 8). The questionnaires were anonymous and included open, half-open and closed questions. The respondents were filling in the questionnaires unassisted. Efforts were made for the questions to be as concise, clear and precise as possible, according to the instructions

included in the book *The Practice of Social Research* (Babbie 2004, 270–276). Due to the quite small number of respondents the results of the questionnaires do not have universal nature but rather the value of individual statements. They should be considered qualitative research.

I. 8. 6 Analysis of graphic materials

The analysis of the rich graphic materials was an important aspect of the work. It mainly included the drawings created during the charrette in Chicago. The graphic conveyance of content is analysed within the field of visual communication. According to Marion Müller and Stephanie Geise, the message included in an image can be studied at three levels:

- analysis of the production – when and how was the image created?
- analysis of the product – what is presented in the image and how is it presented?
- analysis of impact – how do people influence images and how do images influence people? (Müller and Geise 2015, 15–18).

The last item is especially important in studying the role of the drawing in communication during a charrette workshop.

There exists also an important connection between the contexts of image creation, which may be: artistic, commercial, journalistic, scientific, political, private or religious, and its reception which may be classified along the same lines. The impact of graphic material depends thus on the combination of these two factors; it will be different in a situation of a commercial production and commercial reception and different in the case of an artistic production combined with commercial reception (op. cit., 24–25).

During the charrette in Chicago, the following contexts of production should be distinguished: commercial (the basic context), artistic (when looking at the created drawings as a piece of art), journalistic (a drawing as media communication) and political context (drawings containing elements reflecting the political and social issues). The reception of the created images had all the four above-listed aspects, to which a scientific context should be added (using the drawings in the present dissertation) and a private context (each resident could see the created drawings). There are numerous pairs of mutual relationships between production and reception which demonstrates the complexity of the visual communication process in charrette workshops.

II. DESIGN TOOLS

II. 1 Scope of the concept

The traditional understanding of the word ‘tool’ is associated with the craft – with the modification of the material with the use of an instrument. Its actions are initiated by the creator’s gesture. Christian Gänshirt classifies the gesture as the primary design tool, from which visual tools evoking images have been developed (German: bilderzeugende Werkzeuge): sketch, work sketch, design drawing, perspective and model. Apart from gesture, the author classifies the language as one of the primary tools serving the designer; the language, which is the starting point for language tools (German: sprachliche Werkzeuge), such as description, critique, theory, calculations and program (Gänshirt 2011, 81). This division, referring to visual and linguistic impressions, corresponds interestingly with the dual nature of the cerebral hemispheres, described in Subchapter III. 2 (see p. 62).

The tools can therefore be understood customarily in connection with the hand and include, among others, a pencil, a charcoal, a ruler, a template, a knife, a cardboard, a computer mouse and a tablet pen, but the term ‘tool’ can also be used to describe the notion of ‘computer’, and therefore related software programs, the programming act itself, a printer or a scanner.

In spite of the huge differences between the above mentioned elements, a large and open approach to the issue of ‘design tools’ – selectively classified and defined in the next subchapter – has been adopted. It can be supported by the fact that many architects and urban planners use their own original instruments created by them for specific purposes. This is confirmed by the New York architect Elizabeth Diller:

> Everything can be considered a tool by us, a tool which helps us think. But the real challenge is always connected with the framework conditions set for the design project; they are what makes a new tool necessary for rising up to them. It may also be the other way round; sometimes a new tool allows us to direct our thinking on a completely new path that we would never have thought about before. However, we are not obsessed with tools. What we may deem necessary in a given moment becomes a tool.[8] (Krasny 2008, 44)

[8] ‘Alles kann für uns ein Werkzeug sein, das uns denken hilft. Aber die wirkliche Herausforderung liegt immer in den Rahmenbedingungen, denn oft sind sie es, die die Erfindung eines neuen Werkzeugs notwendig machen. Oder umgekehrt, manchmal erlaubt ein neues Werkzeug in eine Richtung zu denken, an die man zuvor nie gedacht hätte. Aber wir sind nicht von ihnen besessen. Zum Werkzeug wird, was immer wir gebrauchen können.’ (translation into English: Joanna Pętkowska-Hankel)

The range of possibilities is basically infinite. Yona Friedman creates photomontages and models from any type of material (op. cit., 54). The Edge Design Institute Ltd. office from Hong Kong uses Lego bricks at work (op. cit., 48). Antonio Gaudi built hanging chain models with lead weights attached to simulate loads which, after being photographed by the sculptor Vilarrubi, formed the basis for the architect's sketches, helping them find the form of the object (Moravánszky 1983).

Each tool operates according to a different system of reduction of the complex problem record, which is, in this case, an architectural or urban design project. For this reason, it is important to know the characteristics of the tool being used, as it affects both the cognitive processes and design thinking (Gänshirt 2011, 61, 91).

II. 2 Classification and definitions

Below is the classification of the most common architectural and urban design tools. The selection, however, does not exhaust all the possibilities; it has been restricted to correspond with the subsequent parts of the dissertation.

II. 2. 1 Architectural drawing

The term 'architectural drawing' is understood as sketches, schemas, orthogonal projections, perspectives and axonometric projections in both freehand and digital forms. The Subchapter II. 3 will elaborate on the extended definition of 'architectural drawing'.

II. 2. 2 Physical model

The adjective 'physical' has been added to the noun 'model' in order to emphasise that only the models existing in real space (and not in virtual one) are encompassed in this term. They can be made by hand or designed in a computer program, and later cut out by machine or printed on a 3D plotter.

Models appear in various degrees of detail, in which they resemble a drawing. In a conceptual form, they constitute a design aid similar to the initial sketch, diagram or schema (example in Fig. 64). In the advanced stage, architects and urban planners build or commission the construction of mock-ups which are sometimes a very precise form of presenting a design solution. Marian Fikus writes about the place of the mock-ups in the design process:

> The understanding of the spatial construction that characterises every urban and architectural work is also possible by building mock-ups, but, generally, constitutes already a secondary phase to the source one. Making a mock-up is associated with functioning in relatively long time intervals. Graphic record can be made instantly, almost in parallel to the thoughts that trigger it.[9] (Fikus 1991, 25)

It is worth noting, however, that models, although they rarely offer the human scale look, provide the freedom to view a design from perspectives that would not be available in case of a drawing. The creation of the model itself constitutes a kind of simulation of the construction of the designed object.

Physical models make it much easier to visualise thoughts; however, they are used less frequently as documents serving the constructors at the execution stage. They mainly represent the general form of the object, while drawings can simultaneously convey other information, at various levels of abstraction and detail. For this reason, the work on the model is developed at some point in the form of a drawing or in a computer program.

II. 2. 3 CAD

Computer Aided Design (CAD) encompasses 'the totality of all devices and computer programs used to support design actions (mainly engineering design), including tools for calculation, sketching, modeling, projection, coordination, simulation, etc.'[10] (Słyk 2012, 210). Originally, CAD was associated with the optimisation of sketching, but it should be noted that currently computer-aided design offers a much wider spectrum of possibilities and will be perceived less and less frequently as a 'digital T-square'. It is influenced by the constant development of information technologies which – with respect to design practice – take on three basic forms:

1) digital integration of information from specialists involved in the design project,
2) digital organisation of office work at all stages of the design project with respect to presenting and communicating information to many parties involved in the design project (also, and perhaps primarily, to the client),

[9] 'Uzmysłowienie konstrukcji przestrzennej, jaką charakteryzuje się każdy utwór urbanistyczno-architektoniczny, poprzez budowanie makiet jest także możliwe, ale z reguły stanowi już fazę wtórną do źródłowej. Wykonanie makiety wiąże się z działaniem w stosunkowo długich przedziałach czasowych. Zapis graficzny może być wykonywany błyskawicznie, niemal równolegle do myśli, które go wywołują.' (translation into English: Monika Fryszkowska)

[10] 'ogół urządzeń i programów komputerowych służących wspomaganiu czynności projektowania (głównie inżynierskiego); obejmuje narzędzia kalkulacji, kreślenia, modelowania, projekcji, koordynacji, symulacji itd.' (translation into English: Monika Fryszkowska)

3) digital expression of the designed form, i.e. ways of transferring methods that allow expression of the designed object (such as conventional sketching and physical models) to the digital environment (Szalapaj 2005, 6).

Re 1), 2)

The first two points allow Building Information Modeling (BIM), i.e.

> a system that integrates building information about design, implementation and operation, consisting of a common database and programs using it, ensuring mutual coordination. Thanks to BIM, it is possible to quickly take into account the correlation between various engineering industries and between the states of buildings far-off in time (eg. optimisation of the design project in terms of construction and operation costs); visualisation of information from various fields facilitates the work of interdisciplinary teams and remote work[11] (Słyk 2012, 209).

Similarly, City Information Modeling (CIM) exists on the city scale.

The design often takes place directly on a model which contains a digital database on buildings, whose data can be processed. The model consists of objects, each of which usually represents a single component, such as a window or a wall. In this context, the object is part of the code which contains a geometric definition and the rules relating to it. Some of the data contained in the object is assigned by the user. These data are called parameters, while the objects containing the data – parametric objects (Scheer 2014, 108). In order for the model to correspond to the object, it must simulate it. The issue of simulation will be developed in Subchapter V. 2. 5.

Re 3)

The third point is directly related to computational design and to generating the object's form, which differs from BIM, in which information management is more important. Computational design uses methods thanks to which data is not only stored and organised, but also analysed and created. This is possible thanks to the software programs which offer greater possibilities of creating three-dimensional forms than the BIM technology does. David Scheer predicts that in the near future, design tools may have both these features developed equally to the same extent (op. cit., 165).

[11] 'system integrujący informacje o budowli dotyczące projektu, realizacji i eksploatacji, składający się ze wspólnej bazy danych oraz programów z niej korzystających, zapewniający wzajemną koordynację. Dzięki BIM możliwe jest szybkie uwzględnianie zależności między różnymi branżami inżynierskimi oraz między odległymi w czasie stanami budowli (np. optymalizację projektu pod kątem kosztów budowy i eksploatacji); wizualizacja informacji pochodzących z różnych dziedzin ułatwia pracę zespołów interdyscyplinarnych oraz pracę na odległość' (translation into English: Monika Fryszkowska)

David Scheer points to the three broad categories of computational design, offering various manners of creating and editing shapes. In the first one, a designer creates a form manually, using an interface which allows him/her to control complex mathematical processes generating shapes. The second category is parametric design and the third one – the algorithmic design. In this case, shapes arise from a set of values (parameters) and computational procedures (algorithms) that build the characteristics of the object's form. The designer can be compared to a software developer determining the conditions that must be met by a form, while the computer itself is responsible for generating it. The role of the designer consists in interpreting the results and checking whether they meet various criteria, including the visual ones. This is a 'bottom-up' approach, in which mathematical basic correlations initiate the design project, in contrast to the traditional design oriented on a 'top-down' relationship (op. cit., 142).

The dynamically developing possibilities related to information technologies give the opportunity to transform a digital model into a physical object. It enables computer-aided manufacturing – CAD-CAM, using output data from the designer's computer for computerised numerical control of CNC machines. 3D printing, on the other hand, enables the fabrication of objects by successively placing thin layers of material until the form is created (Fig. 3).

Fig. 3 The Bald Eagle's beak prosthesis made using 3D printing technology
by engineer Nate Calvin, founder of Kinetic Engineering Group

II. 3 Architectural drawing

II. 3. 1 Scope of the concept

For the purpose of the dissertation, it has been assumed, that the concept of architectural drawings constitutes a wider and – at the same time – a narrower group than the concept of freehand drawing. Wider, because this group encompasses also two-dimensional drawings made with the use of CAD techniques – drawn with the help of tools which do not allow for a full reflection of gesture (such as a computer mouse). Narrower, because it only covers architecture-related imaging (Fig. 4). This subchapter describes how close this relationship should be, so that the drawing could be called architectural.

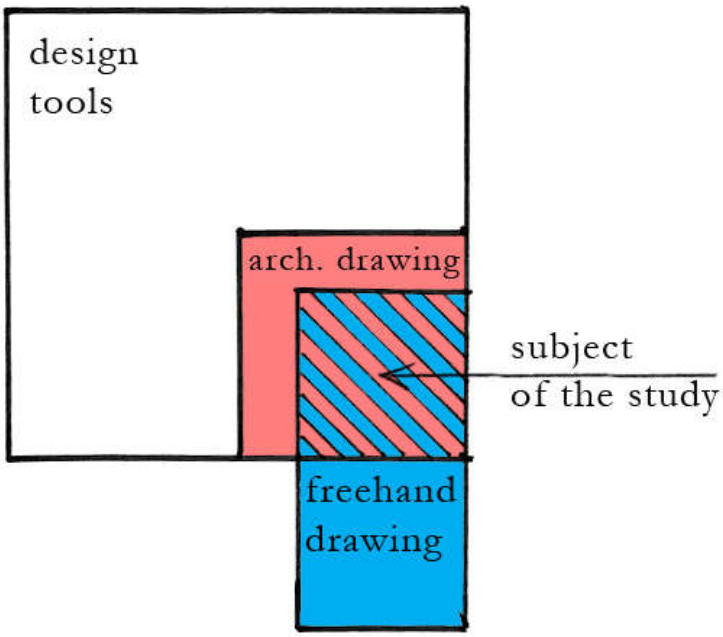


Fig. 4

Before considering this issue, it is worth explaining why the text does not contain a separate category of urban planning drawings. It was decided to combine both concepts under the term of architectural drawings, following the reasoning of Leszek Maluga, who defined the architectural drawing as a 'graphic record of the design of a new object or the transformation of an existing fragment of space'[12] (Maluga 2006, 17). 'Space' is the key word for both architecture and urban planning.

[12] 'graficzny zapis projektu nowego obiektu lub przekształcenia istniejącego fragmentu przestrzeni' (translation into English: Monika Fryszkowska)

The main distinguishing feature of architectural drawing has been described by Henryk Dąbrowski: 'Drawing – an architect's workshop tool, and not an end in itself. Its essence is the information contained therein.'[13] (Dąbrowski 1983, 42–43) Władysław Fuchs notes that '[architectural drawing] is characterised by a strictly defined goal: illustration of architectural thought'[14] (Fuchs 1994, 12). A similarly broad definition has been given by Andrzej Białkiewicz: 'Architectural drawing is both an architect's drawing and a drawing depicting architecture. It can be defined therefore on the basis of the content and the identity of its author.'[15] (Białkiewicz 2006)

Leszek Maluga points out that the exact assignment of some images to architectural drawings is a complex task. He proposed dividing them into three groups. The first group encompasses architectural and design drawings, i.e. drawings made for the purpose of illustrating the design project intended for implementation. The second group encompasses the architect's drawings, created for the purpose of design, but also art works, composition studies, theoretical considerations, spatial fantasies, and travel sketches. Maluga also included autonomic architectural drawings in this category (see V. 4). He excluded 'architecture-themed drawings' from the 'architectural drawing category – all the pictures representing existing and non-existent architectural objects, not necessarily authored by the architect and regardless of the reason for their creation'[16]. He emphasised what was mentioned at the beginning of the subchapter – the essence of architectural drawing in all its forms and manifestations is to depict the idea of space (Maluga 2006, 22–24).

A broad view of architectural drawing was adopted in the dissertation, reflecting the very complex and multidimensional activity of architects and urban planners. The most important distinguishing features are the above quoted: information content and the goal, which is an illustration of thought connected with existing, non-existent or designed architecture or urban space. At the same time, following Leszek Maluga's line of thinking, the drawings depicting architecture but not made by architects were excluded from the discussed category.

[13] 'Rysunek – narzędzie warsztatowe architekta, a nie cel sam w sobie. Jego istotą jest zawarta w nim informacja.' (translation into English: Monika Fryszkowska)

[14] '[rysunek architektoniczny] wyróżnia się ściśle określonym celem: ilustracji myśli architektonicznej' (translation into English: Monika Fryszkowska)

[15] 'Rysunek architektoniczny to zarówno rysunek architekta, jak również rysunek przedstawiający architekturę. Można go więc definiować na podstawie treści oraz tożsamości jego autora.' (translation into English: Monika Fryszkowska)

[16] 'rysunki o tematyce architektonicznej – wszystkie obrazy architektury istniejącej i nieistniejącej, niekoniecznie autorstwa architekta i bez względu na powód ich powstania' (translation into English: Monika Fryszkowska)

An architectural drawing uses a particular convention of record (see V. 2. 5), most often in the forms listed below.

Orthogonal (rectangular) **projection** – mapping of a three-dimensional object on a plane, called a viewing plane; parallel projection in a direction perpendicular to the viewing plane. Each point in the space is assigned a point on a viewing plane through which passes a straight line perpendicular to the viewing plane and passes through a given point in space (Bieliński 2015, 19–21; Encyklopedia Szkolna Matematyka 1997, 356).

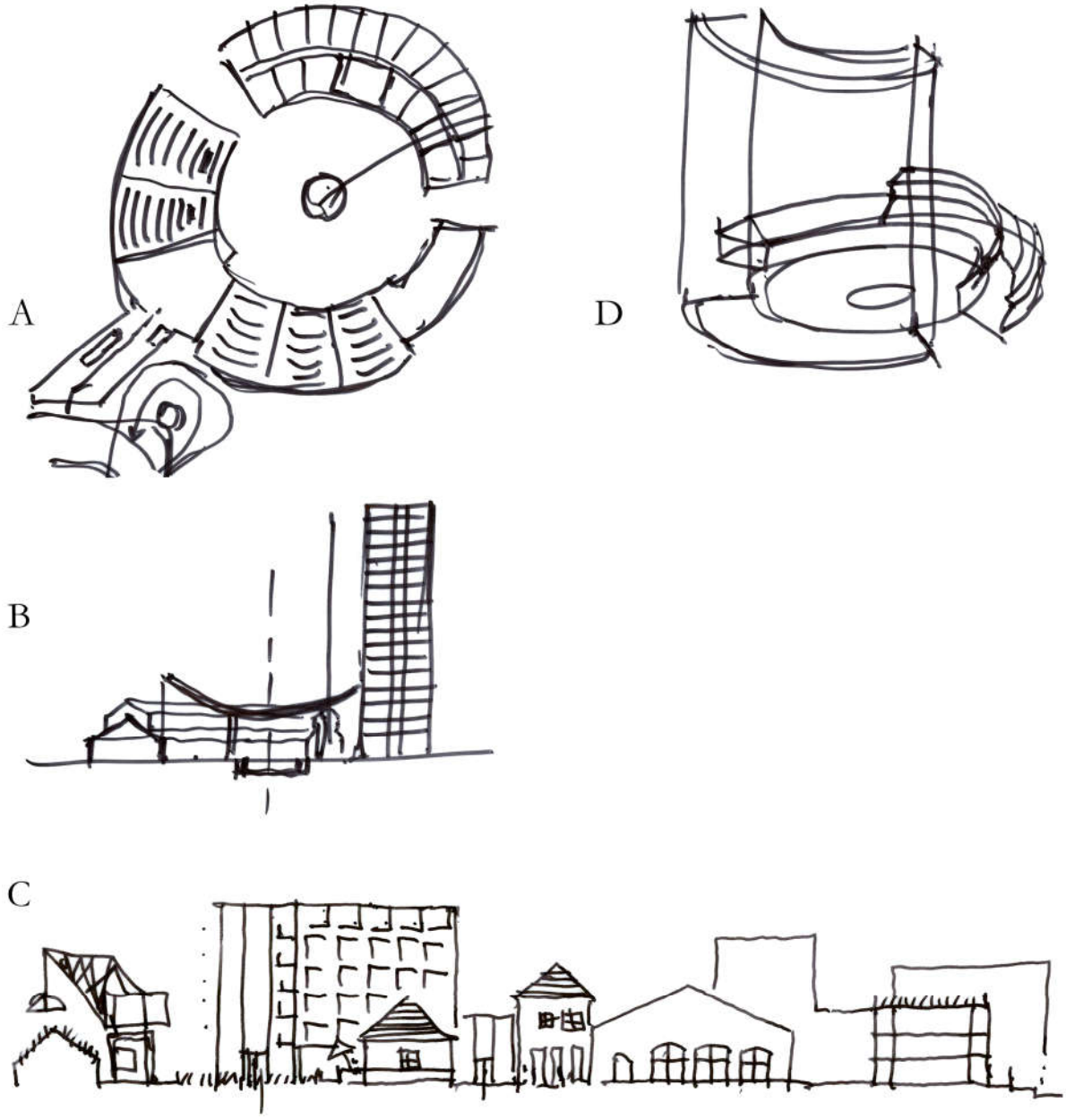


Fig. 5 Michał Owadowicz, design sketches made during the charrette workshop on the roundhouse in Gniezno, 2017; A – plan, B – cross-section, C – elevation of the square, D – perspective

The most frequent orthogonal projections used to describe architecture and urban design are: plan (projection), section and elevation. The plan shows the horizontal cross-section of the building from above, thus the principle of room arrangement, their layout, functional spatial relationships, axes, communication, etc. are visible (Fig. 5A). The cross section is *de facto* a vertical section of the designed object and provides information about interiors, height relations, number of floors, etc. (Fig. 5B) In the case of elevation, it is the question of viewing the object from the outside – it may be a front elevation, side elevation or the so-called fifth elevation – roof view. Elevations provide information about external walls, their colour, texture, layout of window and door openings, etc. (Fig. 5C)

Although it is a manner of recording with strictly defined rules, it does not mean the inability to use various drawing techniques, shadows, textures, values, colours, lines, as well as recordings on different scales and with varying degrees of detail. Orthogonal projections can be made manually as quick conceptual sketches, with low accuracy, without maintaining the scale. Then they have the character of a diagram[17]. Within the framework of orthogonal projections, there is a large range of possibilities for authoring drawings.

Linear (converging) **perspective**[18] is the representation of three-dimensional space or objects on a surface created by projecting them on the picture plane (central projection). This plane intersects the pyramid with the apex located at one point – the centre of view (eye) – and the basis for determining individual points in space. The image of a given real point will be created in the place where the plane of the image will be pierced by the radius running from that point to the eye. The lines parallel to the image plane keep the direction, changing the size. The lines not parallel to the plane of the image, but in fact parallel to each other, have a common vanishing point on it; in the case of horizontal planes, the vanishing point occurs on the line called the horizon (Panofsky 1991, 27–28; Witwicki 1954, 26–50). An example of a sketch made in perspective is shown in Fig. 5D.

It is worth noting that there are more variants in the way of presenting the three-dimensional features in the drawing, as Kazimierz Bartel wrote:

[17] The types of architectural diagrams have been characterised by Tom Porter (Porter 1997, 87–89), and can also be found in Tab. 2.

[18] The publication titled *Perspective as Symbolic Form* by Erwin Panofsky (Panofsky 1991) describes the dominance of this method of representing three-dimensional space in Western culture, its history and interaction.

> A drawing which reminds a person looking at the view of a three-dimensional object has the features of a perspective drawing. Difficulties that lie in checking and classifying visual sensations which, however, have such a highly subjective character, make the above description clearly relative.[19] (Bartel 1958, 223)

There is also an aerial (atmospheric) divergent, and backstage perspective, as well as an isometric perspective, discussed below under the heading 'axonometric projection'.

Axonometric projection[20] is a kind of parallel projection and is a reflection of three-dimensional space or objects on the plane, using a rectangular system of axes. Axonometric projection is distinguished from perspective by the pursuit of maintaining the real dimensions of projected objects, and sometimes the sizes of angles parallel to the chosen plane are also maintained. In the case of dimetric projection, two of the three axes of space appear foreshortened, and in the case of isometric projection – all of the three axes of space appear foreshortened (Bieliński 2005, 45, 53–54).

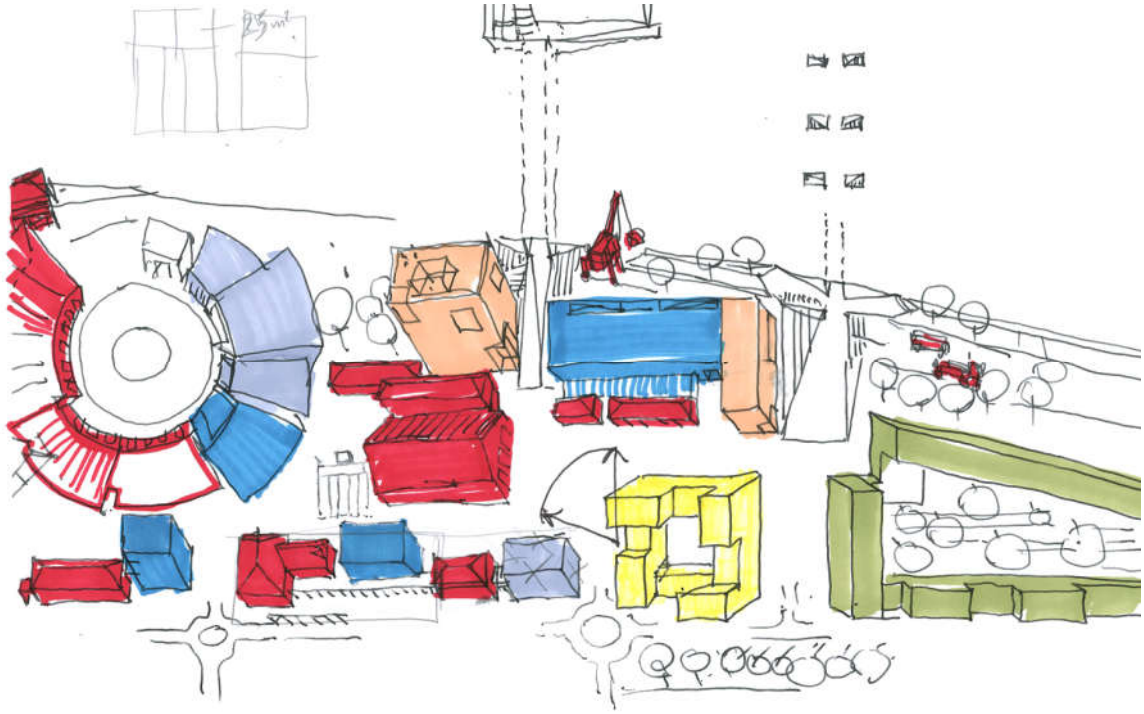


Fig. 6 Michał Owadowicz, design sketch of the roundhouse in Gniezno, 2017, containing elements of axonometric projection and convergent perspective

[19] 'Rysunek przypominający patrzącemu nań widok trójwymiarowego przedmiotu ma znamiona rysunku perspektywicznego. Trudności leżące w sprawdzaniu i klasyfikacji wyobrażeń wzrokowych, które mają wszakże charakter tak wybitnie subiektywny, sprawiają, że określenie powyższe jest wyraźnie względne.' (translation into English: Monika Fryszkowska)

[20] Massimo Scolari's book titled *Oblique drawing* is devoted to axonometric projection, its history and significance. It counters the view on the dominance of perspective in visual representation (Scolari 2012).

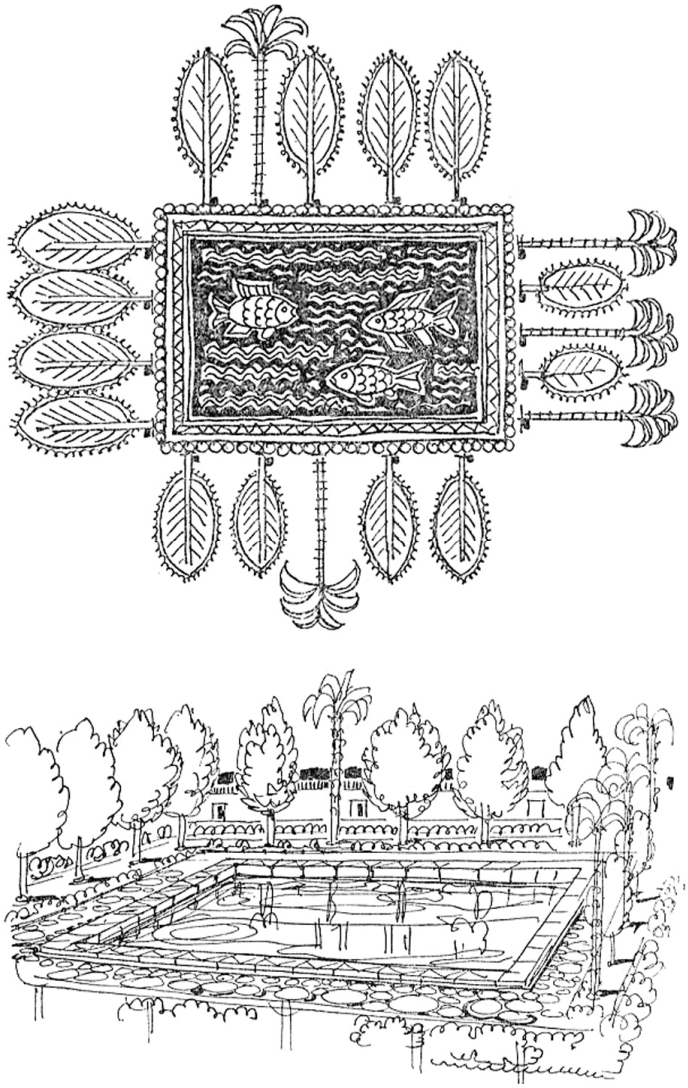


Fig. 7 Jan Knothe, fish pond depicted according to the so-called Egyptian method (top) and in perspective (bottom)

Axonometric projection is a convenient variant of imaging objects, mainly due to the accuracy of dimensions and angles while showing three-dimensionality; there is a useful feature to add a third dimension – height – to the plan drawn in the orthogonal projection, maintaining the added lines parallel (Fig. 6).

Rudolf Arnheim was sceptical about the affirmation of representations faithfully reproducing reality according to the rules of projection. Arnheim saw the discovery of the rules governing the central perspective associated with the mechanical reproduction of reality as an event threatening creativity (Arnheim 2004, 284). He pointed to other, alternative forms of record which often conveyed information about objects better than geometrical constructions. One of these forms was the Egyptian method, presenting the objects of interest as the sum of their most characteristic views (Fig. 7). Arnheim would add: ‘The power of all visual representation derives primarily from the properties inherent in the medium and only secondarily from what these properties suggest by indirection. Thus the truest and most effective solution is to represent squareness by a square.’

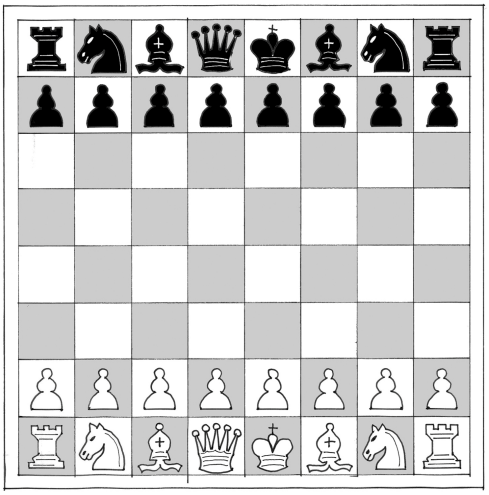


Fig. 8

(op. cit., 116). Taking into account the stages of perception (Fig. 22), the Egyptian method is based on the stage of the synthesis of features, omitting the final phase of identification and recognition. Peter van Sommers addresses the issue in a similar manner, giving as an example a common way of presenting a chess board (Fig. 8) which does not correspond to the actual perception of the object, and yet it is difficult to portray it more accurately. A drawing record that corresponds closely to visual perception is sometimes inadequate and does not meet the basic requirements of a drawing: cognitive, communicative and emotional (van Sommers 1984, 259).

The architectural drawing requires the use of a set of symbols adopted in the designers' environment. As a result, it contains a significant semantic load, which opens up the possibilities of different understanding of the message and its interpretation. Another situation arises in the case of design record using a digital three-dimensional model which simulates the designed object and aims to render its realism in all possible aspects. The positive and negative consequences of the use of conventions in architectural drawing, also in relation to computer simulations, are discussed in Chapter V.

II. 3. 2 Categories

Many authors have attempted to categorise drawings created during the design process (the design phases have been taken from Subchapter IV. 3), which is summarised in the table (Tab. 2). It shows the most common drawings, which means that their categories may also appear, to a lesser extent, in a different design phase.

The drawing design process is described by Leszek Maluga in a synthetic way, distinguishing the preliminary phase, initial phase, proper design phase, approval and implementation phase, during which drawings from 'intimate' become more and more 'socialised' – the audience is expanding (Maluga 2006, 34). A simple division into drawings from nature and design drawings is proposed by Władysław Fuchs. Drawings from nature are usually made in the programming phase; they also form the basis when teaching future architects and urban planners the craft of drawing.

DESIGN PHASES					PREDOMINANT WAYS OF RECORD					
Author:	*Vinod Goel*	*RIBA*	*B. Lennertz, A. Lutzenhiser*	*Leszek Maluga*	*W. Fuchs*	*M. Fikus*	*M. Suffczyński*	*T. Porter*	*M. Graves*
			Charrette System:	Phases:	Sketches:	Drawings:	Graphic:		Diagrams:	
Programming	Problem structuring/ Preliminary design	Briefing/ Analysis	Research, engagement, and preparation	Preliminary	Intimate	From nature	Model	Sketch	Schematic, Operational, Functional, Flow, Analytical	Referential sketch
Concept	Design refinement	Synthesis	Charrette workshop	Initial	Intimate/ Socialised	Design	Spatial	Conceptual drawing		Preparatory study
Refinement	Detailing	Evaluation	Plan adoption	Proper design	Intimate/ Socialised	Design	Spatial	Working drawings, Visualisation		Definitive drawing
Documentation				Approval	Socialised	Design	Verbal			
Construction				Implementation	Socialised	Design	Spatial			

Tab. 2

The predominant way of graphic expression in comparison with the design stages;

the table shows the dominant record, which does not mean that its other possibilities do not occur in a given phase.

The table presents the three basic ways of record described by Marian Fikus: graphic verbal (e.g. letters, sentences), graphic model ('abstraction, condensed form of graphic expression of the seed of thought'[21]) – expressed with signs (dots, lines, planes etc.) and spatial graphic, which 'maps, in the interdisciplinary universal language of drawing, the spatial structure of development programs. It is – from the three records discussed – the most appropriate skill.'[22] (Fikus 1991, 31–33) Michał Suffczyński indicates the next steps of reaching a design solution: from a sketch, through a conceptual drawing and a working drawing, to visualisation (Suffczyński 2008, 88–119). At the concept stage, the designers use diagrams that are 'evidence of an idea being structured – it is not the idea but a model of it, intended to define its characteristic features' (Porter 1997, 87). Porter distinguishes five types of diagrams: schematic or synthetic, operational, functional, flow, and analytical (op. cit., 88). Michael Graves divides drawings into three categories: the referential sketch – the record of findings or type of a diary; the preparatory study documenting the inquiries, questions which arose, a basis for further work; and the definitive drawing which is a version close to the final document. It is suitable for further estimates and studies due to the greater accuracy of the reproduction and is the answer to the question, not an instrument raising them, like earlier drawings (Graves 1977, 236–237, 240).

II. 3. 3 Specificity

The most insightful and precise story about the design project underlies the sense of the architectural drawing. The information that has been recorded with its help comes to the fore. Michał Suffczyński devoted his doctoral thesis to the subject of structural drawing, i.e. not the only, but recurrent notation manner, enabling an exhaustive description of the object or space. Suffczyński describes the structural drawing as: 'record of spatial forms based on the analysis of their geometrical structure, their overall understanding and the graphical presentation of internal structures'[23] (Suffczyński 2008, 17). Władysław Fuchs also used this term in relation to the so-called Warsaw School of Architectural Drawing, and thus the drawing method created by Zygmunt Kamiński and continued for over a hundred years at the Faculty of Architecture of the Warsaw University of Technology. Fuchs distinguishes two types of spatial analysis which leads to the creation of

[21] 'abstrakcja, skondensowana forma graficznego wyrażania zalążku myślowego' (translation into English: Monika Fryszkowska)
[22] 'odwzorowuje, w interdyscyplinującym uniwersalnym języku rysunku, strukturę przestrzenną programów zagospodarowania. Jest – z trzech omawianych zapisów – umiejętnością najwłaściwszą.' (translation into English: Monika Fryszkowska)
[23] 'zapis form przestrzennych w oparciu o analizę ich budowy geometrycznej, ich całościowe rozumienie i graficzną prezentację struktur wewnętrznych.' (translation into English: Monika Fryszkowska)

a structural drawing: 1) a superficial analysis, focusing on external aspects, such as edges, planes and textures, and 2) a structural analysis, based on 'the understanding of overall forms, regardless of whether the element is visible or not from a given place' (Fuchs 1994, 51). An example of a superficial analysis was shown using a dodecahedron drawn in chiaroscuro (Fig. 9B), and of a structural one – in a linear drawing (Fig. 9A). According to Suffczyński, the drawing integrating both these analyses is the most complete and the most saturated with information visual reproduction of a fragment of the drawn space (Suffczyński 2008, 18). The dodecahedron in a linear-chiaroscuro drawing with a clearly visible internal structure can be an example of such integration (Fig. 9C).

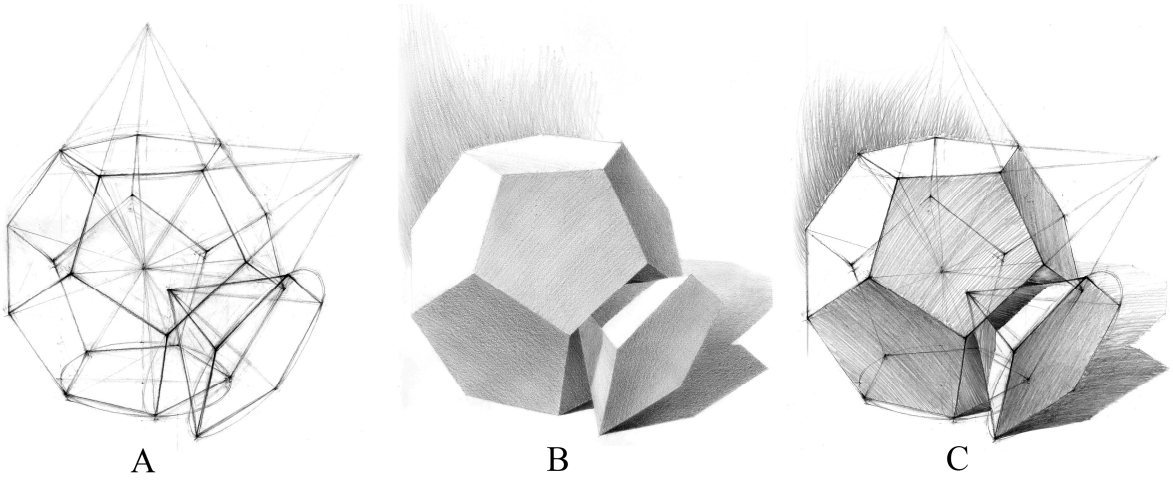


Fig. 9 Michał Suffczyński, structural analysis (A), surface analysis (B) and a combination of both (C)

It cannot be said, however, that this type of space imaging is a prerequisite for teaching and presenting the design idea. It is important to understand the object; the form of recording thoughts and conclusions is secondary. Drawings created at the Faculty of Architecture of the Cracow University of Technology can be cases in point. At first glance, they are only characterised by the superficial analysis. Shadows and textures are clearly visible, contrary to the linear sketch, which occurs only to a small extent. Checking the geometrical accuracy of the drawing allows, however, to state that the author has constructed the object in a sufficiently correct manner. Therefore, the structural analysis was carried out, but it was not recorded in the form of lines showing the internal structure; that in no way devalues either the observation or the entire drawing.

Some of the interesting differences between the Cracow School of Drawing and the Warsaw one[24] are shown in students' works (Fig. 10).

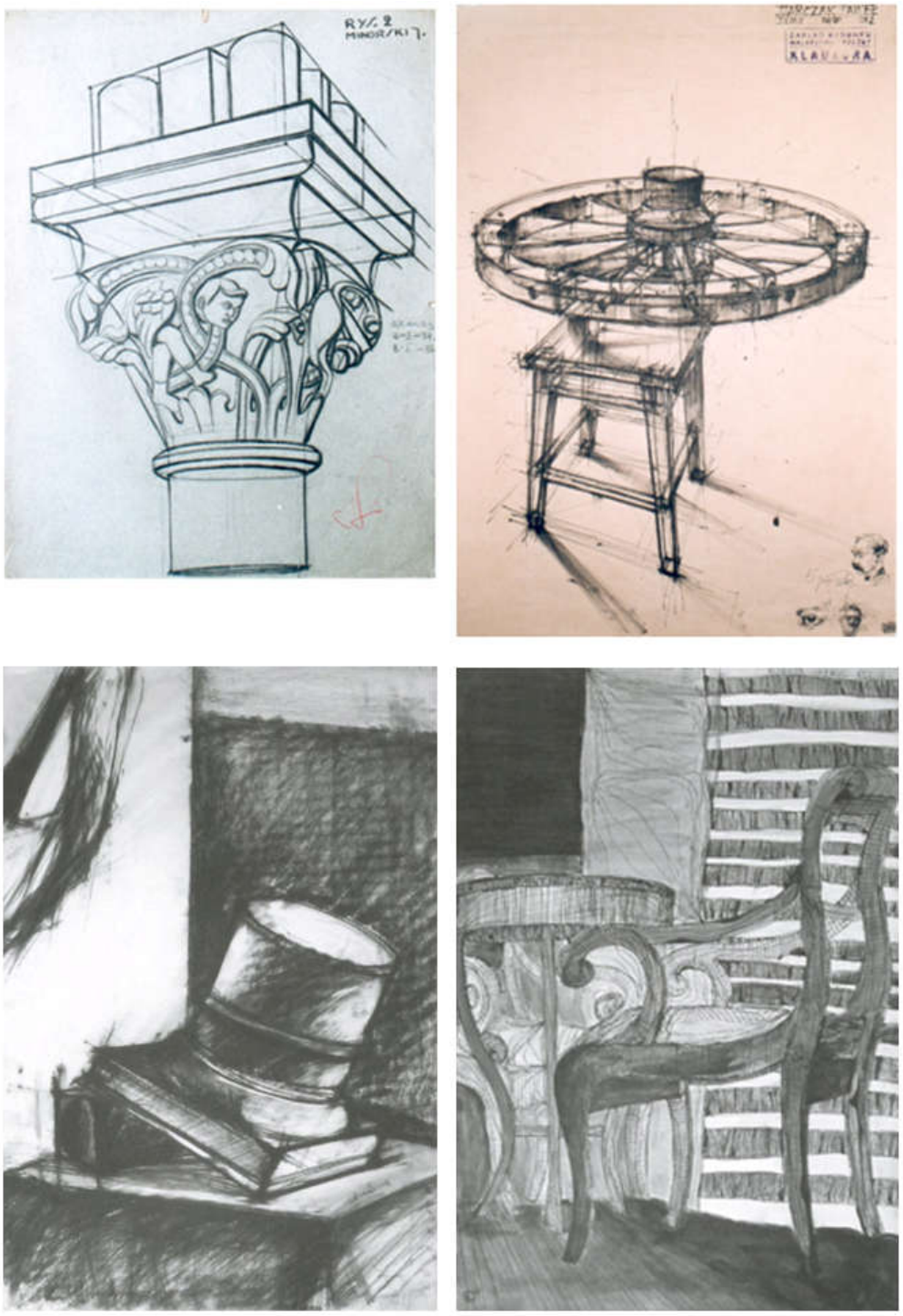


Fig. 10 Students' works created at the Faculty of Architecture of the Warsaw University of Technology (top) and of the Cracow University of Technology (bottom)

[24] The doctoral thesis by Mirosław Orzechowski (Orzechowski 2001) is dedicated to the Warsaw School of Drawing, while to the Cracow School of Drawing – habilitation dissertation by Andrzej Białkiewicz (Białkiewicz 2004). The differences between both schools are indicated by Konrad Kucza-Kuczyński in the introduction to post-conference publication (Kucza-Kuczyński 2015).

II. 4 Relations between the architectural drawing and other tools

II. 4. 1 Historical outline

In order to outline the current relations between the architectural drawing and the design tools defined above, it is worth presenting how the mapping of the design idea on plane was shaped to the present possibilities of digital three-dimensional modeling.

Władysław Strzemiński emphasised that the drawing was one of the oldest methods of articulating thought, which has survived to our times. The changes in the way of drawing reflect, according to him, not only the evolution of architectural thought, but also bear witness to the development of visual awareness of societies throughout the history. Strzemiński called visual consciousness 'the degree to which the reality is reflected, which a given society has achieved at a given level of its historical development'[25] (Strzemiński 2016, 133).

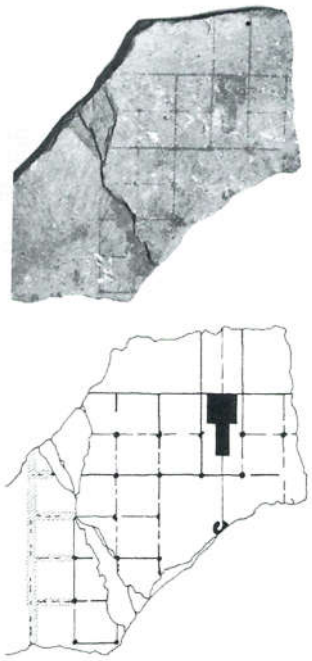


Fig. 11 The plan of tamarisk cultivation fields with the location of the Egyptian temple in Deir el-Bahari, near Memphis

An oversimplified picture which, however, illustrates well the essence of changes in the drawing record of architecture and urban planning is presented by David Scheer (Scheer 2014) in the form of a division into four epochs. The division was made, taking into account the issue of authorship, which was indirectly influenced by the tool used by the designer. These changes alternated historically with the desire to produce identical copies (the goal achieved in the era of the industrial revolution), which changed the face of many specialties, including architecture. The question of identity is the second element after authorship, which was outlined below.

The first epoch is the oldest times, in which the architect had the function of a designer and builder-craftsman. The design decisions were made by him in the building material or passed them on to the workers verbally at the construction site, participating directly in it. There was no barrier

[25] 'stopień odbicia rzeczywistości świata, jaki dane społeczeństwo osiągnęło na danym poziomie swego rozwoju historycznego' (translation into English: Monika Fryszkowska)

between designing and construction site. At the same time, the architect was rarely recorded in history as the author of an object.

One of the earliest examples of the design idea imaging, close to orthogonal projections, was the plan of tamarisk cultivation fields together with the location of the temple in Deir el-Bahari, near Memphis, dates back to 2,100 BC (Fig. 11) (Porter 1997, 6).

Edward Robbins, citing the research of the architectural historian, Spiro Kostof, proves that the architectural drawing was the basis of the architect's workshop as early as in Ancient Greece and Rome, submitting two arguments to support this thesis (Robbins 1997, 11). First of all, he doubts as to whether constructing such sophisticated elevations without the possibility of scaling their elements in the drawing was possible. Secondly, the necessity to master the art of drawing was already emphasised in Vitruvius' famous treatise dating back to the 1st century BC. The drawing was used to achieve *dispositio* – 'the disposition in their just and proper places of all the parts of the building, and the pleasing effect of the same' by means of *ichnography* – 'the representation on a plane of the ground-plan of the work, drawn by rule and compasses', *orthography* – 'the elevation of the front' and *scenography* – 'the front and a receding side (…), the lines being drawn to their proper vanishing points' (Gwilt 1874, 9–10). In addition to the plan and elevation, a convergent perspective (called *scenography*) appeared in the treatise, the use of which is known, among others, from the Pompeian wall paintings (Fig. 12).

Fig. 12 Sketch of a Pompeian wall painting – the use of a convergent perspective

The Chinese and Japanese culture was dominated by views similar to axonometric projection, in which parallel lines do not converge, the objects which are further away are represented higher and the dimensions remain unchanged. A similar procedure of placing objects which were far away higher on a piece of paper was used by artists in medieval Europe in the so-called intentional perspective. Medieval architects and painters also appreciated the advantages of a divergent perspective, exposing the side walls while showing the frontal ones. Another important example of the use of architectural drawings in the Middle Ages is the Plan of Saint Gall monastery dating back to around 820 AD drawn on parchment (Fig. 13) or the famous drawings from the medieval sketchbook of Villard de Honnecourt, which is a manual of a construction workshop.

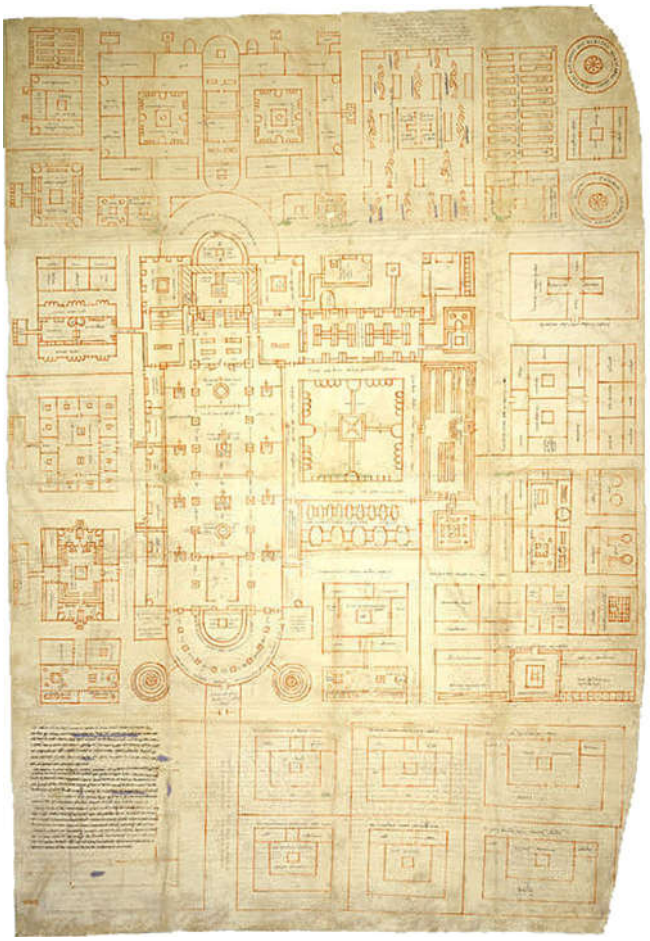


Fig. 13 Plan of Saint Gall monastery

The material products of human hands were unique and inimitable at the time. Perfect copies did not exist; even the books transcribed by the scribes bore the signs of originality in the sense that it was technically impossible to retain full fidelity to the original. ‘Copying by hand, regardless of the motivations of the artist and his desire to remain

more or less faithful to the model, is always to some extent a creative act'. (Carpo 2001, 11)

The 'invention of architectural design' (Carpo 2011, X) introduced by Leon Battista Alberti in his epoch-making treatise *De Re Aedificatoria* dating back to the mid-15th century is a symbolic turning point defining a first revolutionary change and the entrance into the second era. This breakthrough consisted in the recording of design ideas in the form of a drawing, which gave rise not only to architectural drawing, but also to design understood as the pre-construction action, completed before its implementation and not directly related to it, contrary to what it was before. Thus, the drawing played a significant role: it contributed to the separation of theory from practice, design from construction, as well as to preserving the status of the architect as of the building's author, mainly by granting priority to the design project before its implementation.

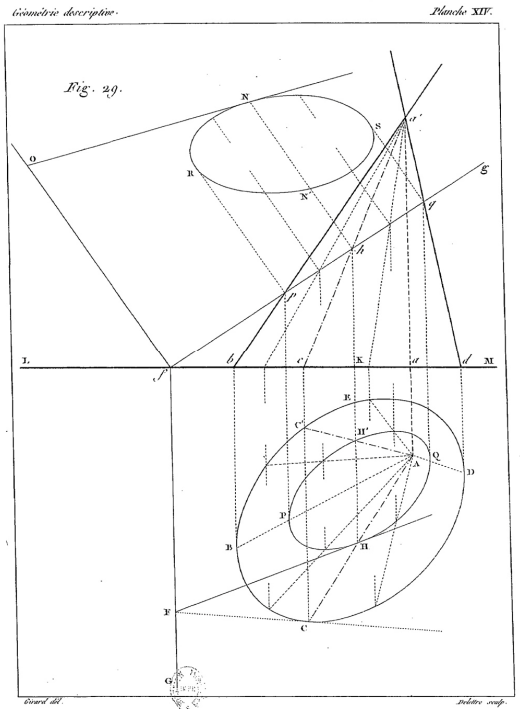


Fig. 14 Illustration to the Gaspar Monge's treatise – cross-section of a cone

This breakthrough coincided with the development of rules for drawing a convergent perspective, an achievement attributed to Filippo Brunelleschi and Leon Battista Alberti; the principles of the convergent perspective were described by Leon Battista Alberti in the treatise titled *De Pictura* of 1435. The aspects of geometry and proportions could be presented from that moment with the depth of perspective. The importance of these innovations was additionally intensified by the invention of printing, which also influenced the change in architecture – the spread of Renaissance ideas. Printed treatises, textbooks and architectural templates contained mechanically reproduced illustrations (woodcuts) which, thanks to the compatibility with the original, could be used extensively, in contrast to manually reproduced drawings which could rarely be considered fully reliable. Mario Carpo (Carpo 2011) elaborates on these changes, which rely precisely on the importance of 'sameness'.

According to Leon Battista Alberti, the building was a faithful copy of the design. The design itself obtained superiority over its implemented version. As Mario Carpo notices: according to Alberti 'the design of a building is the original, and the building is its copy' (op. cit., 26). The architect, in order to describe his/her idea, adopted a convention of inscribing three-dimensional objects into a drawing which was close to orthogonal projections most commonly used today. Thanks to the orthogonal projections, the architect gained the opportunity to communicate his/her ideas and test the validity of solutions in the comfort of his/her design studio, without any inconvenience related to the physical hardship on the construction site. These epochal changes in the graphic representation are documented by the drawing achievements of Baldassare Peruzzi, Donato Bramante, Leonardo da Vinci, Antonio da Sangallo, Michelangelo, Andrea Palladio and later Giovanni Battista Piranesi.

Plans, sections, elevations and perspectives, as mentioned earlier, have been in use for a very long time. However, the geometric accuracy of the mapping of a spatial object on a two-dimensional plane was achieved only at the turn of the 18th and 19th centuries thanks to the publication of Gaspard Monge, who is considered to be the inventor of descriptive geometry (Fig. 14).

Architectural drawings based on orthogonal projections, until the second half of the 20th century, were made exclusively by hand, with the help of drafting tools (Fig. 15). The possibility of copying drawings was limited until the first photocopier was introduced to the market by Xerox in the late 1950s, allowing to freely copy drawings in any number. Mario Carpo points out the analogy of this revolutionary change to the much earlier industrial revolution, which also enabled the production of repeatable, identical products (op. cit., X).

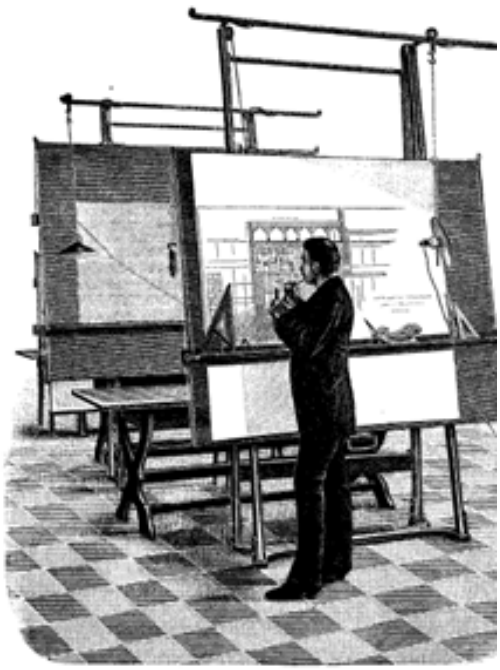


Fig. 15 Illustration from a Norwegian magazine attached to the article about the new drawing board (1.8 x 1.2 m, height 2.8 m, weight: 220 kg)

The breakthrough brought about by the appearance of a photocopier coincided with another revolutionary change which marked the

third era – the introduction of computer-aided design. The era of digital recording brought changes and, consequently, the situation of designers slowly began to change. However, the very method of notation, based on the achievements of Gaspard Monge, has not changed – only the act of drawing has been accelerated (Fig. 16). Still, the improvement was so significant that one can call this technical achievement revolutionary.

The changes taking place at present delineate the fourth era, not because of further, even more perfect methods of drawing. The two-dimensional method of presenting the idea on the plane in the form of a drawing is being replaced by modeling of three-dimensional objects, simulating its appearance and operation. The model contains a variety of detailed information: about its shape, function, materials, construction, mutual relations etc. It enables the generation of traditional, two-dimensional drawings, if required.

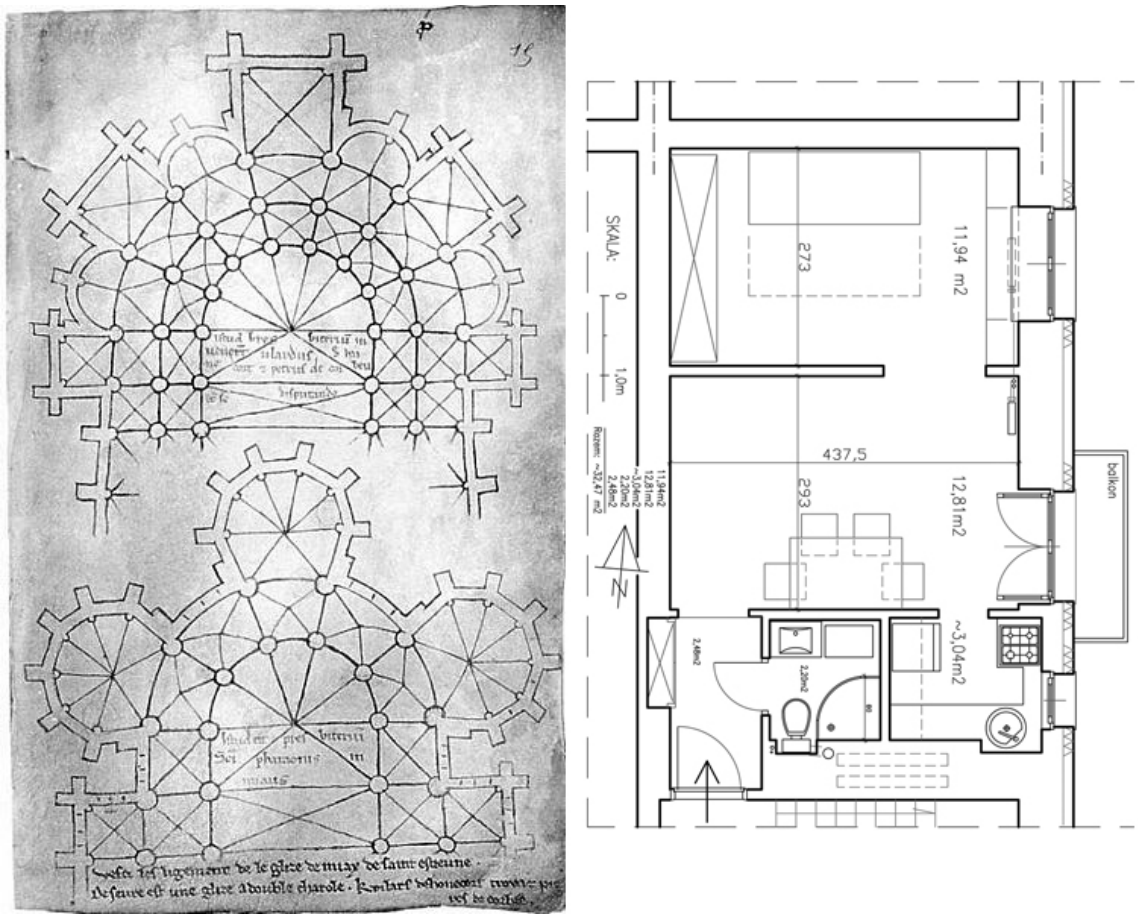


Fig. 16 The convention of architectural drawing based on orthogonal projections throughout history: a drawing by Villard de Honnecourt (left) and a contemporary drawing of a flat made with the use of CAD software (right)

Mario Carpo notices how similar is the diversity of forms in times of the advanced craft before the industrial revolution and the changeability of forms resulting from free modeling in the present digital world (ibid.). Carpo suggests the emergence of a new form of craft: digital craftsmanship. This name seems to be adequate to him, given the freedom of individual shaping of various forms. Software programs with an interface that allows manual manipulation of a solid figure or to model an object using parameters enable the production of various forms. The historical change involves the transition from mass production, or mechanical duplication, consisting in creating identical copies, into an algorithmic one, enabling the production of various mass copies thanks to mass customization (op. cit, 99–104). At a closer look at traditional crafts, one can find, of course, many features that differ significantly traditional crafts from digital ones (such as errors committed by a craftsman, sometimes used in a creative manner, or the author's unique style resulting from a deep understanding of the material); the comparison, though, seems interesting. This topic is discussed in Subchapter V. 2. 2.

Digital technologies have so significantly expanded their scope of application in recent years that they are currently seen not only as design tools. They play an important role in the integration of the architectural development process in such aspects as the object's functionality, construction, materials selection, etc. They affect transformations in architecture and urban planning that concern not only the organisation of work and construction production technologies, but also the broad thinking about the design process and shaping its new theory.[26]

II. 4. 2 Contemporary outlook

In order to better visualise and understand the changing place of drawing in the realm of design, two diagrams can be compared. The first is Robin Evan's 'The Arrested Image' (Fig. 17), which was published in a book released in the early 1990s, and the second is 'The Arrested Image Revisited' (Fig. 18), which was published by architect Adam Dayem in 2013 (Dayem 2013).

'The Arrested Image' was created in a time when architecture diagrams were the default means of saving and transferring data. The discussed diagram combines five elements of the design process and demonstrates the interrelations between them. Robin

[26] These changes are of interest to many theoreticians and practitioners of architecture, among whom it is worth distinguishing those who approve of them (including Greg Lynn, William Mitchell, Frank Gehry, Peter Eisenmann, Zaha Hadid), as well as those who approach them with reserve (Juhani Pallasmaa, Leon Krier, Kenneth Frampton, among others).

Evans emphasises that four of those components nearly always take the form of an image (perspective, orthogonal projection, perception, imagination), whereas the fifth one, i.e. the structure that is being designed, rarely does so. The top-right vertex, which is separated from the rest of the diagram with a dashed line, represents the observer. The diagram should be viewed as a regular tetrahedron whose four vertices remain in equivalent relationships (design, perspective, orthogonal projection, perception). Evans claimed that the remaining element, i.e. imagination, has a different nature and thus forms a different relationship with the remaining components.

Evans then goes on to describe the complex interrelations between the five sources of data used in the design process. Those interrelations involve a two-way flow of information which is often hampered by data loss or distortion resulting from the adopted method of data recording, e.g. when the orthogonal drawing is misread by the observer (Evans 2000, 366–370).

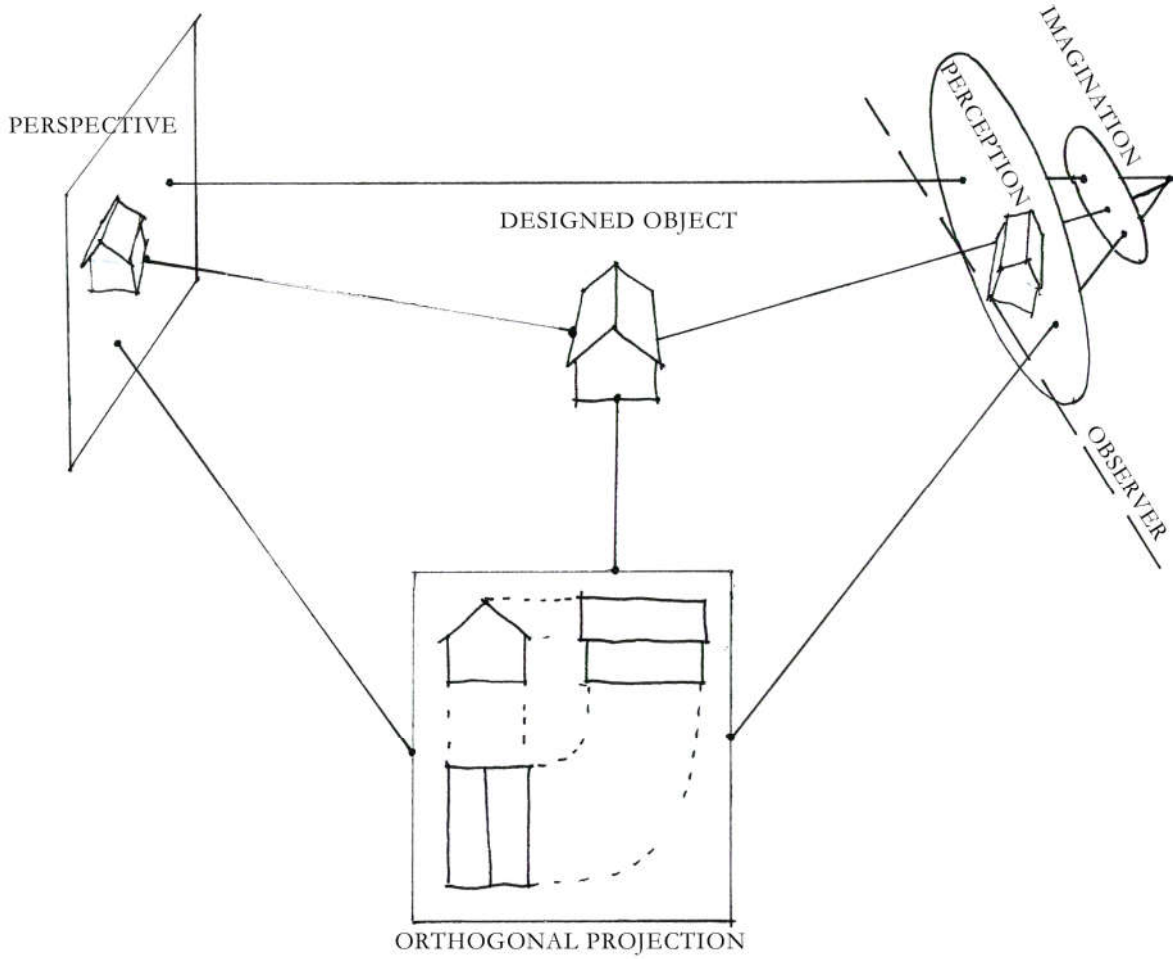


Fig. 17 Robin Evans, ‘The Arrested Image’

Twenty years later, Adam Dayem introduced four fundamental changes to Robin Evans' diagram. First, perspective was replaced by a three-dimensional digital model. An external information (external sources) component was also added, which the author defines as the impact that programming and algorithm- and parameter-based operations, which aim to analyse the data and translate it into code, have on the process. The above sources, acting as a filter that affects the other elements of the diagram, change the manner in which the designer sees and imagines the design. The result is a hybrid, human and non-human (mathematics-based), research and design methodology. The third important departure from Evans' diagram involves establishing a direct link between the model and the design. Digital models containing detailed project data are becoming more accurate and are sometimes used in the process of creating the final product, i.e. the construction process. Fourth, the drawing is closely related to the model, however it is also purposefully made different. In doing so, the author wished to emphasise the ease with which a three-dimensional model may be used to create countless two-dimensional

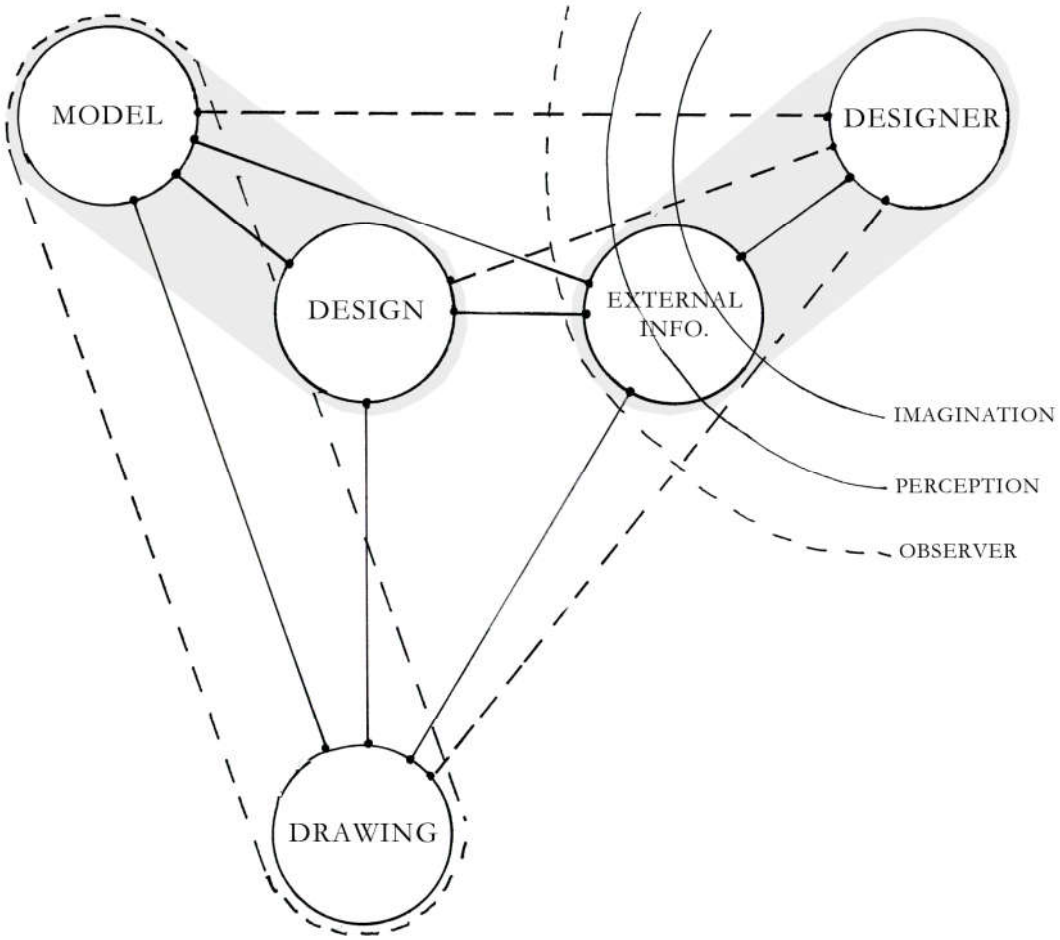


Fig. 18 Adam Dayem, 'The Arrested Image Revisited'

drawings. The opposite is also true, albeit seems more difficult to implement. It is that analog-digital relationship between drawings and models that Adam Dayem uses to define the contemporary role of drawings, making way for unpredictable, creative undertakings and discoveries.

Adam Dayem introduced the very general category of 'drawing', which includes drawings generated using a model, freehand sketches and abstractions, to replace orthogonal projection. Furthermore, he did not create separate categories for 2D and 3D representations; it can be therefore assumed that both are included in that broad category. Disregarding the various forms and functions of drawings seems to be a gross oversimplification. Orthogonal projections generated using a model cannot be equated with freehand sketches made when analysing the context, searching for inspiration or researching design solutions. Therefore, the category should be split into at least two subcategories: digital and freehand drawings. The importance of 'external sources', which Dayem referred to as a 'filter' that changes the manner in which the observer sees the context, also seems exaggerated. There is no doubt that those sources are a new, valuable component of the design process, but they should not take precedence over other equally valuable means of perceiving and working out creative solutions (Pętkowska 2018).

II. 4. 3 Causes of contemporary shifts

This chart (Fig. 19) shows the data management issues that have long affected the architecture-drawing-based design process. Insufficient communication between the parties engaged in the project (also among design team members), misunderstanding the investor's needs and errors occurring during writing and reading data often generate financial losses. The data format used is one of the causes – the often very complex drawings are difficult to accurately decipher even by seasoned professionals. The primary cause of the issues outlined in the diagram, however, results from architects and other designers (urban planners, construction workers, communication specialists, etc.) usually knowing more than they decide to include in conceptual drawings. They leave out certain information because drawing all of the details would be extremely time consuming. Thus, the stage at which detailed diagrams are drawn should be carefully considered. Drawings are unable to store information that goes beyond the current phase of the project. Such information has to be included in a different drawing, document or remain stored in the designer's mind. That leads to data being lost between the various stages of the project (which is usually evident when progressing to the execution stage) and the misunder-

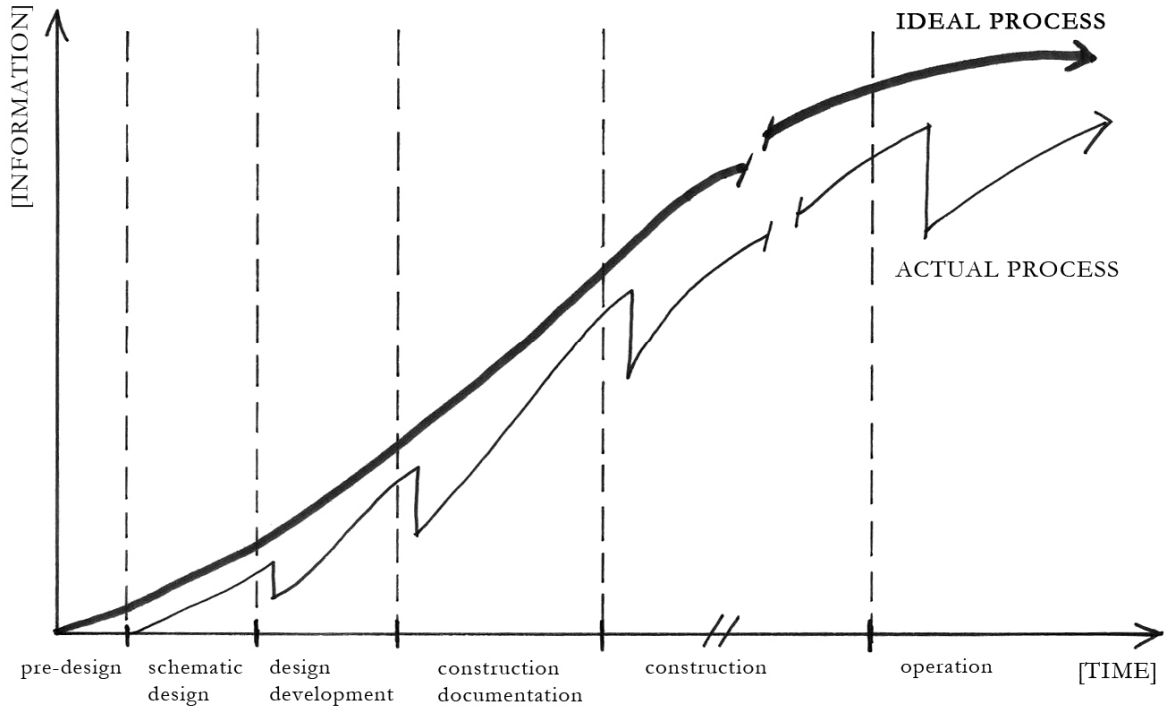


Fig. 19 David Scheer, a diagram depicting project data flow management depending in time in an idealised and updated process, based on architectural drawing.

standings that follow, not to mention the financial losses that often result from it (Scheer 2014, 115–116). The expenses associated with introducing changes to project documentation will grow with time and progress made, and the range of possible changes will shrink (Fig. 20).

This has been remedied by developments in digital technology, such as Building Information Modeling (BIM).

> The transcoding nature of digital instruments means that they may be used at all stages of architecture design. Data gathering, design drawings, documentation, working plans and specifications as well as inspection and management mechanisms of the finished structure are structurally cohesive. There no longer is a number of distinct architecture design tools, as they have been replaced by an integrated coordination system. The predicted construction, thermal, economical, timeframe and ease of use parameters may impact the design process before they are actually created.[27] (Słyk 2012, 198)

This results in reduced investment costs which, in turn, boost the trusts of investors and other parties involved in the construction project.

[27] 'Transkodująca właściwość cyfrowych instrumentów powoduje, że mogą występować we wszystkich etapach działalności architektonicznej. Informacje gromadzone w czasie analizy, szkice projektowe, dokumentacja, instrukcje wykonawczo-technologiczne, a wreszcie mechanizmy kontroli i zarządzania gotowym obiektem są pod względem strukturalnym spójne. Nie mówimy już o zestawie narzędzi służących tworzeniu architektury, lecz raczej o zintegrowanym systemie koordynacji. Przewidywane efekty konstrukcyjne, termiczne, ekonomiczne, harmonogram wykonania, wygoda użytkowania mogą wpływać na formowanie założeń, czyli zanim faktycznie zaistnieją.' (translation into English: Monika Fryszkowska)

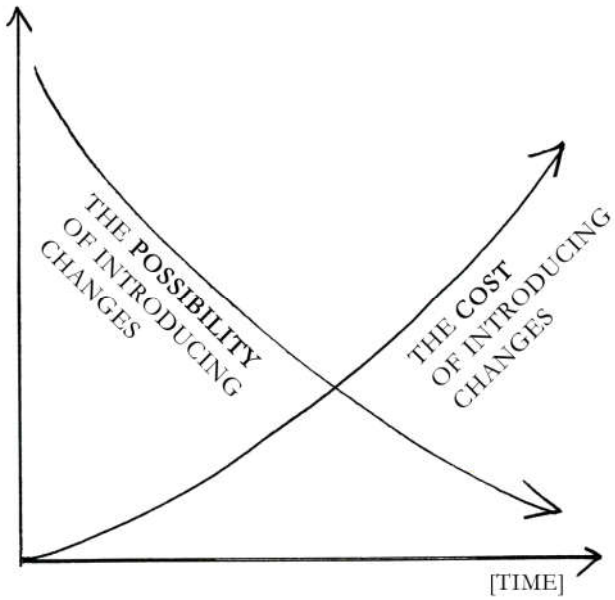


Fig. 20

The European construction market constitutes almost 10% of EU's GDP (approximately 1.2 trillion Euros annually). Each year, enormous losses are generated by the lack of appropriate data flow management systems – approximately 1/3 of all construction projects in the EU exceed their projected budgets and schedules (those figures were presented by the EU BIM Task Group at the 'New Face of BIM' conference that took place in November 2016 in Warsaw). As can be seen, the above issues generate huge financial losses. The EU took notice and decided to introduce a relevant directive of the European Parliament and of the Council (2014/24/EU), of 26 February 2014, on public procurement. The directive does not impose the usage of BIM in the EU, but it certainly is a step forward in that it recommends using the technology. Many countries already had relevant legislation in place that required adhering to BIM standards, especially in the area of public procurement.

The above changes to the design process are irreversible, not only due to the economic reasons that have caused them in the first place. Computer simulations, of which BIM is one, are becoming more prevalent in everyday life, ranging from computer games to social interactions taking place via social media, and thus digital reality is becoming a dominating trend in society. There seems to be widespread acceptance of reality becoming replaced by its virtual representations. Subsequent generations will be more used to this new reality where not only products, but also experiences are becoming virtual. This topic will be covered in more depth in Chapter V.

II. 5 Freehand drawing

II. 5. 1 Characteristics

This subchapter aims to analyse the definitions of freehand drawing and assess whether they are still relevant in today's digital world. The encyclopædia entries quoted below do not make a distinction between 'drawing' and 'freehand drawing', but a closer look at the definitions of 'drawing' leads to the assumption that they include the category of 'freehand drawing'. Definitions of 'drawing' usually include the following four elements.

1) Dual nature: the initial stage of a process / a finished work of art

Drawing is defined as 'a form of visual art forming the basis for painting, sculpture, graphic design, architecture and handicrafts'[28], as well as an 'artistic technique'[29] (Wielka Encyklopedia PWN 2004, 138). The first part of the above definition is similar to the one contained in Mała Encyklopedia Architektury i Wnętrz [Pocket Encyclopedia of Architecture and Interior Design]: '[drawings] often form the initial stages in the process of creating various artworks (graphic design, painting, sculpture)'[30] (Krajewski 1974, 375–376). Encyclopædia *Britannica* contains a long paragraph on the ties between drawing and other art forms: 'The bond between drawing and other art forms is of course very close, because the preliminary sketch was for a long time the chief purpose of the drawing' (Brittanica, XXXVII 2003, 252), as does *Brockhaus Enzyklopädie*: 'Artistic drawing may constitute a preliminary stage (study, sketch, design, linear sketch) in the creation of another art form (painting, sculpture, architecture), or be itself an artwork.'[31] (Brockhaus Enzyklopädie, XXIV 1994, 466).

The dual nature of drawings translates into a wide variety of drawing types. There have been attempts to categorise them, made by Beatrice Gysin among others, who distinguished graphical representations of a utilitarian nature, such as informational or explanatory drawings, and artworks, including a separate artistic category (Gysin 2012, 8–9). The duality of drawing also allows for those two categories to mix, which is true for architecture diagrams which have both artistic and utilitarian features.

[28] 'dziedzina sztuk plastycznych leżąca u podstaw malarstwa, rzeźby, grafiki, architektury i rzemiosła artystycznego' (translation into English: Monika Fryszkowska)

[29] 'technika w której zostało wykonane dzieło sztuki' (translation into English: Monika Fryszkowska)

[30] '[rysunek stanowi] często przygotowawcze studium jako projekt do kompozycji w innej technice (grafika, malarstwo, rzeźba)' (translation into English: Monika Fryszkowska)

[31] 'Die künstlerische Zeichnung kann als vorbereitende Arbeit (Studie, Skizze, Entwurf, Vor–Zeichnung) im Dienst der anderen Kunstgattungen stehen (Malerei, Bildhauerei, Architektur) oder ein um seiner selbst willen geschaffenes Kunstwerk sein.' (translation into English: Joanna Pętkowska-Hankel)

2) Linearity and condensed information

All of the analysed definitions emphasise the importance of linearity in drawing as one of its constituting characteristics. 'A drawing is a representation on a plane, based on the use of lines.'[32] (Brockhaus Enzyklopädie, XXIV 1994, 466) The use of lines translates into the ability to convey a concise message, as noted by Barbara Siomkajło: 'Drawings are able to instantly convey a succinct message about a certain aspect of reality by using simplified, abstract forms which, due to their nature, may further emphasize the idea or message'[33] (Siomkajło 2001, 165). Karel Teissig notes that the process of converting a colour image into a dash and contour language requires a sophisticated artistic ability to abstract (Teissig 1982, 7). The entry in *Britannica* also accentuates the importance of lines in conveying a succinct message: 'The principal element of drawing is the line. (…) Conscious and purposeful drawing represents a considerable mental achievement, for the ability to reduce spatial objects existing in the world around one to lines drawn on a plane presupposes a great gift for abstraction.' (Brittanica, XXXVII 2003, 251) Linearity is also linked with pace and expression: 'Drawing is one of the quickest and simplest methods of artistic expression as it depends almost solely for its effect on the use of line.' (Chambers's Encyclopædia, IV 1950, 631) Yet, the artist has the freedom to use other techniques: 'Drawings accentuate linear flow, however many drawings feature shading effects achieved using the hatching technique – (…), the wash technique – (…), or white paint (e.g. gouache) to bring out lighter areas.'[34] (Kozakiewicz 2003, 359)

In his essay titled 'Colours and Drawing', Władysław Tatarkiewicz presented the historical evolution of the relationship between colours and drawing, and the long-standing domination of drawing as an art form in the eyes of many art theoreticians. According to Tatarkiewicz, there are three reasons why drawing remained the leading art from since the beginning of the early modern period, up to the 20th century. First, as was already mentioned in point 1), drawing formed the basis for all other visual arts. Furthermore, theoreticians claimed that drawing, unlike colours, affects not only the viewer's senses, but more importantly stimulates the intellect. To be able to draw, one first has to gain an understanding of the object being drawn, its structure and internal order. The third

[32] 'Zeichnung – Gestaltung auf der Fläche, vor anderen durch Linien.' (translation into English: Joanna Pętkowska-Hankel)

[33] 'Cechą rysunku jest zdolność do natychmiastowego, skrótowego przekazu określonego aspektu rzeczywistości przy zastosowaniu uproszczonych, abstrakcyjnych form, które mogą podnosić jeszcze dobitność zawartej idei czy komunikatu.' (translation into English: Monika Fryszkowska)

[34] 'W rysunku akcent położony jest na walory linearne, choć w wielu rysunkach dużą rolę gra światłocień, zakładany szrafowaniem – (…), lawowaniem – (…), lub za pomocą świateł położonych białą farbą kryjącą (np. gwaszem).' (translation into English: Monika Fryszkowska)

important aspect that contributed to drawing's triumph over colour resulted from the fact that drawing is subject to the laws of mathematics, which was tied to the discovery of the principles of perspective and, later, descriptive geometry. Currently, both drawing and colour are regarded as equally important aspects of painting (Tatarkiewicz 1972, 404–408).

3) Tools and substrates

The tools and substrates used to create a finished work are what distinguishes the various drawing and painting methods, as well as art forms. This assertion was found in all of the analysed definitions, e.g. Encyklopedia PWN: 'Drawing differs from painting in the substrates (usually paper) and techniques used: dry (charcoal, graphite, coloured pencils, pastels) and wet (pen, brush, ink).'[35] (Wielka Encyklopedia PWN 2004, 138) The broad selection of available drawing tools and substrates, including much more than just paper, is another important feature of drawing.

4) Tactility

Juhani Pallasmaa notes the importance of tactility in drawing: 'Sketching and drawing are spatial and haptic exercises that fuse the external reality of space and matter, and the internal reality of perception, thought and mental imagery into singular and dialectic entities.' (Pallasmaa 2009, 89) This feature of drawing is directly associated with the cause-effect process that is inherent in sketching. It consists in the relationship between the movement of the hand wielding the tool and the mark that it makes on the paper: 'Drawing also differs from other visual arts, such as lithography and etching, in that there is a direct relationship between the creative process and the resulting artwork.' (Brittanica, XXXVII 2003, 250)

II. 5. 2 Scope of the term

The question of tactility touches upon the issue of using computer-aided drawing methods which break the sensual link between the tool, which is wielded by the artist and has a certain set of characteristics, and the substrate on which the drawing is made. Those modern techniques were mentioned in two of the analysed definitions and, although digital, they are nevertheless considered to fall under the category of 'drawing' – 'an expression of the author's individualism, who wields one or more tools of his choice:

[35] 'Od malarstwa odróżnia go [rysunek] podłoże (najczęściej papier) oraz techniki: suche (węgiel, grafit, kredki, pastel) i mokre (pióro, pędzel tusz, atrament).' (translation into English: Monika Fryszkowska)

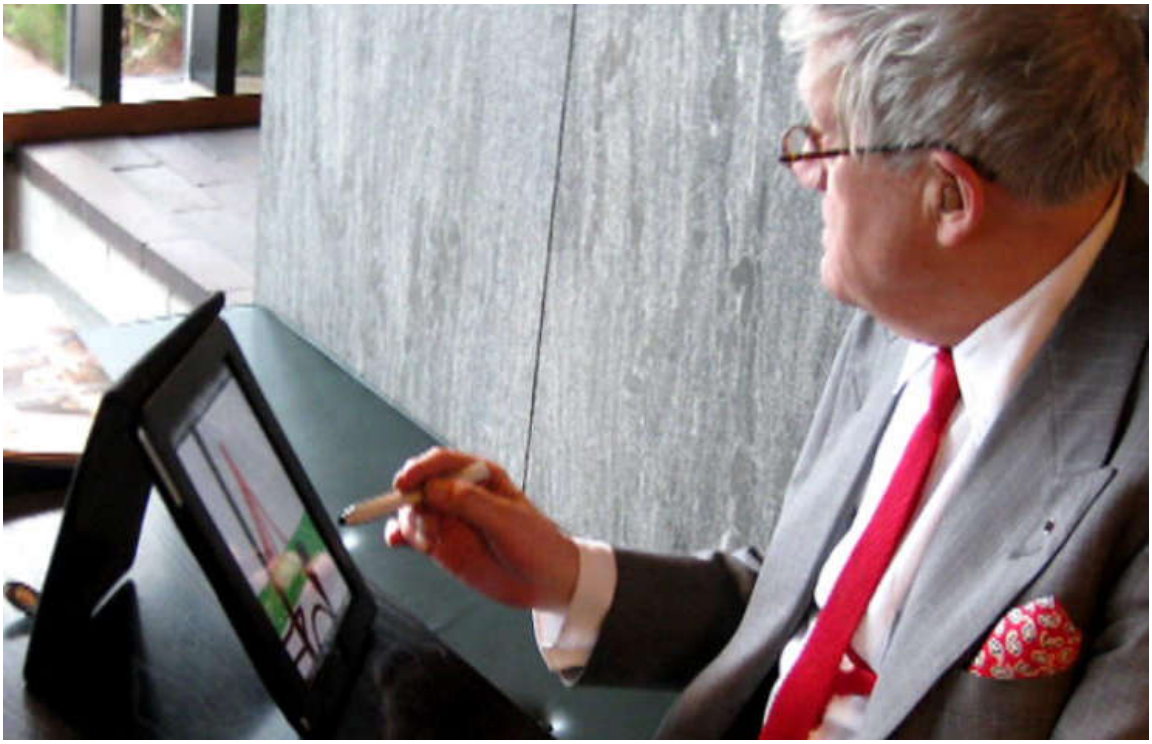


Fig. 21 David Hockney drawing on the tablet

black or coloured pencils, chalk, graphite pencils, charcoal, stylus, pen or brush… or even a computer screen.'[36] (Encyklopedia Powszechna Larousse, II 2003, 1356) The Brockhaus encyclopædia also broadened the category to include digital media and emphasised the meaning of gestures: 'Computers currently make it possible to harness the spontaneity of gestures by using special tablets, light styli, magnifying glasses and mice.'[37] (Brockhaus Enzyklopädie, XXIV 1994, 466).

At this point it is worth considering if computer-assisted drawings – taking advantage of input tools and software that translate the artist's hand movements into a digital image – may indeed be categorised as freehand drawings. For instance, can David Hockney's drawings (Fig. 21), which were made using a computer tablet, be considered freehand drawings?

[36] 'wyrazem indywidualności artysty, który trzyma w palcach jeden lub więcej odpowiednich, wybranych przez siebie narzędzi: czarną lub kolorową kredkę, kredę, ołówki z mineralnym grafitem, węgiel, metalowe sztyfty, piórko lub pędzelek i tusz… aż po ekran komputera.' (translation into English: Monika Fryszkowska)

[37] 'Der Computer erlaubt heute auch den spontanen gestischen Ausdruck mittels spezieller Graphiktabletts, Lichtstift, Lupe oder Maus. Damit wird die Computergraphik um die künstlerische Zeichnung erweitert.' (translation into English: Joanna Pętkowska-Hankel)

Angela Million, Sławomir Gzell and Elizabeth Plater-Zyberk make note of the importance that gestures have for digital drawings and their categorisation:

> I think a freehand drawing is anything, where there is a drawing, in which the hand, the eye and the brain are tracing the same pattern. So whether that happens with a pencil or pen on paper or it's happening on a tablet, I think it's still the same connections of those three tools – eye, hand, brain; of those three body components. So I think it's different than running a mouse. (Elizabeth Plater-Zyberk, 3 October 2015, 0:37–1:20)

Harald Kegler notes that tablet drawings are similar to traditional ones in that they both allow for nearly identical forms of expression, which are further expanded through digital software. According to Kegler, the two techniques are akin to each other as both require the artist to have a set of developed skills, regardless if he is drawing on paper or on a screen. Yet, traditional drawing remains the foundation that may be expanded upon through the use of a computer (Harald Kegler, 5 December 2016, 20:20–22:25).

The opposite view, i.e. that drawings made using a tablet should not be categorised as freehand drawings, was presented by Juhani Pallasmaa. In his view, there is a lack of 'external reality of space and matter' when using a tablet (Pallasmaa 2009, 89). Krzysztof Koszewski expressed a similar opinion in an interview:

> I would limit the category of freehand drawings to settings where traditional tools are used. So, drawings made using a tablet should not be considered freehand drawings. Although the interface does record the movements of the artist's hand, it modifies them. That is why I would distinguish between the two categories based on the tool that is used. (…) the interface modifies the input simply because the imprint made by the movement of the tool over the surface is, in that case, only a simulation. Nothing much happens. And when we think about traditional techniques, and freehand drawing is one of them, then we should keep in mind the importance of the tools that are used. Thus, the drawing is an artefact. It is physically present, one may pick it up or even tear it to pieces if one so desires. Whereas in the case of electronic devices no artefact exists, or rather does not necessarily have to exist. We have unintentionally touched upon the second criterion, the tool, in addition to drawing being a physical object, a trace.[38] (Krzysztof Koszewski, 2 February 2017, 0:50–3:25).

When asked if a printout of a computer-assisted drawing could be regarded as an example of a 'physical trace', he said that a printout does not change anything – the virtual nature of the drawing remains unchanged and is similar to building renderings, for example.

[38] 'Raczej bym tam go [rysunek odręczny] sytuował, gdzie mamy do czynienia z tradycyjnym narzędziem. Czyli jednak w przypadku tabletu to nie byłby rysunek odręczny. Tam w grę wchodzi interfejs, który już modyfikuje to co rysujemy, mimo że notuje ruch ręki, także myślałbym tu [w definiowaniu] o narzędziu. (…) na pewno interfejs jest czymś co modyfikuje proces choćby dlatego, że jednak ten fizycznie zostawiany ślad na podłożu jest tylko, w przypadku interfejsu, symulowany. Tam nic takiego się nie dzieje. A jeśli już myślimy o tradycyjnych technikach, a o takich myślimy jeśli przywołujemy rysunek odręczny, to też to tradycyjne medium, którego używamy, ma znaczenie. Czyli rysunek jako artefakt, fizycznie obecny i możliwy do wzięcia do ręki albo też podarcia, jeśli ktoś ma taką chęć. Natomiast w przypadku wszelkich urządzeń elektronicznych ten fizyczny artefakt nie istnieje, w każdym razie nie musi istnieć. I tutaj niechcący wyszło drugie kryterium – czyli narzędzie – plus fizyczny ślad w postaci rysunku jako przedmiotu.' (translation into English: Monika Fryszkowska)

Having analysed the above information and my own drawing experience, it has been decided that the broader definition of 'hand drawing' will be used in the following chapters of this work. Two conditions have been proposed that a drawing should meet in order to be classified as such: it has to feature a sensual connection between the hand, eyes and mind and an accurate rendition of gestures, regardless if the work is made in the material or virtual world. In the latter case, it is necessary to use a so-called input device allowing for the most accurate recording of gestures, e.g. a light pen (although it should be noted that the available software merely simulates the literal nature of traditional drawing). Computer mice do not meet the above criteria.

Drawing implements, such as a compass, ruler or French curve, also affect the artist's gestures. Yet, drawings made with their use are nevertheless classified as freehand drawings, mainly because of the tremendous skill required to use them in the drafting process. Furthermore, parts of technical drawings are purely hand-drawn, and most viewers will not discern them from the parts that have been using various implements (Fig. 110, 113, 114, 139–144).[39]

As was mentioned in Subchapter II. 1, Christian Gänshirt attaches particular importance to gesture. The impact of gestures is also reflected by Gert Hasenhütl (Hasenhütl 2009, 342) and Beatrice Gysin in her definition:

> [drawing] is a material rendition of a gesture which draws attention to a thought, image, feeling or discovery. Sometimes the only reason for a drawing's existence is to cover a surface using a drawing implement and, as such, as a pure drawing, is in itself a gesture. A drawing may also materialise itself in space in the form of a three-dimensional phenomenon. Therefore, for a drawing to be created, there has to exist a premeditated expression of a gesture – (…) – or an image of something concrete.[40] (Gysin 2012, 6)

[39] In English, the term used is 'freehand drawing', while in German – 'Freihandzeichnen'. The dilemma of classifying drawings made with a ruler to freehand drawings could be solved in a simple way – it would be enough to subtract from the adjective 'freehand' the element 'free', and in German from the noun 'Freihandzeichnen' – the element 'Frei' (in German 'free'). In both cases, what would remain would still mean a hand drawing, though perhaps made only with 'hand' ('hand' in English, 'Hand' in German).

[40] 'Sie [Zeichnung] ist materialisierte Geste, die auf etwas Gedachtes, Gesehenes, Gefühltes oder Erfundenes verweist. Manchmal ist sie einfach nur automatisierte, rhythmische, auch unbeabsichtigte Ablagerung von Zeichenmittel auf Trägermaterial und verweist so – als reine Zeichnung – auf die Geste an sich. Zeichnung kann sich auch materialisieren im Raum, als dreidimensionale Erscheinung. Die Zeichnung genügt also entweder einer mehr oder weniger beabsichtigten gestischen Hervorbringung einer Spur – (…) – oder aber sie bezeichnet etwas Bestimmtes. (…)' (translation into English: Joanna Pętkowska-Hankel)

III. COGNITIVE PROCESSES

Cognitive processes are the basic components of the creative process (Nęcka 2005, 53) – and this also applies to designing. Among these processes visual perception, remembering and thinking can be distinguished as related the most to freehand drawing in the design process. This relation was described primarily in Subchapters V. 1 and V. 2.

III. 1 Senses

Phillip G. Zimbardo distinguishes ten senses that enable us to receive stimuli from the environment: vision, hearing, smell, taste, touch, warmth, cold, equilibrium, kinesthesis and pain. Through the senses the energy reaching us from the outside world is transformed into sensations. Sensation is a primary, basic feeling induced by stimuli and the activity of the receptors. It reflects one feature of an object without reflecting the others (Mączynska-Frydryszek, Jaskólska-Klaus and Maruszewski 2001, 24). Zimbardo differentiates between sensation and perception, the latter being the object of interest of the present subchapter. Perception (in a broad sense), that is perceiving, is 'elaboration, interpretation, and assignment of meaning to a sensory experience'. It is a process superior to the reception of sensations and it depends to a large extent on the experiences and characteristics of an individual who perceives (Zimbardo 1992, 215). Hence, drawing, which is a notation of the perception process, shows such marked individuality.

Rudolf Arnheim already in 1954 observed the following phenomenon:

> We have neglected the gift of comprehending things through our senses. Concept is divorced from percept, and thought moves among abstractions. Our eyes have been reduced to instruments with which to identify and to measure; hence we suffer a paucity of ideas that can be expressed in images and an incapacity to discover meaning in what we see. (…) The inborn capacity to understand through the eyes has been put to sleep and must be reawakened. This is best accomplished by handling pencils, brushes, chisels, and perhaps cameras. (Arnheim 2004, 1)

The role of perception is exactly to give meaning to sensations. Rudolf Arnheim's extensive and renowned publication *Art and Visual Perception* was the response to the observed problem.

As the title of the book already suggests, the sense of vision holds primary place in the reception of the outside world, a thesis confirmed by the author in the course of his

reflections (op. cit. 166–167). Zimbardo, in turn, attaches the greatest importance to the senses of vision and hearing (Zimbardo 1992, 245–246). The non-visual spatial indicators include: kinaesthetic sensations originating from the muscles, conceptions recreating the past kinaesthetic sensations and hearing sensations (Mączynska-Frydryszek, Jaskólska-Klaus and Maruszewski 2001, 227–229). In the book *Experiencing Architecture*, there is a chapter devoted to the 'hearing' of architecture which is a poetic description of the importance of the sense of hearing in the reception of architectonic space (Rasmussen 1999, 224–227).

It is also worthwhile to devote short reflection to the sense of touch. According to James Gibson the understanding of our 'sense of being' consists of two factors: 1) the basic human orientation in space – the sense of the body being in vertical position implying the existence of the horizontal plane on which the person is standing and, indeed, 2) the haptic sense (the sense of touch relating to the entire body) (Porter 1997, 30). With the development of the technological revolution in the last several decades the role of tactile sense has become largely limited in many professions. Instead of a technical pen, a T-square and a French curve used by an architect to draw on tracing paper, the designers nowadays observe the effects of their mouse clicks on a computer screen. The continuity of the connection between the tool, the hand and the brain was broken. It was then that the simple cause and effect relationship between the activity of operating the tool and its trace on the surface of e.g. paper disappeared. The fundamental importance of the sense of touch in creation and reception of architecture is stressed by Juhani Pallasmaa. He draws attention to the holistic dimension of the human nature, with the human being equipped in body and mind combined into one whole, and the fact that in the present times this physical dimension of human nature is too often forgotten. Also in education and in thinking processes, including design thinking, Pallasmaa gives priority to tactility, coining up the notion of the embodied wisdom of architecture resulting from direct sensual experiences (Pallasmaa 2009) (see V. 2. 1).

Despite the above-mentioned role of other senses in the reception of space the present work focuses on visual perception. This stems from the conviction about the primacy of the sense of vision with regard to freehand drawing which is used for notation of the perception processes. The description of perception processes is intended to show that what humans can see is not only the result of a passive activity of the system of vision but an active process of distinguishing important features of objects in space.

III. 2 Visual perception

Zimbardo divides the process of visual perception into three stages (Fig. 22). The first stage is the earlier-mentioned sensation or, in other words, a sensory analysis (1) which consists in the brain cortex encoding information coming from light waves reaching the eyes. Already at this stage the basic spatial features like boundaries, edges or brightness are distinguished. At the second stage of the synthesis of features or perceptual organisation (2) the answer to a question is sought: 'how does the object look like?'. The question refers to the interpretation of the objects perceived in the first stage. They acquire legible shapes and forms. Their shape, size, movement, distance and position are discerned. This stage of perception was described by Rudolf Arnheim as the forming of perceptual concepts. 'Vision deals with the raw material of experience by creating a corresponding pattern of general forms, which are applicable not only to the individual case at hand but to an indeterminate number of other, similar cases as well.' (Arnheim 2004, 46) The third stage called the identification and recognition (3) intends to give meaning to observations and answer the question: 'what is this object?'. The ball is distinguished from an orange and the objects undergo esthetical classification e.g. into beautiful and ugly, known and unknown. The perceptions are filtered by experience, attitudes, opinions, theories and memories of the observer connected to the object (Zimbardo 1992, 257–258). The image depends on the totality of visual sensations which the observer has experienced before with regard to a given object or types of objects.

The basic issue related to perception which will be useful in the subsequent chapters of the dissertation, is the discord between 'the visible thing' and 'its image' (Witwicki 1954, 5–9). To the observer, the picture on the wall has the shape of a trapezium (Fig. 22 (1) – sensations) although he/she knows that the picture is rectangular (Fig. 22 (2) – synthesis of features). The difference between the data flowing from sensations and the knowledge is the basic problem in the teaching of freehand drawing – as frequently the symbols of the object become activated (rectangle) instead of their true shapes as received by the eye (trapezium) (see pp. 82–85). Psychologists refer to the actual physical object with the term 'distal stimulus' and to the image formed on the retina based on this object – 'a proximal stimulus'. The distal stimulus – 'the visible object' – is three-dimensional while the proximal stimulus – 'the image' – is two-dimensional. The receiver needs to determine the physical features of the distal stimulus based on its two-dimensional image.

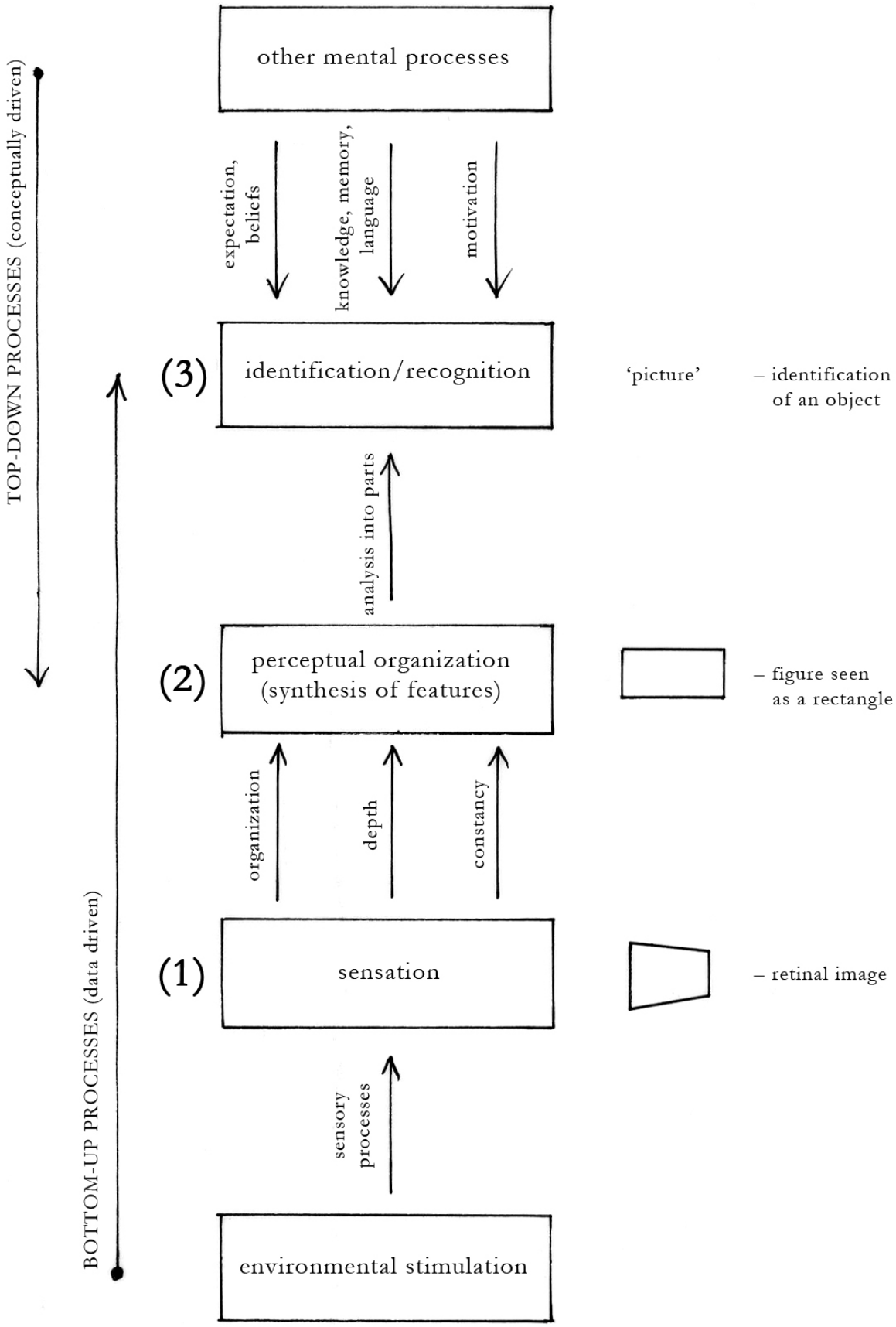


Fig. 22 Philip Zimbardo, stages of sensations (1), perceptual organisation (2) and identification/recognition (3)

The three above-mentioned stages belong to bottom-up processing controlled by the incoming data. Primary sensory information is transmitted to the higher levels of the nervous system and analysed more deeply. There is an opposing, top-down, concept-driven process taking place at the same time which engages other information – knowledge, experiences, memory, language and cultural background, expectations, beliefs and motivation (Mączynska-Frydryszek, Jaskólska-Klaus and Maruszewski 2001, 54).

It is worth highlighting some detailed processes of the previously described synthesis or perceptual organisation, and thus the second stage of the entire visual perception. The breakdown into regions consists in determining the boundary between two areas on the basis of information about the changes in texture and colour. This allows to isolate the figure and the ground, which is achieved by determining its boundaries interpreted as a contour. Moreover, there is a tendency to add object edges based on the existing shapes – this phenomenon is called closure. Perceptual grouping occurs primarily on the basis of the similarity of elements that are combined in assemblies (op. cit., 207–212). Grouping is primarily subject to the law of simplicity, supreme in the visual perception, which Arnheim defines as follows: 'Any stimulus pattern tends to be seen in such a way that the resulting structure is as simple as the given conditions permit.' (Arnheim 2004, 53) Spatial and temporal integration belongs to the higher levels of perceptual organisation. It allows to construct the spatial layout of the whole environment from sections of reality perceived in the field of view (Zimbardo 1992, 282).

The third stage of visual perception – identification and recognition – refers, to the greatest extent, to the above-mentioned top-down process, since not only the raw data derived from experience is used, but also the previously accumulated knowledge. During this process, the recognition by components, which exemplify the simplest geometric solids, takes place. A human being, for example, is recognised as a set of six cylinders – a trunk, a head, two legs and two hands. After the activation stage of the memory components, the object has been recognised. The influence of context and expectations is also considerable, which encompasses the use of schemas and perceptual set, consisting of a tendency to respond to a stimulus in a specific manner (Fig. 49). It can be conditioned socially, culturally, or personally; it can also depend on the individual's sensitivity, including the visual one (op. cit., 292–294).

From the conviction that the eye acts only as a transmitter for visual stimuli on their way to the brain stems the photographic metaphor – often used, though irrelevant – the

comparison between the human eye and the functioning of the photographic camera. This comparison takes into account only the optical aspect of the visual process (in which only partial similarity can be determined). It should be emphasised once again that perception is generated mostly by the nervous system, which leads to the distinguishing of the objects' properties, their grouping, comparing, and interpreting etc. (Mączynska-Frydryszek, Jaskólska-Klaus and Maruszewski 2001, 23)

The right cerebral hemisphere is responsible for the process of visual perception. The knowledge of this fact was spread by Roger Sperry whose discoveries contributed to the understanding of the dual nature of the human brain and the phenomenon of lateralization. Lateralization consists of the occurrence of asymmetry in the activities of both cerebral hemispheres. On this basis, two modes of information processing have been distinguished. In case of right-handers, the left hemisphere is responsible for the use of language, reading and writing, as well as for the analytical, computational and sequential thinking. Thanks to it, humans are able to reason abstractly and logically, verbalising – step by step – their inquiries. The right hemisphere handles perception, visual thinking, transformations, spatial relationships and emotions. It is used for intuitive and subjective feelings, works holistically and synthetically. Research has also shown that the right hemisphere is responsible for design thinking (Goel and Grafman 2000). Most of the complex activities involve the cooperation of both cerebral hemispheres. The left hemisphere may communicate visual experiences received by the right hemisphere, but this occurs in verbal form. The right hemisphere is predestined for recording impressions coming in a visual form, for example as a drawing. Sperry's experiments showed that the right hemisphere dominates in case of the problem solving in which the studied subject is required to draw the representation of spatial dependencies or, for example, to copy and draw test figures such as the Necker cube, house, Greek cross etc. (Sperry 1968, 1974). The left hemisphere, storing knowledge about an object and activating diagrams and symbols during the act of drawing, tends to dominate the right hemisphere. Betty Edwards points to this phenomenon as the most important obstacle in the teaching of drawing, consisting in the notation of 'pure' visual stimuli, i.e. the aspect belonging to the right hemisphere's domain (Edwards 1999).

The relationship between the above described perceptual phenomena and the meaning of freehand drawing, especially at the pre-design stage and during the preliminary design, has been described in Subchapters V. 1 and V. 2.

III. 3 Remembering

The consequence of perceptual processes – the reception and recording of stimuli – is remembering the things that have already been seen. Nęcka observes a direct connection of the role of memory in creative work in which both the content of knowledge and the organisation of knowledge are important, especially in the structure of long-term memory (Nęcka 2005, 68).

It is worth to take a closer look at remembering which is a productive process and a continuation of the active process of perceiving (Zimbardo 1992, 365). Remembering an experience is connected to three processes. Encoding (1) consists in transforming the information from the stimuli into neural code that can be processed by the brain. Storing (2) of the encoded material works more efficiently when the remembered facts and actions can be linked to past experiences (op. cit., 351–352). Retrieval (3), the last stage of remembering, consists in obtaining access to the recorded information. There are two methods of retrieval: recall and recognition. Recalling is understood as revoking from memory of 'pure' information acquired before. Recognition is a much more effective method. It allows one to become aware of the existence of a given stimulus which has been seen or heard before. During the recognition process a stimulus already received in the past is compared with the current observation (op. cit., 347). An active sensual contact with the objects in space, strengthened further with drawing, can help retrieve objects through recognition.

There exist three types of memory: sensory, short-term and long-term memory. Sensory memory has the task of storing sensations received from the stimuli originating from all the senses. It is a primary type of memory: registration of data stored for a very short time, without their categorisation. In the case of visual data, an observation retained in iconic memory is referred to as an 'icon'. The icon remains on the retina for approximately half a second, which is enough time to register the stimulus before it is transmitted for further processing by the nervous system (op. cit., 349).

The icon in freehand drawing is used for repeated comparing of a sketch drawn from nature with the drawn object. As described with the terms coined by Kazimierz Bartel: a draftsman transfers onto paper the image of an object (a visual object). To transfer the image an artist must retain the view from a given angle in his memory for a very short moment, refreshing it with another glance if necessary, the sensory memory having an

active role in the process. Bartel refers to this activity as copying an object as opposed to constructing it (which is drawing from imagination and from memory) (Bartel 1958, 223–224). Short-term memory receives a stimulus recognised by sensory memory. It has a very limited capacity. In reflections on the role of drawing in the profession of an architect and urban planner sensory memory is shown to have the least importance among the three distinguished memory types.

Long-term memory is divided into procedural memory (the method of performing an activity and the acquisition of an ability e.g. to draw) and declarative memory. Declarative memory, which requires a conscious effort, relates to the notation of information about specific facts. It can be divided into semantic memory, based on 'hard' facts, abstract notions, without reference to the time, place or experience of a given person, and into episodic memory. Thanks to the latter, it is possible to register events known from an individual's experience. Episodic memory carries information on the location of an event in time and space; it also plays an important auxiliary role in recalling information in connection to an activity (e.g. drawing) or an event. It is so because most of the notions are stored precisely in relation to personal experience (Nęcka, Orzechowski and Szymura 2006, 366–369).

The context in which a person acquires information also plays a crucial role in respect of long-term memory. It has been demonstrated that if the same circumstances are recreated at the moment when the person is searching for the information in their memory, they will access more easily the acquired knowledge. This phenomenon is referred to as context dependence (Zimbardo 1992, 360, 362).

Both the functioning of episodic memory, the phenomenon of recalling, as well as context dependence are important in building a 'database' through freehand drawing, as described in Subchapter V. 1.

III. 4 Thinking

The thinking process follows the perceptual processes described above: the perceptual organisation (Fig. 22 (2)) and pattern recognition (Fig. 22 (3)), as well as remembering. Thinking leads to the formation of new representations based on available information and results from the interaction of numerous mental operations: inference, abstraction, judging, imagining, reasoning, problem solving and creativity (op. cit., 391).

Reasoning consists in drawing conclusions from a set of facts and branches off into deductive and inductive reasoning. Deduction is the process of reaching conclusions using logic from two or multiple theorems (premises). Inductive reasoning is based on elaborating hypotheses on the basis of accumulated observations. The theorem is then tested against other evidence. The conclusion does not result from a logical interrelationship between facts, but rather from a decision related to past experiences. Induction is used in scientific considerations (Nęcka, Orzechowski and Szymura 2006, 444–446). Nigel Cross suggests that design reasoning is not entirely of a deductive or inductive nature; Cross attributes abductive reasoning to it. Abduction creates explanations and is a process that works in the direction opposite to deduction. Cross quotes C.S. Peirce: 'Deduction proves that something *must* be; induction shows that something is *actually* operative; abduction suggests that something *may* be' and Lionel March: 'Logic has interests in abstract forms. Science investigates extant forms. Design initiates novel forms. A scientific hypothesis is not the same thing as a design hypothesis.' The design hypothesis suggests the possibility of something to take place – it proposes and conjectures – and that is precisely what is the most important in design (Cross 2011, 27).

Problem solving is a thinking process divided into three parts:

- initial state: information which needs to be completed, and the lack of which results in a problem;
- goal state: a sufficient collection of information to be achieved;
- set of operations: measures to be taken to move from initial to goal state.

There are well-defined and ill-defined problems. A well-defined problem can be characterised by strictly defined initial state, goal state and operations necessary to be performed; while an ill-defined problem can be characterised by the lack of these data. Phillip Zimbardo gives design, among others, as an example of solving an ill-defined problem (Zimbardo 1992, 402). In such cases, the basis of action means a more accurate definition of the three components of the process and the transformation of the problem into a well-defined one which can be solved by using a sequence of operations. Nęcka emphasises that it is precisely the active approach to the task, its modification, redefinition, and even the replacement of it with another problem that forms the basis of creative thinking (Nęcka 2005, 72).

With the passage of time, each person accumulates more and more knowledge about the functioning of the world, and that allows them to reduce the number of ill-defined problems. The understanding of the problem, however, does not come automatically – one needs to find schemas created from the corresponding situations which had taken place in the past. Making use of analogies is yet another feature of creative thinking, consisting in finding a higher-order similarity between the past and present situations (op. cit., 72). It corresponds to the precedent mentioned in the following chapters of this work (see V. 1. 3, p. 89), whose creation supports sketching from nature.

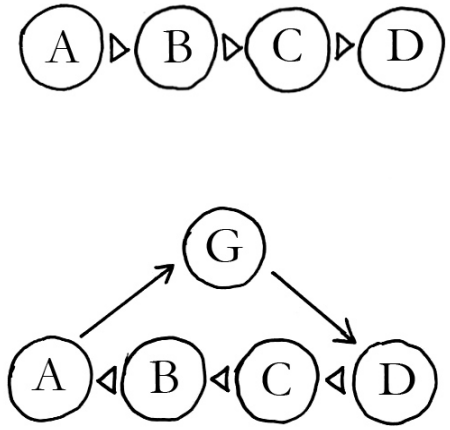


Fig. 23 The sequential transition from A to D is carried out in vertical thinking, while the lateral thinking falls foul of the logical linear sequence of actions, 'jumping' from A through G to D.

Some problems, on the other hand, require a fresh approach and new solutions and reaching them on the basis of clichéd formulae can be unfeasible. Precedents may have a negative impact on creating new solutions, because they suggest already well-known manners of problem solving. This issue is called **functional fixedness** and is a mental attitude that was created analogously to the previous state of thought. Fixedness has the potential to speed up perception and find answers, but when all the previous ways of action do not work at a given moment, it can also inhibit the reaching of innovative solutions (Zimbardo 1992, 402–404). The research studies referred to by Edward Nęcka show that the use of analogy can trigger the 'rigidity of thought', while creative people are characterised by a lesser tendency towards it (Nęcka 2005, 72–74). This would explain that children, who did not have the chance to develop too many precedents, are more creative than adults.

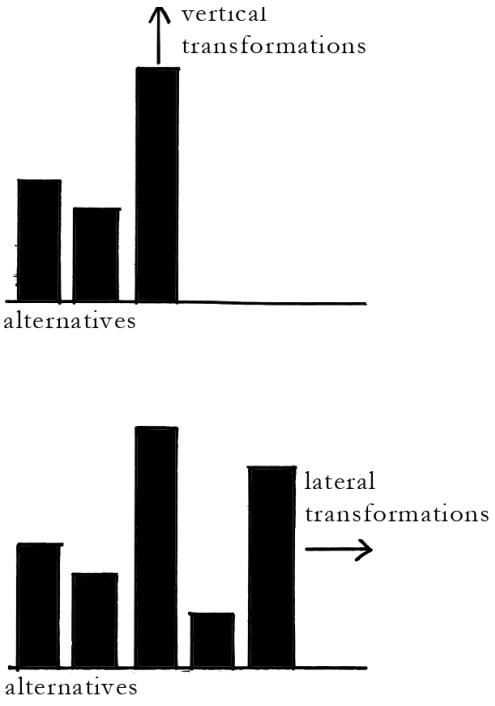


Fig. 24 Lateral transformations are responsible for the emergence of new alternatives, while vertical transformations are responsible for deeper exploration of the already chosen path of reasoning.

One of the design strategies recommended by Nigel Cross is to treat problems as if they were being dealt with for the first time (Cross 2011, 75–78). This attitude is also the basis for lateral thinking, otherwise referred to as ‘sideways thinking’. The term, introduced by Edward de Bono, means thinking which takes the exploration of the new possibilities of looking at a given situation – **lateral transformations** – as a starting point. It does not focus on solving the problem, but on the process of dealing with it. The term ‘creativity’ is associated with lateral thinking, because it allows to reformulate old methods of problem solving. Patterns of behaviour, and thus the above-mentioned functional fixedness, prevent people from following new, non-obvious paths, suggesting well-known, proven, but often not the best solutions. They use the second path of reasoning – vertical thinking, i.e. sequential, logical and result-oriented. Each subsequent step in this mode must be justified, and the solution is often applied on the basis of the predetermined action (Fig. 23). In this area, the details of the chosen path are explored through vertical transformations. Both thinking modes are complementary (Fig. 24). Lateral thinking, due to the above-mentioned properties, is particularly important in designing (de Bono 1990, 6–9, 18–43). Freehand drawing favours lateral transformations, what has been described in Chapter V.

IV. DESIGN THINKING

Designing was a prerequisite for progress and a natural human cognitive function – formerly a collective ability which has been passed down from generation to generation. The concept and manufacturing were intertwined into one creative act, as part of which attempts were made directly on the material, to transform it into tools, jewellery or buildings. Contemporary society, however, having acquired the great achievements of the Renaissance and the experience of the industrial revolution, separates design from the act of material creation of the designed object. This differentiation resulted in the necessity to transform the design concept into a visual representation, which gave rise to the architectural drawing, and the design process that is currently known. This subchapter distinguishes the participants of the design process, its stages, the specific problem features, which is a project task, and the specificity of design thinking resulting from the above.

IV. 1 Participants in the design process

The main participants in the architectural and urban design process are:

- contracting entities (paying clients): investors, owners,
- revising and authorising institutions (legislators, regulators),
- designers: architects, urban planners, discipline engineers (e.g. structural engineers, transport engineers, landscape architects, etc.),
- contractors (makers),
- users – not only residents, but also non-governmental organisations, local entrepreneurs, etc.

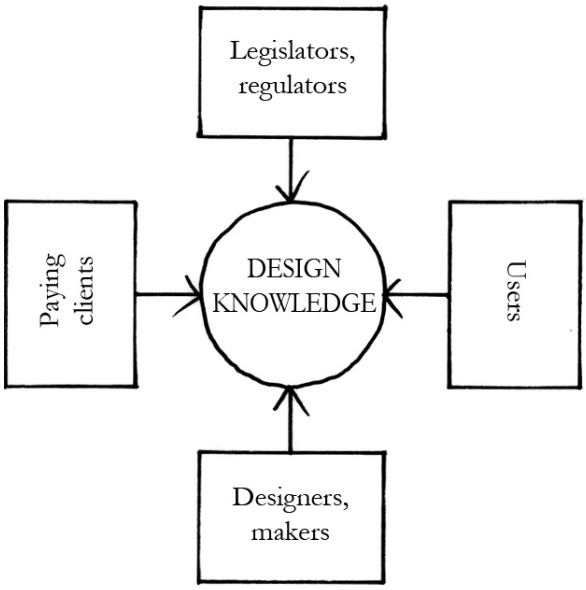


Fig. 25 Bryan Lawson, components of design knowledge constituting at the same time the sources of its restrictions

It should be added that in the design project described in Chapter VI conducted using the charrette method, future users are not a passive audience, only commenting on the results of the team's work, but become its active members taking part in designing (in which drawing as a communication medium is particularly helpful). This is the basic principle of the charrette workshop, and more broadly speaking: of the public participation itself.

Each participant represents both a source of design knowledge (Fig. 25) and a source of restrictions, because he/she examines the solution in the light of law regulations, engineering, utility, ecology, etc. These constraints do not only restrict designers, but can also have a positive impact on their work, by narrowing the area of creative exploration, which sometimes makes the design take on an interesting, non-standard form.

IV. 2 Features of a design problem

Vinod Goel presents the most common features that characterise the problems faced by designers (Goel 1995, 85–87):

1) Availability of information. Neither the initial state nor the goal state of the problem have been fully specified; the set of operations to be carried out to move from one

state to another has not been specified either. The design problem is an ill-defined problem (see pp. 65–66).

This has been confirmed by the research study carried out by Ömer Akin, who notes that it is not possible to fully include the complexity of the problem in the design brief; hence the initial state needs to be subject to constant clarifications during the work process. In designing, it is desirable to find new ways to solve the problem, which is in contrast to well-defined problems, in which it is not expected that the originally established operation set will be changed. What is more, each designer has a self-developed, subjective apparatus assessing the correctness of both the undertaken actions and the goal state. The assessment of the final form of the design may also be mutable – architects often admit after some time that they would design an object differently than what they had done at the first attempt (Akin 1986, 21).

2) Nature of restrictions. They are usually two-dimensional. The first type – nomological restrictions – consists in the necessity to observe the laws of nature. The second type is connected with social, political, legal and economic restrictions which, in contrast to the nomological ones, are subject to negotiations.
3) Size and complexity of problems. Design problems are generally large scale and complex and that is why their solving is time-consuming.
4) Components. Complex design problems are composed of parts whose composition is not easy to read from the structure. Their prime factorisation depends on the designer's experience and practice.
5) Linking of parts. The components of the design problem are not logically interlinked; however, some dependencies of a different nature occur.
6) Correct and incorrect answers. There are no accurate or inaccurate answers to the design problem; only better and worse answers.
7) Input and output data. The input data contains information about the object's users, the goals to be achieved and the ways in which the design would be implemented. Output data is the specification (detail design) of the object. Functional information results from the relations between them.
8) Feedback. During the work, designers do not receive real feedback from the future users. They must simulate and anticipate the potential reactions of the object's users. The real feedback is given only when the object appears in the material form as

a building; this feedback, however, cannot change the design anymore, it can only impact the shape of the designer's next work.

9) Costs of errors. A design error is fraught with the risk of incurring considerable costs.
10) Independent functioning of the object. The designed object must fulfil its tasks without the designer's involvement.
11) The difference between the object specification and its reception. The detail design differs from the process of object specification and its reception.
12) Temporary separation between the object specification and its reception. The detail design precedes the process of object specification and its reception.

The charrette method (see VI. 1) represents one of the manners to deal with the disadvantages of the above-mentioned features. It helps to gather output data (1, 7), deal with restrictions, especially those subject to negotiation (2), and above all to receive feedback, still during the designing stage (8) which impacts the finding of a compromise, and therefore stands for less expensive changes (9).

A BIM system that integrates data (1, 7) has a similar effect, facilitating overcoming constraints, especially nomological ones, which are easier to describe numerically (2), highlighting components (4) and connections between them (5), reducing the cost of possible errors (9), enabling control of the functioning of the completed object (10) and reducing the gap between the object specification and the object itself (in its physical dimension) (11).

IV. 3 Design phases

Fig. 26 shows two schemas of design phases, from the beginning of the design process to the start of the production of technical documentation: 1) created by RIBA (Royal Institute of British Architects) and juxtaposed with it 2) model by Vinod Goel (Goel 1995, 190).

The Goel model begins with problem structuring consisting in extracting information from long-term and external memory (notes, books, building codes, etc.). The initial state, goal state and the set of operations (see p. 65) – design activities – are subject to refinement. This stage is based mainly on the design brief provided primarily by the investor and corresponds to the first stage of the RIBA model. The next step is the transition to problem solving, and to preliminary design in the first place. The analogous stage in the

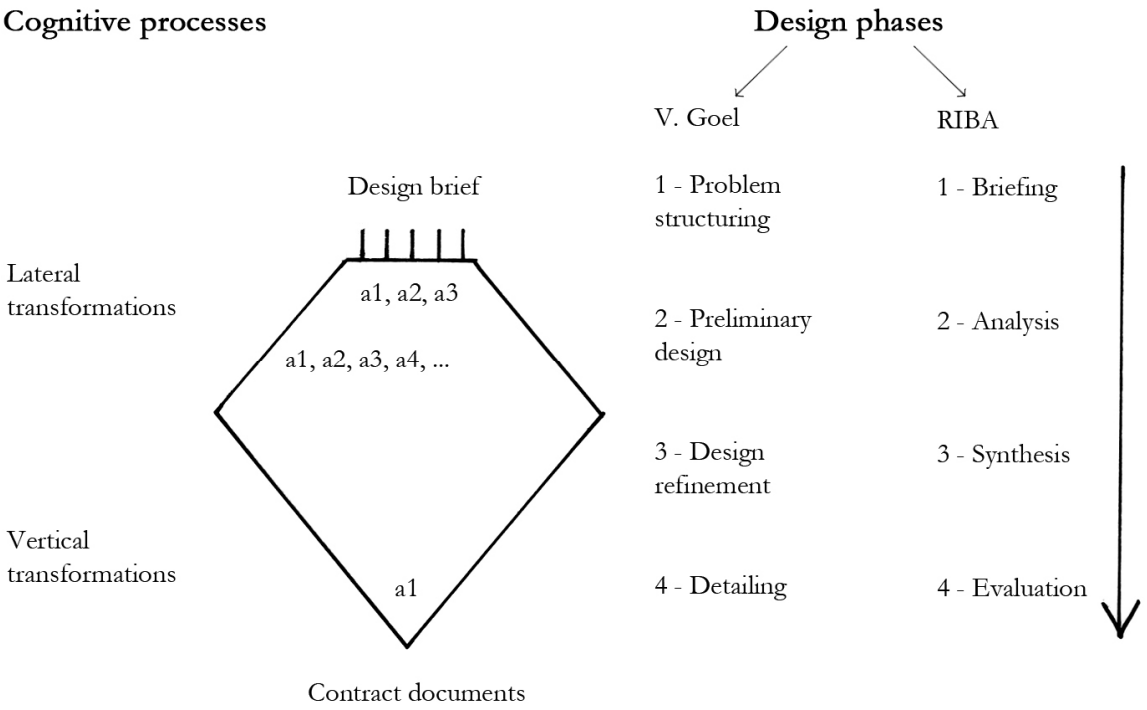


Fig. 26 Vinod Goel, cognitive processes juxtaposed with design phases

RIBA model is the analysis. The processed data is of a very general nature. At this stage, precedents (defined on p. 89) may come to the fore, requiring adaptation to a given project. Lateral thinking leads to lateral transformations, and thus to considering alternative ways of thinking. The design refinement (according to RIBA: synthesis) and detail design (according to RIBA: evaluation) represent more structured phases. Vertical transformations resulting from vertical thinking lead to deeper understanding of the design problem and the design solution refinement (op. cit., 125–126).

Robert Knauer presents a similar division: design begins with finding a concept, refining it in the form of a preliminary design, proper design, presenting it to be examined in the light of law regulations, detailed executive design and further design refinement (Knauer 2002, 9).

Both the RIBA and Goel models contain a linear and directional sequence of the design process phases – an idealised state. In fact, design often consists of cyclical and repeated activities, not always following the logical order of actions. The stages can also take place simultaneously, connect or change the order (which can often result in errors). Lawson sees this process as ‘a kind of negotiation between problem and solution, and that

problems are not necessarily understood by designers in advance of them generating solutions' (Lawson 2004, 90).

IV. 4 Specificity of design thinking

Reflections about the design process should be deepened by quoting the schemas of the course of creative searches that may occur during the designing phase. It should be borne in mind that these diagrams simplify the process which takes on an individual form in case of each of the designers. Despite this fact, the researchers find some recurring configurations of actions which may occur. They result primarily from the fact that the human brain is not able to process simultaneously an infinite amount of information, thus it uses certain strategies of action.

The definition of design by Horst Rittel, quoted by Christian Gänshirt and describing it as an iterative process of production of changes and restrictions, corresponds the most to the circular model, assuming a return to previous assumptions, confrontation with obstacles and the changes resulting from the above. To reduce the number of unnecessary and incorrect concepts, Rittel recommends the design work which takes into account these restrictions (Gänshirt 2011, 65–66). The circular schema has also been described by Peter Szalapaj, who distinguished two important factors that occur in the design process: analysis and expression (Szalapaj 2005, 7). They interweave in a process called 'ETC' by McKim, where 'E' stands for expression, that is, the expression of design ideas, 'T' – for their testing and evaluation, and 'C' – for the cycle in which these relations take place (McKim 1980, 135). The schema describes a process in which there is continuous progress – inferior solutions are being replaced by better ones in the testing and evaluation process (Fig. 27E).

Rittel, quoted by Gänshirt, also proposes other linear diagrams (Fig. 27A–D) adding that the completely rectilinear model (Fig. 27A) only corresponds to the work of great masters, who have experience which allows them to solve, step-by-step, problems which had previously been solved several times (Gänshirt 2011, 65–66). Michał Suffczyński, based on Peter Rowe's, Donna Herbert's and Władysław Fuchs' works, presents three models: network (Fig. 27F) and the aforementioned: linear (Fig. 27D) and circular (Fig. 27E) (Suffczyński 2008, 86).

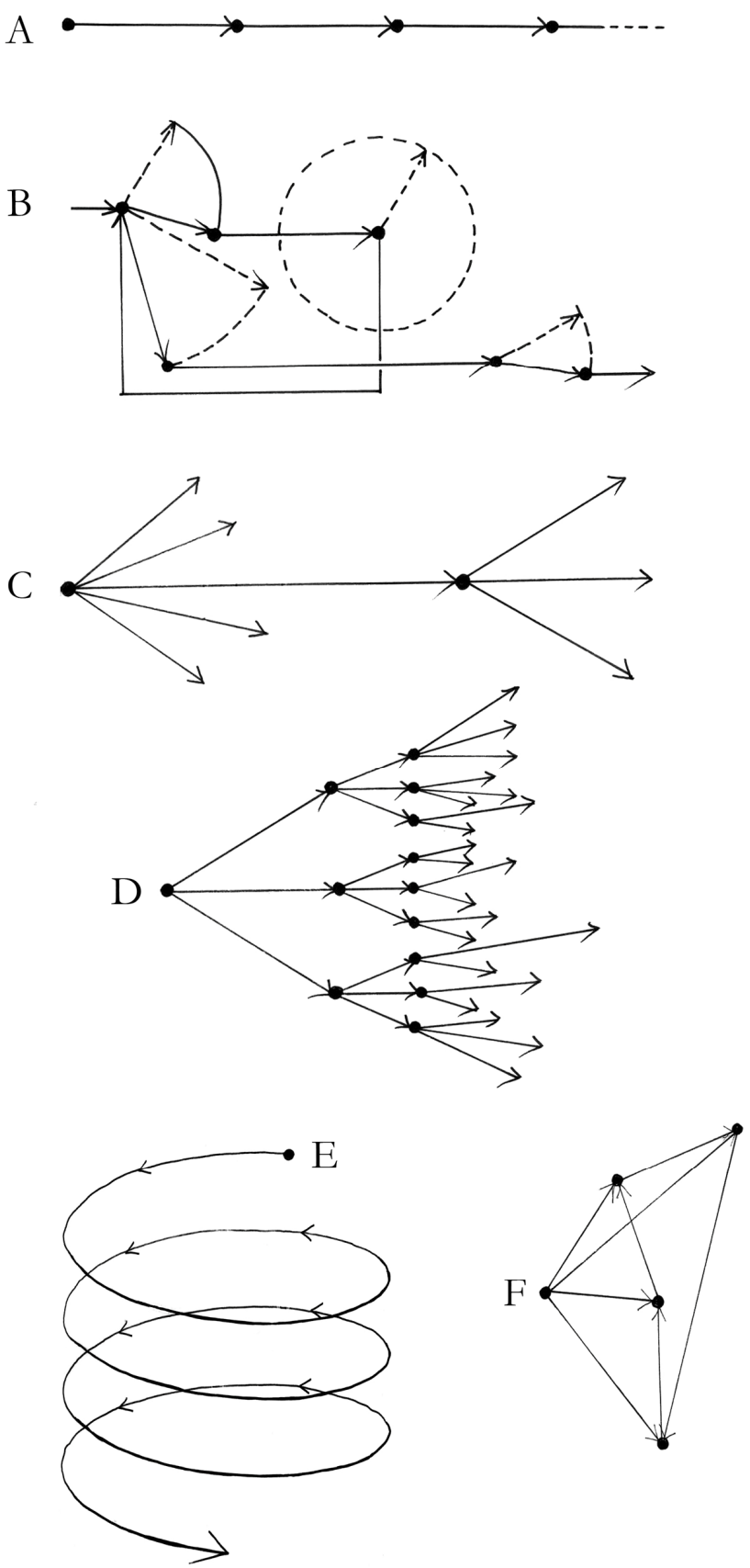


Fig. 27 Design thinking schemas

Horst Rittel: A – linear, B – linear: scanning, C – linear: creating alternatives and choosing from among them, D – linear: multilevel study of alternatives;

Peter Szalapaj: E – circular; Peter Rowe, Donna Herbert: F – network

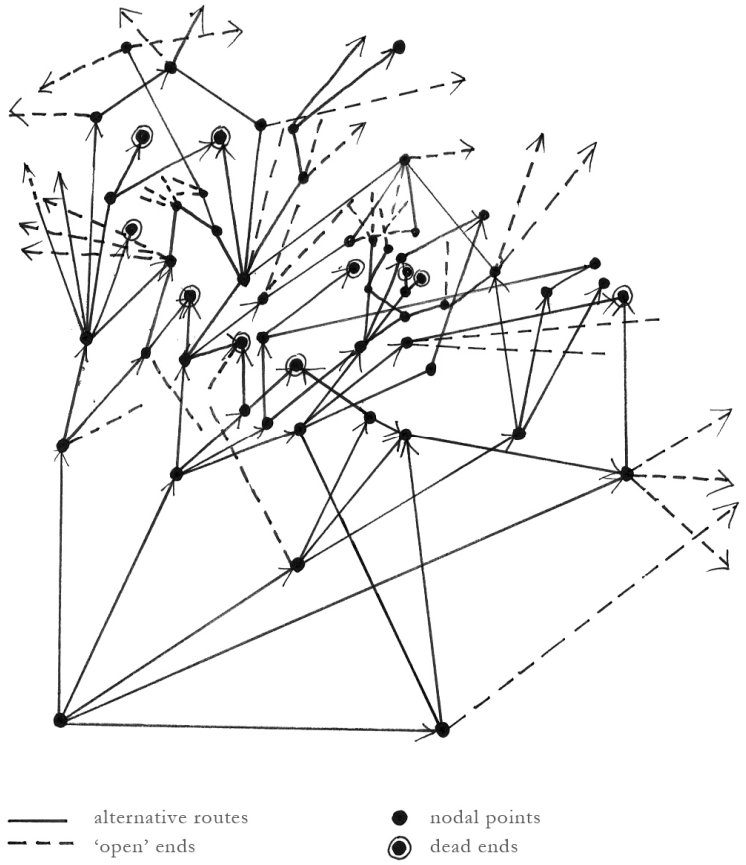


Fig. 28 Anton Ehrenzweig, 'chart for creative scanning'

Juhani Pallasmaa introduces Anton Ehrenzweig's 'chart for creative scanning', which after closer analysis can be considered as a combination of four linear schemas and a network schema (Fig. 28). Pallasmaa adds: 'A creative insight in architecture is rarely an instantaneous intellectual discovery (…) neither is it a linear process of logical deduction. (…) Design is a process of going back and forth among hundreds of ideas (…)' (Pallasmaa 2009, 107–108).

This model is consistent with the research studies carried out by Gabriela Goldschmidt, who writes: '(…) the trajectory the designer follows is not necessarily linear or hierarchical. There is no logical sequence of decisions which stem from one another, nor are concepts firm or even consistent at an early phase (…) it seems that the sequence of arguments within a complex move is not critical'. (Goldschmidt 1991, 126–127) Designing may include a classical method of direct solving of specific problems by deductive or inductive reasoning (see p. 65); in its entirety, however, it is a holistic process in which it is often difficult to determine which element of the proposed object solves which specific problem. In addition, the breadth of knowledge that a designer must

acquire in order to arrive at a satisfactory solution is practically unlimited (Goel and Pirolli 1992), although Ömer Akin notes that dividing design activity into stages gives the possibility of a partial description of architectural knowledge and the logical sequence of actions occurring in these sections, what has been confirmed by his research studies (Akin 1986, 174).

Nigel Cross emphasised the complexity and the unique specificity of the thinking process that takes place during design, which the author called the 'designerly ways of thinking'[41] (Cross 1982). Its existence results from the specific nature of the design problem (see IV. 2). Ömer Akin's research studies have shown that the design path of reasoning combines both intuitive and rational actions. Furthermore, it requires the ability of storing vast amounts of seemingly unrelated information and extremely rapid data manipulation (Akin 1986, 173–176).

Theoretically, in design, each of the above-mentioned decision-making processes may occur in an independent form or in conjunction with another schema. It seems that the situation most suited to the specificity of the designerly ways of thinking has been described in Ehrenzweig's model. It assumes numerous alternative ways that are the result of lateral thinking, which is crucial in design. The schema also foresees dead ends, i.e. failed attempts. Repetitive returns to previous thoughts and concepts, elaborating on them and fleshing them out further are necessary, because design often does not start with a precise formulation of the problem, and the design solution is often difficult to assess, using the zero-one method, as good or bad. Different architects can propose different solutions and, theoretically, each of them has a chance to meet the investor's requirements.

The awareness of such a complex and diverse nature of the processes occurring during designing, their limited predictability and possibility of description is an important starting point for reflection about the place of freehand drawing in design.

[41] Cross classifies the 'designerly ways of thinking' as a specific type of intelligence, design intelligence, referring to several types of design intelligence distinguished by Howard Gardner (Gardner 1983). According to Cross, the aspects of design intelligence are broken down into various types of intelligence from among those distinguished by Gardner, but he did not specify into which (Cross 2011, 135). It can be assumed with certainty, however, that logical-mathematical and visual-spatial intelligence are included in a range of qualities useful for architects and urban planners.

V. FREEHAND DRAWING IN THE ARCHITECTURAL AND URBAN DESIGN PROCESS

From the presented definitions of the architectural drawing, its basic information function emerges. The information provided is the design thought (otherwise known as the design idea). This chapter aims to show its 'journey' through the design process, recorded in the form of drawings.

According to Krzysztof Koszewski, the drawing in design appears 'to record, to convey, to understand' (Krzysztof Koszewski, 2 February 2017, 3:30). At the initial stage, it helps in the reception, remembering and active processing of stimuli from the outside world, for example during plein air workshops or travel (V. 1 Record of 'pre-thoughts'). The use of drawing before designing has been included in this subchapter – as a medium preparing for creative thinking and building a 'database' from which architects draw their inspiration in design. The next stage – proper designing – serves to reproduce recorded and understood information and create new ones (V. 2 Record of thoughts). Drawing is also helpful in communicating with the project team (i.e. in the charrette process understood more broadly: including all people willing to take part in the workshops and co-design) and outside of it, as well as in creating an attractive message at the stage of 'selling' the design (V. 3 Transfer and presentation of thoughts). Subchapter V. 4 also includes a look at the architectural drawing as at an autonomous creation which often has high aesthetic values and the status of a work of art; finally the influence of freehand drawing on the position of the designer in the design process has been discussed (V. 5).

The chapter reveals the dual nature of architectural drawing understood as a cultural act and a basic tool for communication. Edward Robbins expresses the view that it is more important in this second social dimension (Robbins 1997, 5–8, 29–35). It seems to be right, because most often it is not a finite creation and depends only on a single creator. It is created in order to convey a specific message, the reception of which may lead to a discussion and transform the design. Drawing understood as a cultural act, thus enabling the designer to shape his/her thoughts individually, is associated with a sense of freedom of creation (especially when these are creative visions, see V. 4). On the other hand, as a social act, drawing limits this freedom because it is a medium that exposes the effects of the architect's actions to criticism and to confrontation with limitations.

V. 1 Record of ‘pre-thoughts’

I encountered the following phenomenon many times in my didactic experience when teaching drawing: a student who was asked to draw a composition of objects from nature, after photographing an object, begins to make a drawing based on the picture, not looking at the actual model. This obviously contradicts the task (the reason why – it has been explained in this subchapter) and after pointing that out to him/her, he/she ceases to do so. But the phenomenon itself that appeared relatively recently along with the era of smartphones is interesting and disturbing at the same time. It points to the perception based on two-dimensional views, which is dominant in the present world. The ‘pictorial’ society is the result of, above all, the development of digital technologies – the Internet, along with advertising, social networks, multimedia etc. For a young student of drawing, brought up among computers offering two-dimensional images, it is easier to copy a ‘flat’ image from the smartphone screen and onto a ‘flat’ sheet of paper. It is clearly more difficult to perceive the real task posed before such a student – and he/she is right, because the transformation of three-dimensional space into two-dimensional requires much more advanced mental processes, partly described in Subchapter III. 2.

The ‘pictorial’ culture results, among others, from the fact of collecting virtual and not real experiences. In this subchapter, the issue of experiencing real space – by 1) future designers – at the stage of education and 2) designers – at the preliminary stage of getting to know the context, or programming or structuring the problem (see IV. 3) – has been discussed in detail. Analysing the real space is extremely important for architects and urban planners, because it is within the space that the implementation of design projects is being made. With respect to visual perception, it has been described how freehand drawing supports active and analytical perception, which is a condition for future good design.

V. 1. 1 Teaching freehand drawing and visual perception

Drawing requires above all perceptual skills – it is a conscious vision, ‘seeing’ what people tend to just ‘looks at’ every day. Paradoxically, in order to learn how to draw, manual skills colloquially referred to as ‘drawing’ skills are necessary only to a limited extent.

Betty Edwards distinguishes five basic perceptual skills that account for the ability to draw. It is the perception of 1) edges – also those common to several objects, 2) spaces – so-called negative space or the inverse one (Fig. 29), 3) relationships – perspective and

proportions, 4) lights and shadows, 5) the whole – objects in space as a holistic phenomenon (Edwards 1999, 96). The fifth point is due to the mastering of the four preceding ways of perception. The right hemisphere that works holistically makes the drawing – which like walking, skiing or reading – once taught, will never be forgotten.

One can notice how many of the aforementioned processes which organise visual perception, discussed in Subchapter III. 2, have been included in these five skills Edwards listed as necessary for the illustrator. The perception of the edges determines the division into regions and the separation of the figure from the background; the latter can be obtained by marking the negative spaces. The third and fourth perceptual skills distinguished by Edwards make the perception of depth, i.e. the use of perspective and proportion, as well as the correct perception of lights and shadows possible. Spatial and temporal integration results from the perception of the whole of the visible and is the result of the remaining four stages of initiation into drawing.

Drawing is therefore a record of processes organising the perception.

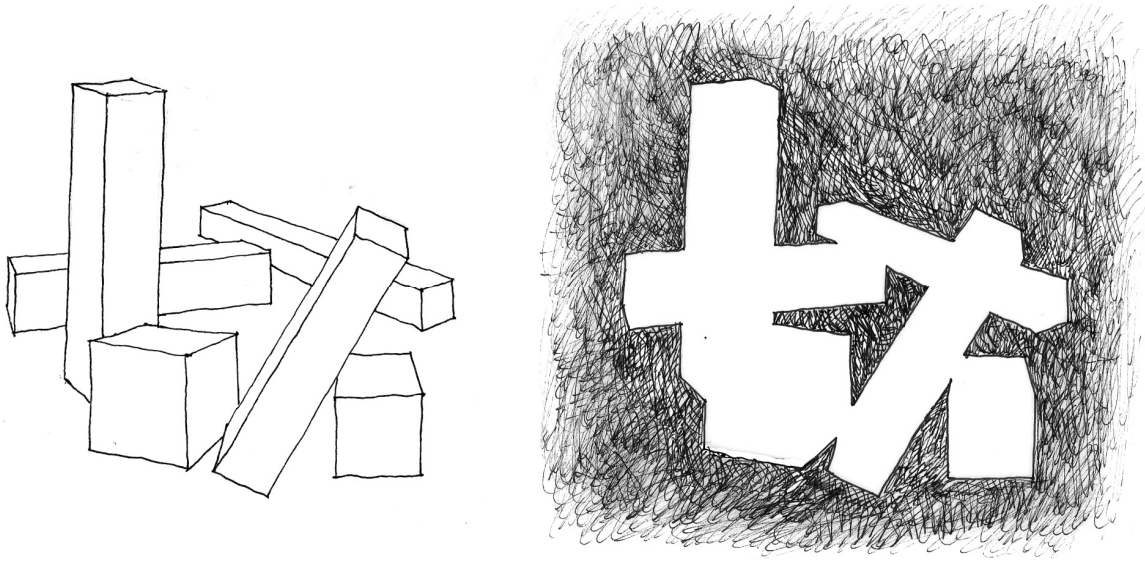


Fig. 29 Negative / inverse space (on the right) contains everything that surrounds drawn objects;
its distinction allows the draftsman to activate the right hemisphere, focus only on the observed shapes, not on the 'content' of the object, and thus eliminate the influence of the left hemisphere, which is responsible for symbolic vision.

The basic problem in the science of drawing is the dominance of the left hemisphere, which tells illustrators to use symbols instead of reproducing what they actually see in front of them. Symbolism is associated with age (Fig. 30 and 31), but it can also be the effect of the context and perceptual set (see pp. 61, 115 and Fig. 49). The use, in drawing, of the schema reflecting the knowledge about the stimulus, i.e. the object, effectively

interferes with drawing from nature. As a result, drawing for example a portrait from the profile contains the view of an almond-shaped eye, as if the face was seen frontally. The left hemisphere encoded this most characteristic information about the shape of the eye, which resembles the Egyptian perspective (see p. 33 and Fig. 7). Due to this part of the brain, there is a discord between the proximal stimulus and the distal stimulus. The same phenomenon occurs in the aforementioned example of a picture hanging on the wall, seen at an angle (Fig. 22). Following the logical reasoning of the left hemisphere, the picture should be drawn as a rectangle, according to the observer's knowledge about the rectangularity of the picture – conceptually controlled top-down processes. The science of drawing consists in reducing the impact of the left hemisphere and on activating the right one. If this turns out to be successful, then understanding at the stage of perceptual organisation (when the trapezium is seen as a rectangle), and then the identification and recognition of the object, will not dominate the actual image created on the retina of the eye at the reception of sensations phase. Drawing and teaching people to look and see the real visual attributes of the surrounding world allows to capture this image (in the case of a picture on the wall – a trapezium).

Sketching provides an opportunity to deliberately switch modes of thinking from logical-verbal, based on the functioning of the left cerebral hemisphere, to the visual-spatial, associated with the right cerebral hemisphere. This involves a different type of processing the incoming information (see p. 62).

It is worth pointing out once again that developing basic drawing skills is not about drawing lines more efficiently, but about improving perception. Perception, on the other hand, involves the understanding of what is seen and the difference in the view of an object (perceived thanks to controlled bottom-up processes) from the object itself (recognised by means of conceptually controlled top-down processes). Mirosław Orzechowski emphasises: 'Drawing – being the result of a full and closed process of perception regardless of the premises that formed the basis for its creation – allows to analyse the perception itself as a set of processes leading to the knowledge about the surrounding world.'[42] (Orzechowski 2015, 39)

[42] 'Rysunek – będąc efektem pełnego i zamkniętego procesu percepcji niezależnie od przesłanek, które stanowiły podstawy jego powstania – pozwala na dokonanie analizy samej percepcji jako zbioru procesów prowadzących do poznania otaczającego świata.' (translation into English: Monika Fryszkowska)

The term of ‘pre-thought’ was intended to point out that design thought does not appear out of nowhere. It results from the earlier collection of experiences, possible mainly due to visual perception. Building this ‘database’ requires active reception, remembering and processing of what has been seen – phenomena aided by freehand drawing from nature.

V. 1. 2 Reception

Such basic action as contact with real and ‘tangible’ space when drawing, marked in recent years by technological changes, has gained additional significance. It helps to detach from the images offered by the media and to focus on the surrounding living environment. In order to understand the value of this experience, it is worth quoting the division introduced by Kazimierz Bartel. He distinguished real objects from visual ones. The existence of the former is absolute, and their features can be determined objectively by measuring them. In contrast, the visual objects are relative and subjective, resulting from the individual’s internal experience (Bartel 1958, 8). Starting from the concepts of the real and visual object, the author suggested the existence of an analogous – real and visual space.

> The property of the real space is determined by the Euclidean geometry, according to which this space is unique, three-dimensional, infinite and homogeneous. In its infinity, it can only be conceived, but never seen; when we want to relate the sense of sight to it, we are forced to consider only its p a r t.[43] (op. cit., 11)

This ‘part’ builds the visual space – perception – perceived individually by every human and being subject to the laws of physics, atmospheric conditions, observer’s moods and other factors modifying its reception. The division made by Kazimierz Bartel can be combined with the division into the physical (mathematical) and existential space proposed by Juhani Pallasmaa.

> Existential space is structured on the basis of meanings and values reflected upon it by an individual or group, either consciously or unconsciously; existential space is a unique experience interpreted through the memory and experience of the individual. On the other hand, groups, or even nations, share certain characteristics of existential space that constitute their collective identities and sense of togetherness. The experimental lived space, not physical or mathematical space, is the object and context of both the making and the experiencing of art and architecture. (Pallasmaa 2009, 128)

[43] ‘Własności przestrzeni rzeczywistej określa geometria Euklidesa, według której przestrzeń ta jest jedyna, trójwymiarowa, nieskończona i jednorodna. W swej nieskończoności może ona być tylko pomyślana, ale nigdy widziana; gdy chcemy odnieść do niej zmysł wzroku, zmuszeni jesteśmy uwzględniać tylko jej c z ę ś ć.’ (original spelling, translation into English: Monika Fryszkowska)

The design projects are implemented in the visual, i.e. existential space, although design itself takes place mostly in the real, i.e. mathematical space. Understanding this discrepancy is an important element of a good, conscious and respectful design context. Drawing from nature is an instrument which is helpful in becoming acquainted with the visual space. It triggers an accurate observation of the environment in time: changing light, colours, people's behaviours, the atmosphere of the place etc. and makes the observer aware of how many factors the designer must take into consideration – completely different from the numerical data (area, distances from the parcel edges, heights, etc.).

The drawing from nature at the stage of gaining knowledge and gathering experience intensifies the process of perception, although it is worth noting that not all authors need a drawing record to consciously perceive the environment (see p. 102). The importance of forming the experience at the pre-design stage was emphasised by Juliusz Żórawski (Żórawski 1973, 135). He expanded the terms he created: 'cohesive form' and 'free form', by adding: 'cohesive situation' and 'free situation'. The author regarded the cohesive situation as an event shaped according to certain rules, with a specific order and sense, and an active character, directed at a specific goal. He also introduced the term 'the field of internal state', occurring between the receiver and the subject of sensations which, according to Żórawski, interact with each other. According to the author, 'a mature individual is all the more valuable as the more his/her field of internal state is clearly shaped by numerous totalities, strongly different in character, rich in parts and distinctly cohesive.'[44] (op. cit., 138) It is valuable to capture the totality of the situation that one is experiencing. Żórawski emphasised the role of contemplation whose autonomous character he saw as a condition for deepening the sensitivity and knowledge (op. cit., 157). Drawing benefits from the record of perceptual processes in the form of a drawing is conditioned upon making it [a drawing] from nature. Plein air workshops fit into the definition of a cohesive situation proposed by Żórawski: it is an action with a specific cause and purpose, composed of necessary steps. All the senses, not only vision, take part in the reception of the environment. The illustrator creates his/her experiences based on a lot of information. In this way, he/she has a chance to develop his/her perception, hence the active perception, while in parallel acquire some progress in drawing skills.

[44] 'dojrzała jednostka jest tym bardziej wartościowa, im jej pole stanu wewnętrznego jest wyraźniej ukształtowane z licznych, silnie odmiennych w charakterze całości, bogatych w części i dobitnie spoistych.' (translation into English: Monika Fryszkowska)

The process of developing perceptual abilities depending on the age is shown on the example of two themes performed outdoors during family drawing workshops: 1) shed in the garden painted blue (Fig. 30) and 2) a historic wooden church in Lachowice (Fig. 31). Drawings of the youngest children aged 4–6 years old are of a narrative nature (Fig. 30A and 31A). They record the spotted shape which is the most important for the child, the change of materials, the colour and detail which for some important reasons was distinguished from others. The following drawings manifest clearly the development of the children's stage – symbolic drawings made by children aged 7–10 (Fig. 30B and 31B). They do not take into account the three-dimensionality of objects, and the emphasis has been placed on details – the children have attached importance even to the smallest details. The elaborated drawing schemas helpful in recording what has been seen and in transmitting information to receivers are noticeable. Figures 30C and 31C drawn by children aged 10–12 demonstrate changes in spatial vision – the shed got a sidewall which proves that children started noticing the three-dimensionality of the objects.

The next stage of this development has been shown in the drawing in Fig. 31D, made by a fifteen-year-old girl who managed to render the horizon line with great accuracy and draw lines that converge in perspective. It helped her to perceive the depth which she rendered through the overlapping of plans – the roofs and church towers.

The awareness of the existence of natural drawing stages occurring in parallel with the development of a young person is a necessary starting point for further considerations related to the usefulness of drawing in adult work – at the pre-design stage. The phase of the drawing record which takes into account full spatial vision with noticing proportions, depth and perspective does not always come automatically with age. Five drawings made by adults (Fig. 30D–F and 31E–F) differ in the degree of reflecting the reality. Symbolic vision still exists, e.g. in the form of a tree, the trunk of which is visible in its entirety (Fig. 30F and 31F), as is usually the case in children's drawings or in the approach to details (Fig. 31E). Errors also affect the perspective. The height of the shed was about three meters from the ground to the roof ridge. As it was situated on a flat surface, it could not have been perceived by the seated illustrator from above, as shown in Fig. 30D. This incorrectness consisting in positioning the horizon line too high is characteristic of children's drawings (Fig. 30C). The same error can be found in Fig. 31E (balustrade of arcades) and Fig. 30F (the door and the frontage of the object), although to a lesser extent.

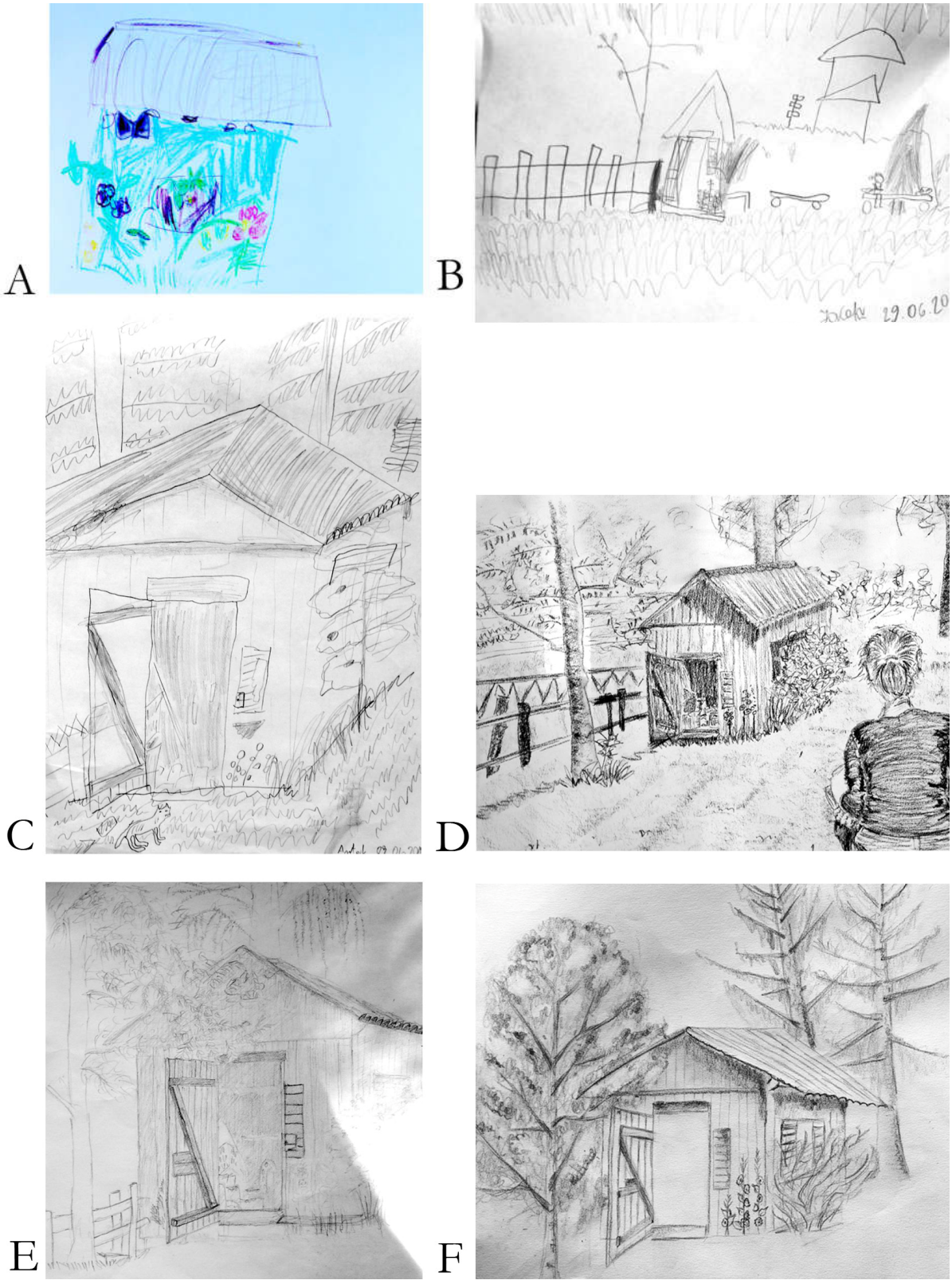


Fig. 30 Drawings depicting the shed made by participants of family workshops of various ages, 2017

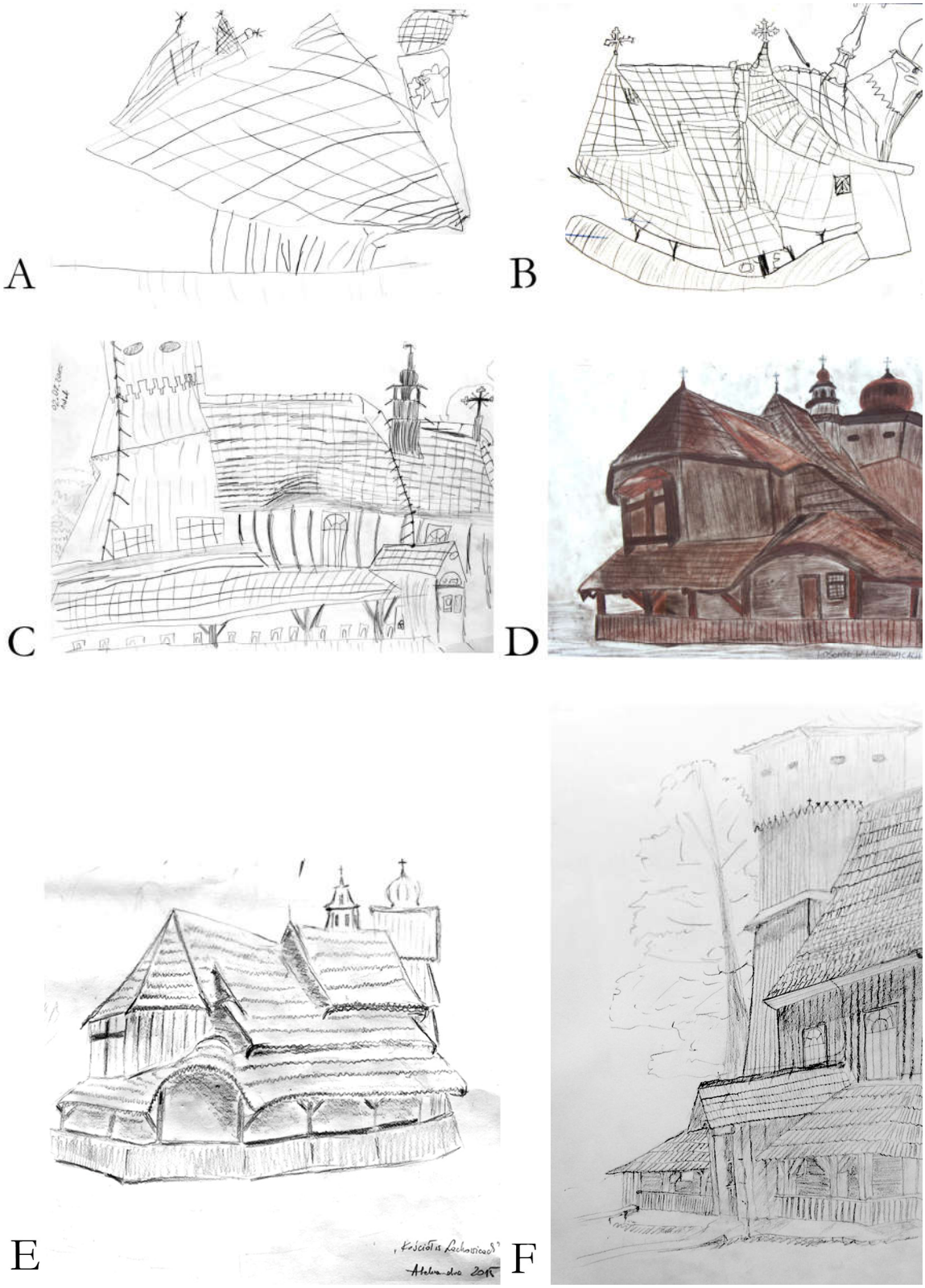


Fig. 31 Drawings depicting the church in Lachowice made by participants of family workshops of various ages, 2017

Drawings made by adults are characterised by greater awareness of the phenomena occurring in the environment: chiaroscuro, linear and aerial perspective, but the schematic record still appears. The drawing workshops during which the presented paintings were created were aimed at limiting the use of symbols in favour of the observation of real shapes and colours. The experience in conducting this type of plein air workshops allows me to state that in many cases there is progress in the perception of space which is visible in the drawings. An example is represented by Fig. 31F – a drawing made by an adult who had already participated in several similar workshops.

There are people who exhibit truly innate drawing abilities, and therefore perceptual abilities; they draw much better without studying than people who learn drawing skills though make slow progress in many cases. In such cases, they can feel discouraged and demotivated to use this medium. But in most cases, although drawing is a natural activity known to every person since their childhood, the conscious use of a pencil or a crayon comes only with practice. Mirosław Orzechowski maintains, however, that everyone can learn to draw, to a greater or lesser degree of perfection (Orzechowski 2010, 12). It is worth noting that especially for architects and urban planners, the path to achieving better drawing results is valuable – that is, a deeper perception of relationships between objects and their surroundings.

Photography constitutes a variant of visual records, but characterised by different properties than drawing. Here below are those features which, confronted with drawing, explain why photography cannot be called an alternative drawing medium.

The essence of drawing from nature is the occurrence of the above-mentioned cohesive situation which guarantees the active formation of sensations. During sketching, at the stage of education or learning the design context, the incoming data transformation processes are taking place (see Fig. 22), processed by the complex system of interrelated eyes, brain and hands. Not only is the clear record of what has been seen created, but also – by drawing – the author creatively interprets the information obtained. By then, the first associations and ideas have arisen that can be used at a later stage of design. The draftsman chooses drawing tools – this decision also imparts individual characteristics to drawing. Specific attributes of the individual come to the forefront. Drawing can have a metaphorical and symbolic meaning which is also captivating in many artistic photographs. Architects, urban planners, as well as students of these faculties use photography and sketches primarily for utilitarian purposes – to understand and remember what they have

seen. And hierarchisation plays an important role in this activity. In order to select the issues which are either more or less important, what is needed is time. In the era of digital photography, the time devoted to taking a photo is extremely short, and the object of interest often changes immediately afterwards. Rarely is there time for a valuable contemplation of places and events which Juliusz Żórawski wrote about. Bogdan Dziworski, cinematographer, photographer and director, notices:

> Having constant access to the smartphone camera, people can take photos everywhere, regardless of the light and weather conditions, but there is no reflection, no selection, and so very few of these photos will last longer. When people had access to the analogue material – a negative which was quite expensive, it was necessary to save, to consider whether it is worth to take a picture. Even though I shoot films, using a digital camera, I still take photos on film. I do not need to take a thousand pictures, I need 10, 15. Analogue forces me to think.[45] (Sańczuk 2017)

Bryan Lawson linked the development of cheap and easily accessible photography with the fact that architects make 'experimental drawings' quite rarely. These sketches showing the context, but also loose associations, lead Lawson to the emergence of 'experimental knowledge', directly related to the knowledge needed for design (Lawson 2004, 39) (Fig. 32). It does not arise from the imitation of the observed reality, because, as Louis Kahn

Fig. 32 Adam Sufliński, Pantheon, outdoor sketch;
drawings made during travel may be included to the group of experimental drawings.

emphasised, there is no place for imitation where creation occurs. Kahn sees sketching as a 'language of self-expression', adding that 'The more one looks, the more one will come to see.' (Kahn 1991, 11)

One should return now to the problem indicated at the beginning of the subchapter and related to creating a drawing from a photo. The thinking processes that take place during such an operation differ from those occurring while drawing from nature. The real distal stimulus is replaced by a photo. No effort is needed to process spatial sensations (see p. 61 and Fig. 22) or convert them into a two-dimensional image. This is done, by cutting corners – a 'flat' picture is turned into a 'flat' drawing. No complex – binocular or monocular – visual processes responsible for depth perception take place. There is just one image available – taken from a specific place at a given time, so there is no spatial or temporal integration which allows the construction of the environment from its segments within the field of view. This problem has already been noticed by Kazimierz Bartel who emphasised the complexity and relativity of constructing perspective views. He was in favour of observation and advocated that every painter or draftsman should meet the task of creating his/her own system reflecting perceptual phenomena. He was opposed to absolute fidelity to the top-down strict rules of geometry. Kazimierz Bartel – presenting the principles of curvilinear perspective, in which the images of horizontal lines are represented as curved lines, and the principles of collinear perspective, in which straight lines are preserved as straight lines – added at the same time that 'both [systems] will appear to us, let us say, unnatural, that in both we will feel an exaggeration in emphasising their characteristic features.' (Bartel 1958, 173) Then he referred to the research studies carried out by a German mathematician, Guido Hauck:

> The impact of photography on the increased sense of collinearity is growing from generation to generation. Hauck, however, believes that there is a tendency to transgress the principle of collinearity among the artists of all times. (…) Hauck vigorously opposes the school-like pettiness; he speaks against the dilettantism and its limitations which honours photographic accuracy and fidelity as the supreme triumph of art and attempts to hold free artistic creativity within the limits of a geometry template.[46] (op. cit., 176)

The understanding of the space by an architect or urban planner cannot take place in their absence. A drawing from a photo often leads to the misinterpretation of the features of the

[46] 'Wpływ fotografii na coraz większe umocnienie poczucia kolinearności rośnie z pokolenia na pokolenie. Hauck jednak uważa, że u artystów wszystkich czasów zauważyć można skłonność do przekraczania zasady kolinearności. (…) Hauck występuje energicznie przeciw szkolarskiej małostkowości, wypowiada się przeciw dyletanckiej ograniczoności, która czci fotograficzną wierność jako najwyższy tryumf sztuki i waży się na trzymanie wolnej twórczości artystycznej w pętach geometrycznego szablonu.' (translation into English: Monika Fryszkowska)

presented objects. Photos can differ in quality and resolution. There can be fragments that are out of focus or too dark to get information out of them, which often leads to the distortion of reality. This is especially visible in the drawings made on the basis of blurred photographs, when the author 'adds' some invisible elements himself/herself. This type of drawings can therefore only be made by experienced artists for specific purposes, e.g. in the process of visualising a design.

V. 1. 3 Remembering

Objects once drawn from nature can be drawn from memory at a later stage. This results from the functioning of the episodic memory, which allows to link the remembered information with the drawing activity, from the method of extracting information by recognising the previously perceived stimulus and comparing it with the current observation and from the phenomenon of context dependence, if the same conditions shall occur at the moment of retrieval which occurred when remembering (see III. 3).

Betty Edwards distinguishes the ability to draw from memory as the sixth, additional perceptual skill, juxtaposing it with the five remaining basic skills of drawing. When it comes to the degree of difficulty, Betty Edwards ranks it higher than the five basic skills, as the visual memory must be filled with earlier images. Drawing allows to keep these images in memory and to recreate them at a later stage. This skill can be trained, and visual memory resources are constantly enriched (Edwards 1999, 251). According to Kazimierz Bartel, constructing, and thus drawing from memory (but also from imagination), resulting from the studies from nature, improves poor visual memory (Bartel 1958, 223–224). Drawing is also a type of external memory that one can always return to, thanks to its material nature – e.g. in the form of sketchbooks.

Pursuing various professions involves different parts of the body; in the case of athletes – the entire body, in the case of sculptors – hands, in the case of composers – ears. Architects and urban planners mainly use eyes, but Pallasmaa attaches great importance to hand and the connections between hands and the entire neuromuscular system:

> As I sketch a contour of an object, (…) touch and feel the surface of the object of my attention, and unconsciously I sense and internalise its character. (…), I also mimic the line rhythm with my muscles, and eventually the image becomes recorded in the muscular memory. In fact, every act of sketching and drawing produces three different sets of images: the drawing that appears on the paper, the visual image recorded in my cerebral memory, and a muscular memory of the act of drawing itself. All three images are not mere momentary

> snapshots, as they are recordings of a temporal process of successive perception, measuring, evaluation, correction and re-evaluation. (Pallasmaa 2009, 89–90)

Sketching from nature, therefore, stimulates the episodic memory, building autobiographical events – perceptual experiences of a given individual at a specific time and place. The information drawn from this situation, which Pallasmaa would call existential knowledge, and Lawson experimental knowledge, are more effectively remembered than the 'encyclopedic' data unrelated to the experiences. It can be metaphorically stated that drawing is used to create memories based on real experiences. It has an impact on a more conscious and deeper perception of the environment.

Precedents, important in design and education, are stored in the already mentioned episodic memory which forms part of long-term memory (see p. 64). The precedents stand for images stored in an architect's or an urban planner's memory, to which he or she refers at work more or less consciously. These can be design solutions previously used by this designer or patterns taken from another designer, as well as buildings, details, landscapes or entire urban complexes observed during travel. The most strongly formed precedents result from the recording of perceived environment in the form of sketches – the aforementioned experimental drawings (see p. 86) (Lawson 2004, 96). Designers use analytical thinking only to a limited extent – the accumulated experience allows them to recognise the features of a deeply remembered and understood precedent and to apply it to the currently debated problem. This creates experimental knowledge (it can be compared to the knowledge-in-action described in subsection V. 2. 4), which is the basis for the knowledge needed for design (op. cit., 113). It is worth recalling the earlier controversy related to the impact of the precedent on design on the occasion of the above-mentioned phenomenon of functional fixedness (see pp. 66–67).

Gabriela Goldschmidt also polemicizes against the very notion and significance of the precedent; she emphasises that there are never two identical project situations. The designer does not try to fully converge with the precedent, but rather looks for something similar enough to make it useful. She proposes the term 'precedent' to be replaced with 'reference', which is more in line with the nature of this phenomenon (Goldschmidt 1998). In the dissertation, the term of 'precedent' has been used, because of its wider dissemination; however, it encompasses a broader concept, described by Goldschmidt.

How architects and urban planners see the world, what they pay attention to and what they remember directly affects the proposed design solutions. Perception and memory are

always subjective. This is how individuality and creative personality are shaped, clearly recorded in a sketch about the characteristics of the author's signature.

V. 1. 4 Processing – using

A. Learning the context

The architectural or urban design is always created in relation to the place and is based on integrating new elements into the already existing whole.

Marian Fikus notices that this cannot take place without first knowing the conditions of the building plot. At the same time, based on his own experience, Fikus regretfully notices that superficial preliminary research is very often in his field, sometimes without even the so-called site inspection. He proposes an integrated research method, particularly useful in large-scale design projects, where it is necessary to combine many disciplines. It is based on the selection of landscape and ecological issues from the context, followed by their synthesis and assignment to spatial, planning and architectural classifications. The analysis of the location is to be the result of the 'on-the-spot registration' expressed in a drawing (Fikus 1991, 27). These individual graphic notes cannot be replaced by any other notation way of the environmental aspects (film, photos, inventory, map and its specialised studies, etc.) (op. cit., 35). In the conclusions to the examples of the on-the-spot register, Fikus points out that at the initial stage it is not enough to only analyse the starting materials (maps, geotechnical tests, physiography, properties, etc.) and follow the guidelines of the local spatial development plan or land development conditions. Fikus perceives the enrichment of specialist and interdisciplinary studies with an on-the-spot drawing, made directly on site of the building plot, as necessary Marian Fikus sees this as a prerequisite for the transition to the next phase of design, called by him 'the development of seed programmes' (Fig. 33) (op. cit., 28).

The need for an on-the-spot register is primarily due to the need to know both the material context and the immaterial location/place. The latter is often underestimated and ignored in pre-design analyses, perhaps because it cannot be captured in the form of numerical data. Especially in relation to the immaterial context, the post-factum register is of subjective nature, which is why a tool that helps in its registration must correspond to

this very nature. Apart from drawing, the written or spoken language[47] is such a carrier of individual experiences.

This problem has been pointed out by Kazimierz Wejchert: 'In shaping space, thinking in terms of technology and economics, rather than in terms of aesthetics and human sensations, often prevails. Urban solutions are too often evaluated on the basis of two-dimensional plan drawings, instead of the compositional values of space.'[48] (Wejchert

Fig. 33 Works of the second year architecture students made during workshop in the Institute of Drawing, Painting and Sculpture at the Faculty of Architecture of the Warsaw University of Technology presenting the drawing and painting analysis of the conditions of the site and the development of the seed programme.

[47] The publication titled *Schreiben und Zeichnen als Erkenntniswege im Städtebau* [Writing and Drawing as Cognitive Methods in Urban Design) has been devoted to this topic, and in particular the description of the student literary and graphic seminar held at the Technical University of Dortmund (van Haaren and Schmidt-Kallert 2015, 87–95) and individual graphic records made by Bettina van Haaren who has been documenting the cities she visited for over 30 years (op. cit., 71–83).

[48] 'Przy kształtowaniu przestrzeni często przeważa myślenie kategoriami technologii oraz ekonomiki, a nie estetyki i doznań człowieka. Rozwiązania urbanistyczne są zbyt często oceniane na podstawie dwuwymiarowych rysunków planu, zamiast z punktu widzenia wartości kompozycyjnych przestrzeni.' (translation into English: Monika Fryszkowska)

1984, 242) It is worth considering this issue, bearing in mind that the progress of information technologies is making the recording and use of data about the material aspects of the design much easier, such as the conditions of a given location, e.g. wind and solar radiation, or the assumed features of the object (acoustics, lighting, energy balance, etc.). Their record in the form of parameters and models can directly influence the creative process, opening new paths to ideas (e.g. imitating nature with the use of genetic algorithms). On the other hand, significant savings associated with such an approach entail the risk of the performance criteria predominance – especially inadvisable if it is the only starting point for designing. Thus, the importance of the immaterial and metaphysical dimension of the environment seems to be important to emphasise these days.

Kevin Lynch breaks down the environmental image that gives character to the environment into three inextricably linked components: identity, structure and meaning. The identity consists in identifying the object and separating it from other objects; while the structure does so in the spatial relation between the receiver and the object. The third component – meaning – is an element difficult to grasp and at the same time very important in the case of the city (Lynch 2011, 9). Krzysztof Domaradzki describes meaning as 'a literary message of a city image that defies strict definitions'[49]. (Domaradzki 2013, 18) It is attributed individually by each inhabitant, hence the rare occurrence of group integrity of the entire environmental image. Lynch emphasises that it is difficult to impact the meaning by modifying the city structure, hence, while shaping its spatial form, one should concentrate on the first two components: identity and structure (Lynch 2011, 10).

Buildings are erected within the visual space, and not the real one (using the notions coined by Kazimierz Bartel). Therefore the essence of understanding the context in which the design is being created is to know the location's subjective conditions (and hence the 'meaning' described above). It is important even if these will be the feelings specific only to an individual, such as the designer: '(…) the more sensitive the individual, the deeper his or her knowledge of the landscape, the more complete his or her synthesis and the closer his or her formal and functional statements to the landscape.'[50] (Żórawski 1973, 158)

[49] 'literacki przekaz obrazu miasta, który wymyka się ścisłym definicjom' (translation into English: Monika Fryszkowska)

[50] '(…) im jednostka będzie bardziej wrażliwa, tym głębsza będzie jej znajomość krajobrazu, tym pełniejsza w niej jego synteza i tym bliższe temu krajobrazowi jej wypowiedzi formalne i funkcjonalne.' (translation into English: Monika Fryszkowska)

The second, wider perspective of looking at the location's aspects difficult to describe is the collective identity and a sense of community felt jointly by groups of people. They form a space of shared experience, by building both the context of creation and the reception of architecture and art. Jacek Krenz distinguishes nature and local identity as important connoting values within the architectural code of meaning (see pp. 122–123) (Krenz 2010, 52–56).

The special properties of drawing allow to record the above-mentioned space features perceived individually and collectively. In addition to the possibility of recording subjective experiences related to the spirit/*genius loci* of a place, the brevity of the sketch is also important. The two-dimensional plane of paper is not able to reflect all three-dimensional aspects perceived and felt, so the illustrator must make multiple compromises. In this way, the illustrator learns to use an abstract presentation of spatial issues, as well as to read the recorded non-literal contents. If architecture and urban planning has ambitions to move the receiver and convey meanings and values, other than just meeting basic needs, they both must be created based on the mode of perceiving the world as a place made up of metaphors. In order for the buildings to take part in public discourse and communicate content, they need receivers who are conscious of symbolism and metaphors, and who are capable of interpreting them (see V. 2. 5).

B. Teaching composition and formal decisions

The advancement of information technology provides ever wider access to information. However, knowledge flows only from their proper processing. This is of paramount importance in design which is based on drawing conclusions from the collected data.

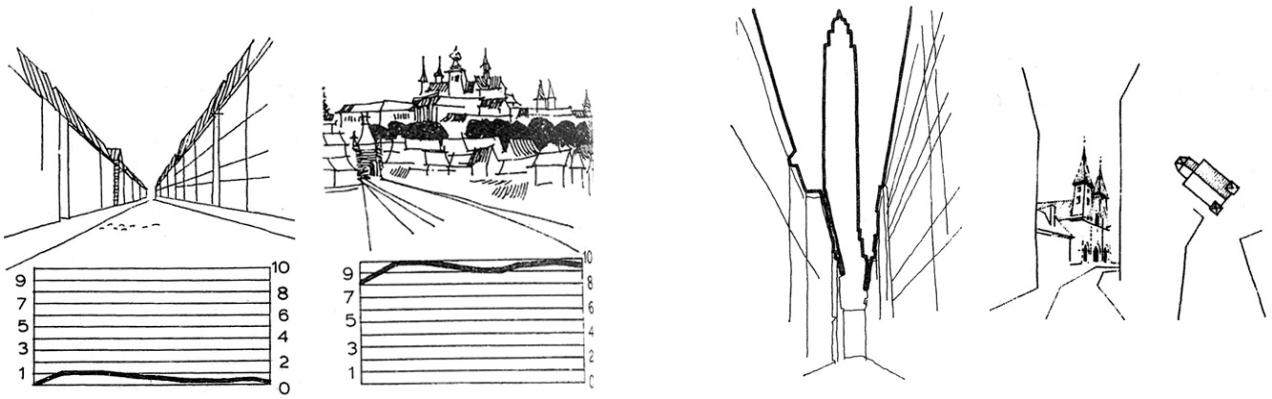


Fig. 34 From the left: the curve of sensations (monotonous and varied landscape), lines and planes directing the viewer's eyes and an open view with a dominant element; illustrations from Kazimierz Wejchert's book

Drawing from nature exemplifies the analysis of information coming from the environment. The meaning of a drawing as an activity has been described above; this subchapter focuses on how the content of the drawing may influence future design.

Formal issues at the time of composing a drawing are very similar to the aforementioned processes which organise perception. A drawing that reflects the reality should be characterised by the figures clearly standing out from the background, bringing to the fore the plans related to the division into regions in an appropriate manner, using the phenomena of the law of simplicity, perceptual grouping and closure. Understanding how our eyes, in connection with the nervous system, perceive the depth (and hence by hiding, linear and size perspective, gradients and light and shadow distribution) allows to make a drawing with spatial features.

Furthermore, the compositional dilemmas faced by the illustrator are sometimes identical to the challenges an architect or urban planner must meet.

The intention of creating a drawing, in its conventional, realistic dimension, is identical with the ambition of urban planning. ‘The main purpose of an urban composition is

Fig. 35 Lech Kłosiewicz, Moscow, Red Square, watercolour
– an example of framing with a high degree of sensation scale

to bring out or to create the beauty in the human environment.' (Wejchert 1984, 96) Although the discussion about the notion of beauty has been going on for many centuries and did not bring the single definition of beauty, it can be assumed, as it is commonly understood, that drawing also strives to achieve aesthetic values.

Drawing from nature begins by selecting the viewpoint (frame). This activity is similar to the analysis of vantage points mentioned by Kazimierz Wejchert in his book (op. cit., 36–42), and consequently to make use of their experience in their later conscious design. The well selected viewpoint breaks the monotony, among others, highlights and brings out features specific to objects and space (Fig. 35 and 36). Urban planners apply the same rules for creating successful spatial compositions. The tool for verifying how a given view catches the observer's attention is the curve of sensations (Fig. 34) (op. cit., 172). It can be referred directly to the task the draftsman is facing when searching for an interesting view. Of course, the result will not always be a successful drawing – as the latter also includes other components, partly listed below – but the view characterised by the high value of the curve of sensations usually has a greater drawing potential. A well-arranged frame also uses other components of urban composition. The most common of these are: dominant elements, lines and planes directing the viewer's eyes and an open view (Fig. 34 and 36).

Fig. 36 Ryszard Rogala, Erice, watercolour – an example of a viewpoint with lines directing the viewer's eyes to the dominant height

Often, the viewpoint selection is preceded by the wandering around the city and looking at urban design perspectives. Sometimes a step to the left or right may bring an unexpected change in the qualities of a given view – the illustrator also learns such

a phenomenon as the apparent mobility of architecture (op. cit., 183). The search for the viewpoint allows a viewer to observe carefully the city's spatial structure which affects the observer: streets, regions, border zones, landmarks, outstanding elements of the landscape or nodal points (op. cit., 49–94) and to create mental maps on their basis (Lynch 1960).

After the viewpoint has been selected, the general elements are being examined. The beginning of drawing usually consists in separating planes characterised by a different degree of inclination (mainly horizontal planes from vertical ones), which allows the draftsman to bring out the basic elements to the forefront: walls, floor and ceiling (Fig. 37 and 38) (Wejchert 1984, 107).

The separation of planes involves drawing a contour that should not be understood only as a line that circumvents objects. This separation is also created by the boundaries between differently lit areas of composition or visual layouts which give the drawing its shape. In addition, the separation of planes allows to record the perceptual phenomenon of the division of the drawing into zones and separates a figure from the background. This analysis is important in designing, because as Juliusz Żórawski pointed out – in architecture every form has a contour (Żórawski 1973, 70).

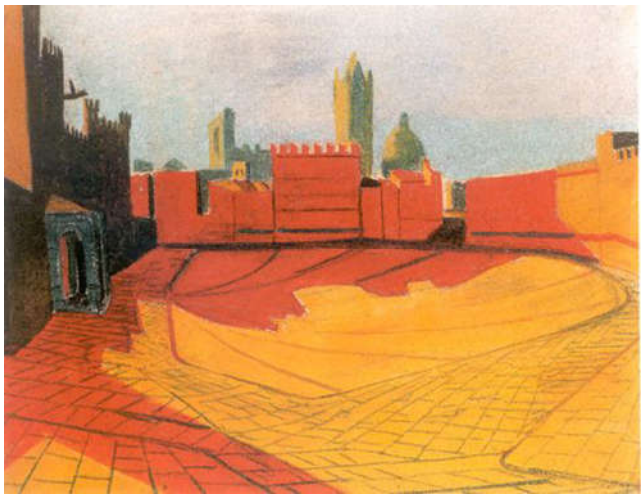


Fig. 37 Louis Kahn, Siena, Piazza del Campo – clearly separated walls, ceiling and floor

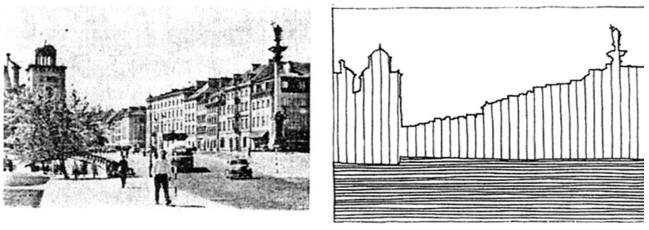


Fig. 38 Ceiling, walls and floor (in urban planning sense), illustration from Kazimierz Wejchert's book

The influence of some principles of building an architectural form and composition, described by Juliusz Żórawski in his works, can be verified by conducting drawing formal experiments. The problem which can be analysed is the relationship between the figure and the background, mentioned on the occasion of perception. The principle which the author illustrates with a schematic view at sunset and without sunset (Fig. 39) is trans-

ferred directly from the visual composition in which the background should complement the figure without creating any competition for it (it is worth adding that the background is not always synonymous with the sky, as often the sky is the subject of the drawing – a figure, and the rest of the drawing – a background). Żórawski emphasises that 'Operating the architectural form consists in, among others, setting figures against the right backgrounds.'[51] (op. cit., 73)

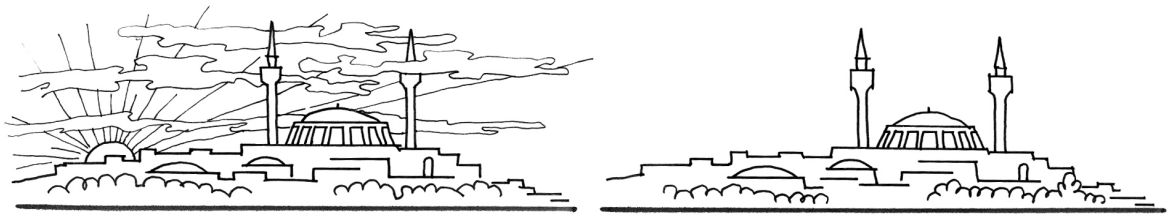


Fig. 39 Juliusz Żórawski, setting a figure against a background

The drawing contains the concept of 'a focus' or 'focal point', defining the area that captures the viewer's attention, the main theme of the drawing. It reflects the accommodation of the eye, during which the focus is maintained on the elements of space that are important at a given moment. The focal point can be achieved using, above all, abundance of detail and sharper contrast. Lines often direct the viewer's attention on focus; or it is placed in the dominant height (Fig. 40). The focus structures the image, subordinating other areas of the drawing to itself. In this way, the illustrator learns to manage the initially blank sheet of paper, organise the composition and make a choice. Two focal points in one drawing compete with one another. This reminds us of the principles of building an architectural form about which Juliusz Żórawski wrote:

> If two multi-piece compositions, hierarchically different in form, are adjacent to each other, bringing them together always entails the risk of an error consisting in overlapping of the fields of formal action. The more cohesive a composition is, the greater its scope of action and the more extensive must be the required sphere of formal action.[52] (op. cit., 104)

Sketching outdoors is a tool that allows the analysis of views, their synthesis and, consequently, the study of composition, especially the urban one.

[51] 'Operowanie formą architektoniczną polega m.in. na ustawieniu form na właściwych tłach.' (translation into English: Monika Fryszkowska)

[52] 'Jeżeli dwa, hierarchicznie różne pod względem formy, wieloczłonowe układy sąsiadują ze sobą, zbliżenie ich do siebie powoduje zawsze niebezpieczeństwo zjawienia się błędu polegającego na nakładaniu się pól działania formalnego. Im bardziej spoisty jest jakiś układ, tym większe jest jego pole działania i tym obszerniejsza musi być sfera konieczna działania formalnego.' (translation into English: Monika Fryszkowska)

Sławomir Gzell wrote about the meaning of the above-described observations and the importance of drawing in his later design practice:

> [W]e built plans and designs by multiplying drawn lines which began as real and contractual lines: terrain edges, frontages, border belts, streets, tracks, axes, directions of looking, etc. By drawing, we embedded our idea in a context and it was a matter of simple drawing skill to do better than others. The knowledge of Wejchert's theory of elements of urban composition helped us (…)[53] (Gzell 2014, 145).

The above-mentioned formal experiments involved in drawing, such as isolating the contour, focal point, leading lines and planes, walls and the floor (in the urban planning sense) as well as composing the focus lead to the separation of the structural skeleton in the drawing. Its definition and meaning has been explained below.

Fig. 40 Joanna Pętkowska-Hankel, Berlin, Charlottenburger Tor
– an example of a focal point accentuated by the dominant element and a plane which directs the viewer's attention.

[53] '(…) budowaliśmy plany i projekty przez multiplikację rysowanych linii, których początkiem były linie rzeczywiste i umowne: krawędzie terenowe, pierzeje, lizjery, ulice, tory, osie, kierunki patrzenia itp. Tak za pomocą rysowania osadzaliśmy nasz pomysł w kontekście i było kwestią zwykłej zręczności rysunkowej, aby robić to lepiej niż inni. Pomagała nam znajomość Wejchertowskiej teorii elementów kompozycji urbanistycznej (…)' (translation into English: Monika Fryszkowska)

C. Noticing rules and solving problems

The structural skeleton can be observed on the basis of contour boundaries of a solid figure, but rarely does it coincides with it (Fig. 41). Its designation is subject to the law of simplicity (see p. 61) – the skeleton is the simplest organisational structure of a given shape (Arnheim 2004, 93–94).

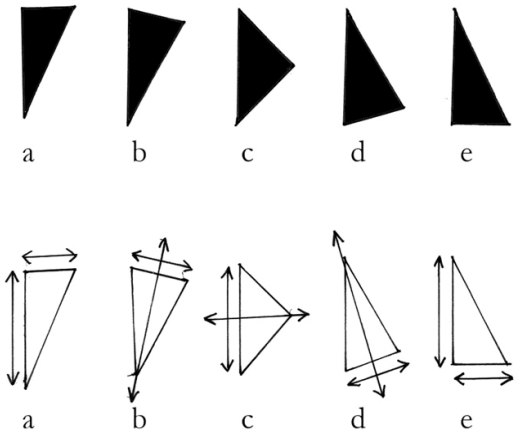


Fig. 41 Rudolf Arnheim, the structural skeleton (marked on white figures) is determined on the basis of contour boundaries of a figure or solid figure (black figures).

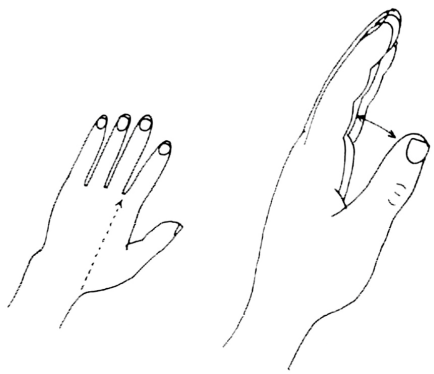


Fig. 42 Peter van Sommers, an example of an object which is well-known to everyone is a human hand. Still, few people would confirm that the prolongation of the lines of the forearm and wrist falls between the index and middle fingers and that in the side view, the thumb clearly stands out from the hand.

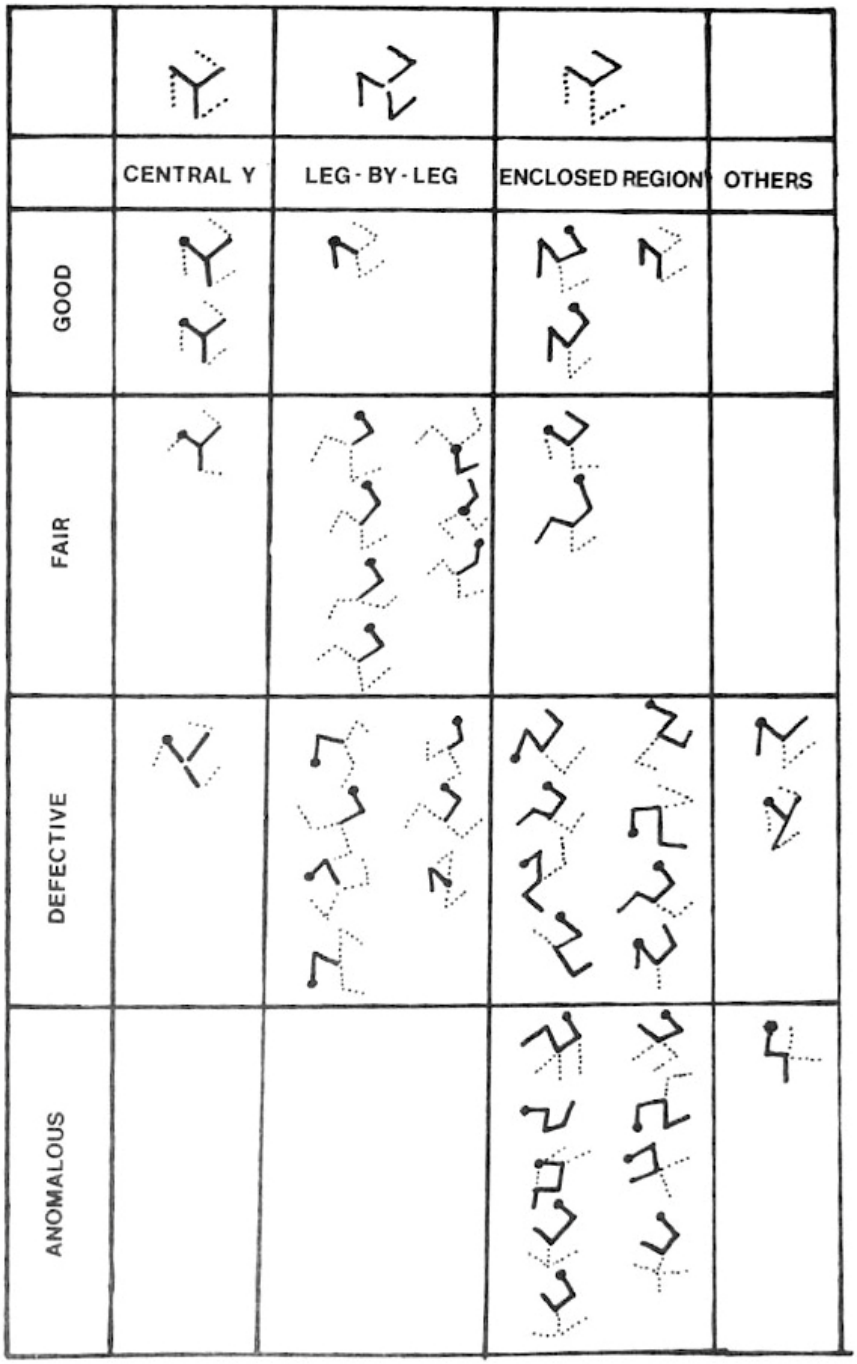
It is a basic element in the process of noticing the rules governing the construction of a perceived object; the latter can be illustrated by an experiment conducted by Peter van Sommers. The starting point for conducting this experiment was the observation that perception may be misleading at the time of recording information derived from it. It turns out that even long-term observation does not guarantee a correct representation of the subject in a drawing from memory (Fig. 42) (van Sommers 1984, 134–135).

The experiment was aimed at showing the course of perceptual analysis – the extent to which the participants notice the rules of creating signs and the adopted drawing strategy. The participants were asked to draw from memory a sign of *trinacria* (after having seen it for a few seconds) – a three-legged symbol depicted on flag of Sicily.

A draftsman facing a difficult task first notices the rules that govern dependencies between the elements. This is a stage of searching for a structural skeleton.

After conducting the perceptual analysis, the subject goes on to apply the appropriate strategy in order to draw the *trinacria*. The

adopted drawing schema must not only be repeated as the directions of the legs of the symbol change, but also integrated with lines already drawn on the paper. An erroneous initial strategy can ruin the final result, which can be seen in the table below (Tab. 3), divided vertically into four most commonly adopted operational concepts based on the symbol's segmentation.



Tab. 3 The results of the experiment conducted by Peter van Sommers: three basic strategies of *trinacria* segmentation are presented in columns, while in rows – the results have been sorted into four groups depending on the similarity of the final drawing to *trinacria*; the dot stands for the starting point, the continuous line – the following steps made, and the dotted line – the last elements drawn by the subject of the experiment.

In the conclusions of the experiment, van Sommers points out that the incorrect perceptual analysis itself is not the source of error, but rather the mutual influence of this analysis and the processes that led, step by step, to the making of the drawing – segmentation.

The results of the ten people who best captured and drew the symbol were analysed. They adopted to a large extent a better initial strategy and correctly located the structural skeleton. The importance of this moment in making a drawing is noticed by Arnheim:

> The guiding image in the artist's mind is not so much a faithful preview of what the completed painting or sculpture will look like, but mainly the structural skeleton, the configuration of visual forces that determines the character of the visual object. Whenever that guiding image is lost sight of, the hand goes astray. (Arnheim 2004, 93)

The most important conclusion, identical with similar studies carried out by Gabriela Goldschmidt, is that the ability to notice general, overriding principles and to overlook details and information classification is useful in the process of solving problems, includeing the design ones. These abilities are triggered by the phenomenon of visual display which in the Goldschmidt's experiment took the form of a drawing. Thanks to this visual demonstration, the architect participating in the study could make functional division of the library plan (specified in the task in the form of a simple contour), by segmenting it and finding the structural sense of the projection (Fig. 43) (Goldschmidt 1991).

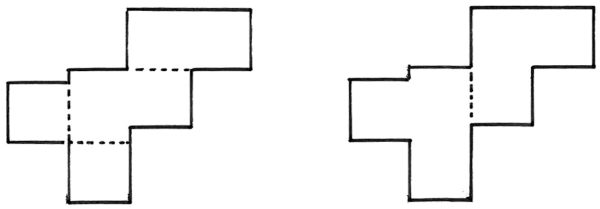


Fig. 43 The architect taking part in the Goldschmidt's study, having received the above figure (continuous line), i.e. the contour of the library plan, made functional segmentation in two versions (dashed lines) based on the contour's structure found by him/her.

Finding the structural skeleton in design work consists precisely in locating the axis, planning a room layout, window and door openings or the urban composition, in which the objective is to structuralise city plans and give them clear rules. The same skeleton makes it possible to read the formation of the observed objects during drawing, which is particularly evident in the structural drawing prevailing at the Warsaw School of Architectural Drawing (see II. 3. 3). Drawing, as a material visualisation of perceptions and

thoughts, can stimulate the perception of logic and structure in the environment, and consequently finding the answer to the design problem.

It is worth noting, however, that in the group that drew *trinacria* best from memory (the row called 'Good' in Tab. 3), there were also people who started to draw by using a defective segmentation which led in other cases to failure. Despite the more difficult and less obvious strategy, they managed to depict *trinacria* correctly. As already has been mentioned, the reason why some participants obtained poor results was their insufficient perceptual analysis, lack of recognition of the structural skeleton or the choice of an incorrect strategy. However, a well-conducted graphical segmentation of the symbol may be enough to draw correctly the previously viewed object. Meanwhile, for some people – whom van Sommers calls 'competent drawers' – it was not indispensable (van Sommers 1984, 156–160). There must be, therefore, some cognitive predispositions which allow illustrators to recall the entire image without recognising the simplest structural skeleton. This would suggest that not everyone needs e.g. drawing practice to notice and apply the principles present in the surrounding objects.

V. 2 Record of thoughts

There is a limit when it comes to the ability of the brain to process complex problems. It is difficult to design only through mental processes, therefore the reflections gain material form, including in the drawing – 'load-bearing structure' for thoughts (Maluga 2006, 52–53). It is a link between the world of ideas and the world of materiality.

Marian Fikus calls drawing in the practice of architecture and urban planning 'a proper skill which is the proof of space perception'. He emphasises the importance of preliminary sketches requiring the greatest concentration and involvement of the intellect. Preliminary sketches are responsible for recording the first spatial preview called the 'seed intent'. According to Fikus, this seed must always be expressed in graphic form, which is a design requirement. Fikus believes that mastering the proper skill is a prerequisite for the architect's true professionalism (Fikus 1991, 25–30).

V. 2. 1 Tactility

It is worth going back to the significance of tactility (the haptic aspect) in drawing and the relation between the eye, the hand and the brain, indicated in Subchapter II. 5. One of the greatest advantages of freehand drawing is the naturalness of this activity – learning to

hold a pencil in the hand precedes learning to write. Such a connection enables immediate representation of the products of thought in the form of a trace on the drawing surface. Both the substrate and the tool used by the designer are material. One can see in a drawing a clear relationship between the cause (thought transformed into a gesture) and the effect (a line drawn on paper). The illustrator also learns the limitations associated with the use of materials; its realisation is an important element in the work of an architect and an urban planner.

At the stage of discussing the drawing's tactility, it seems valuable to refer to studies comparing handwriting with typing. In the context of this work, it makes sense only in the case of the original assumption of the convergence of handwritten drawing and writing activities. Comparing them served as a starting point for Paolo Belardi in his publication in which he points out that it was the graphologist Rudolf Pophal who equated these two activities in the context of brain functioning (Belardi 2014, 23). Betty Edwards also thinks that handwriting is a form of drawing (Edwards 1999, XXI). Even if equating these two activities may seem controversial, they certainly have many common features that give substance to their comparison.

Writing on paper, like drawing, is characterised by one-handedness, while the keyboard requires two-handed typing. Both handwriting and drawing are visually engaging, because the eyesight of the person writing and drawing is focused on the tip of the tool. In the case of a computer keyboard, the visual attention is divided between the tool designed to enter the data and the screen. These are two different, distinct and separated spaces: motor (keys) and visual (screen). The handwriting person must each time make an effort to write the shape of the letter, whereas in the case of a computer, it is enough to find the corresponding key. It can be pressed with various movements, fingers, right or left hand, while the relationship between the hand gesture and the appearance of a handwritten letter is inseparable (Mangen and Velay 2010).

The above features opposing both methods of record – handwritten and digital – have an impact on intellectual processes. Mangen and Velay, after analysing the research studies on remembering the symbols of alphabet, confirm that in both children and adults, letters which were taught through their handwritten representation were remembered and recognised more quickly. Another study showed that taking notes on a computer involves less information processing than handwritten note-taking. Students who typed the lecture content on their laptops delivered worse performance when completing the tasks testing

their knowledge. They had a greater tendency to literally copy entire phrases heard during the lecture, unlike the students who took handwritten notes who (also due to the slower process of handwriting) processed incoming information and recorded it briefly, in their own words (Mueller and Oppenheimer 2014).

The aforementioned common features of drawing and handwriting justify the supposition that the above test results may also refer to drawing. The results of the Mangen and Veley experiment would confirm the meaning of drawing discussed in Subchapter V. 1 in the conscious and active processing of information derived from the environment, getting to know and understanding the environment and, consequently, 'learning' the context. The second conclusion, coming from the Mueller and Oppenheimer research studies, can be of great importance in design: design requires synthesising and deep data processing, which is enhanced by the tactile connection between the tool, the substrate, the hand, the eye and the brain.

In CAD systems, there is no relation between the hand and the material, therefore limitations related to materiality become imperceptible. The hand movement has an outcome in virtual space, which – like the letters in ready-made fonts – has been programmed and has little to do with the designer's gesture that causes it. Similarly, the designer's eyes are disconnected from the hand and focus on the computer screen. The designer's attention is divided between the input device and the monitor, thus the motor space is separated from the visual one. The importance of the tactile aspect is clearly visible in the efforts of peripheral devices designers – the computer mouse (which still remains the most popular tool) is a little intuitive device of dubious ease of use. The tablet reflects the naturalness of the gesture a little better.

Jan Słyk writes about the issue of human-computer interaction:

> Keyboard, mouse, tablet – reduce the user's intention to information specifying (relatively) the location and containing a sequence of commands and parameters (in the interface language). The effect of actions is controlled by tracking changes on a (flat) screen, followed by the next step of the interaction algorithm: correction, refinement, projection change, another decision, etc. The use of devices which offer more direct access to signals transmitted to human senses is a chance to increase the efficiency of computer modeling. These are mainly devices providing full or partial access to virtual reality.[54] (Słyk 2012, 85)

[54] 'Klawiatura, mysz, tablet – sprowadzają intencję użytkownika do informacji określającej (względnie) położenie oraz zawierającej ciąg poleceń i parametrów (w języku interfejsu). Efekt działań kontrolowany jest przez śledzenie zmian na (płaskim) ekranie, po czym następuje kolejny krok algorytmu interakcji: korekta, uściślenie, zmiana projekcji, kolejna decyzja itp. Szansą na podniesienie efektywności modelowania komputerowego jest zastosowanie urządzeń, które w bardziej bezpośredni sposób otwierają

V. 2. 2 Crafts

Tactility is associated with the perception of drawing as a craft. Brockhaus Enzyklopädie defines craft as a productive activity. It primarily emphasises the use of hand – the German word for 'handicraft' – 'Handwerk' – contains the term 'Hand', standing for 'hand'. The craftsman is the central figure in this process, dealing with the resistance of the material with the aid of simple tools (Brockhaus Enzyklopädie, VIII 1969, 148–152). Architecture has the characteristics of craft.[55] Although the profession of the builder has become detached from the profession of the architect, it is still important for the designer to understand the actual process of producing the object he/she invented, i.e. the building. This applies equally to the understanding of the construction process as well as of the properties of the materials.

The architectural drawing, understood as a convention of record, influenced the separation of intellectual aspects from the physical and material properties of the object. As a craft, however, it works in a way that combines these two aspects. Drawing in architecture can be called a 'craft-within-a-craft' (Scheer 2014, 173).

Drawing boards or mock-ups, beautiful and aesthetically studied to the smallest detail resulted in the creation of a special culture of design, requiring exceptionally advanced skills – craftsmanship. This applies to both handmade visualisations and mock-ups. Craftsmen manufacturing them are architects most often because few people, apart from these professionals, have the right background of knowledge and imagination to perform such objects.

By analogy to the craftsman's effort of creating an object, drawing resembles the construction process itself. Marco Frascari notices an interesting relationship between traditional tools: the set square used on paper to sketch lines corresponded to the set square used on the construction site to erect walls (Frascari, Hale and Starkey 2013, 3). Drawing also teaches indirectly working with building materials. They have, as well as drawing techniques, specific properties conditioning their limited possibilities of use. The search for their novel and unobvious use is very important in creativity.

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dostęp do sygnałów przekazywanych ludzkim zmysłom. Są to przede wszystkim urządzenia zapewniające pełny lub częściowy dostęp do wirtualnej rzeczywistości.' (translation into English: Monika Fryszkowska)

[55] The relation between architecture and craft, as well as the great impact the craft has had on the works of Jacques Herzog, Pierre de Meuron, Renzo Piano and Peter Zumthor was presented by Bohdan Paczowski in his essay titled 'Pochwała rzemiosła' [Praise of Craft] (Paczowski 1998).

A real craft, in order to become an art, requires not only efficient handling of the tool and material. In architecture, just like in crafts, what makes the work outstanding is dependent on factors which go beyond the standards of competence – on the individuality of the creator, his/her commitment and dedication to work.

Every craft requires an effort – arduous repetitions and long-lasting learning to deeply understand the tool and the material. The excellent craft of drawing, although not as common and obvious as several decades ago, is still a prerequisite for becoming an architect. It contributes to gaining the investor's respect in the design process and keeping the architect's status of a creator who knows this demanding graphic jargon (see V. 5). It ennobles and teaches humility in the face of decision-making. The craft of drawing, understood from the perspective of the second decade of the 21st century as a slowing limitation at the stage of refining the concept, had the advantage of the necessary and insightful contemplation of the design solution. Errors on paper or tracing paper cannot be corrected easily. Redesigning, introducing changes or starting from scratch, especially with reference to hand-drawn construction documentation, required time and effort, hence the subsequent design versions had to be well-thought-out. The stunning ease of making changes in computer programs, apart from the undoubted advantages, can sometimes result in the lack of in-depth studies on the aspects of the design, and in their superficiality.

The traditional drawing technique as well as the production of physical models ensured a tactile connection between the author and the shaped form. Easily discernible cause-effect relationships between the manual action of hands and the drawing or mock-up resulted in a learning process. This valuable relationship between the author and the material does not occur in the case of computer modeling, even if the model has been printed – the effect obtained of a tangible solid figure is the effect of an automated machine. Understanding the process that took place between modeling and printing or cutting is not important for the designer. Thus he/she loses the direct connection between his/her action and the form that has become its effect. The above-mentioned learning process with the use of traditional techniques concerned the cognition of the attributes of real space and objects found in it.

Meanwhile, digital modeling takes place in a virtual space, unreal and created by a man, so different from the space in which the project will actually be implemented. The designer becomes the user of a computer program – the name itself suggests that he/she

operates inside the world created by someone else (the program developer). It moves away the architect or urban planner from the real conditions of the design, leaving him/her in the world of simulations (Scheer 2014, 176).

Learning about the functioning of the material tool and the material being processed takes place naturally, the limits of the possibilities are clear and tangible. The resistance of the material selected by the designer disciplines the latter. Seemingly, this is a limitation, but the desire to overcome it can stimulate creativity. In the case of digital tools, software developers try to make them as easy and user-friendly as possible, thereby hiding the real mechanisms of software operations from the user. This results in many assumptions, often incorrect, adopted by the user. It helps neither architects or urban planners learn the properties of the tool and create individual, original ways of using it, which is a feature of real craftsmanship. The convergence of digital tools and crafts would be possible in case of combining the profession of designer and software developer into one.

David Scheer suggests that increasing the involvement of the body in design can be ensured by hybrid design, consisting in combining digital and traditional methods, i.e. drawing with digital modeling, and also physical one – creating mock-ups. In addition, Scheer prefers computer models which are not realistic, as their deceptive illusion of tissue materiality and authenticity is reduced. The attractiveness of simulation representations on the screen has such an enchanting potential that designers can forget about the real properties of buildings designed by them. The material expression of architecture can be replaced by a fictitious simulation based only on the visual side of the object (op. cit., 163, 178).

On the other hand, understanding the material combined with parametric modeling can result in very interesting designs and open up new possibilities. The ‘Swish’ stool, designed by the design office Carlo Ratti Associati (Fig. 44), constitutes an example of the above. Swish is made up of 27 thin wooden elements interlocked through a system of individually designed joints and hinges, each different from the other. The same effect would be difficult to obtain, if not impossible, with the use of traditional crafts (including also traditional drawing). Designed digitally and made with the use of CNC technology, this object makes good use of the characteristics of the material from which it is made (Swish for Cassina 2017).

Fig. 44 Swish stool prototype, designed by: Carlo Ratti Associati: Carlo Ratti, Saverio Panata, Andrea Cassi, Andrea Galli, Pietro Leoni, Sammy Zarka; contractor: FGM Works

The stool is an example of the already mentioned digital craftsmanship (see II. 4. 1, p. 45). Diversity, which resulted primarily from the imperfection of hand movements, appears in the digital environment as programmed and fully controlled. Mass customisation of products follows. This is made possible through the vertical integration of the design and manufacturing of objects, in which the file from the designer's computer is transferred directly to production site. The proximity of design and manufacturing, as well as the unitary, original character of this type of objects constitute two features that bring digital craftsmanship closer to how the craft looked like in the pre-industrial era. Mario Carpo, however, points out that the admiration for the uniqueness of handmade craft products resulted from their limited number. Infinite diversity can lead to the loss of the significance of originality. Mario Carpo compares this phenomenon to the current dysfunctional visual communication, caused by an abundance of changing images. Carpo adds: 'sign that changes too often and too randomly may mean less' (Carpo 2011, 10–11).

V. 2. 3 Holism and multiple levels of abstraction

The need for a holistic and systemic approach to design stems from the nature of the design problem, and especially from the first eight points concerning design, formulated by Vinod Goel (see IV. 2). First and foremost, it is affected by the size and complexity of the ill-defined problem, the indistinguishable division into components, and yet the need to link them, and the multidimensional nature of the limitations. The multi-threaded set of input information that must be transformed by the designer into the output data requires a holistic approach to the problem. All this contributes to the fact that design thinking is not systematic (Cross 2011, 75), and can be visualised in many ways, as shown in the schemas from Subchapter IV. 4. Architects and urban planners operate simultaneously on many levels of abstraction. This applies not only to scale variable, but also to simultaneous work over the detail, section, plan and development, e.g. the entire site (Fig. 45 and 46). The systemic approach also results from the fact that not only the design problem, but also the design solution itself has a holistic character – often one decision solves many problems at the same time. For example, the construction of a high church tower meets the functional need in the form of a belfry, which constitutes the square's and the street axis' dominant element, while its successful form resulting from the beauty of the structure may correspond to the aesthetic desires of the town's inhabitants. All these examples of use are contained in a single object based on one good idea.

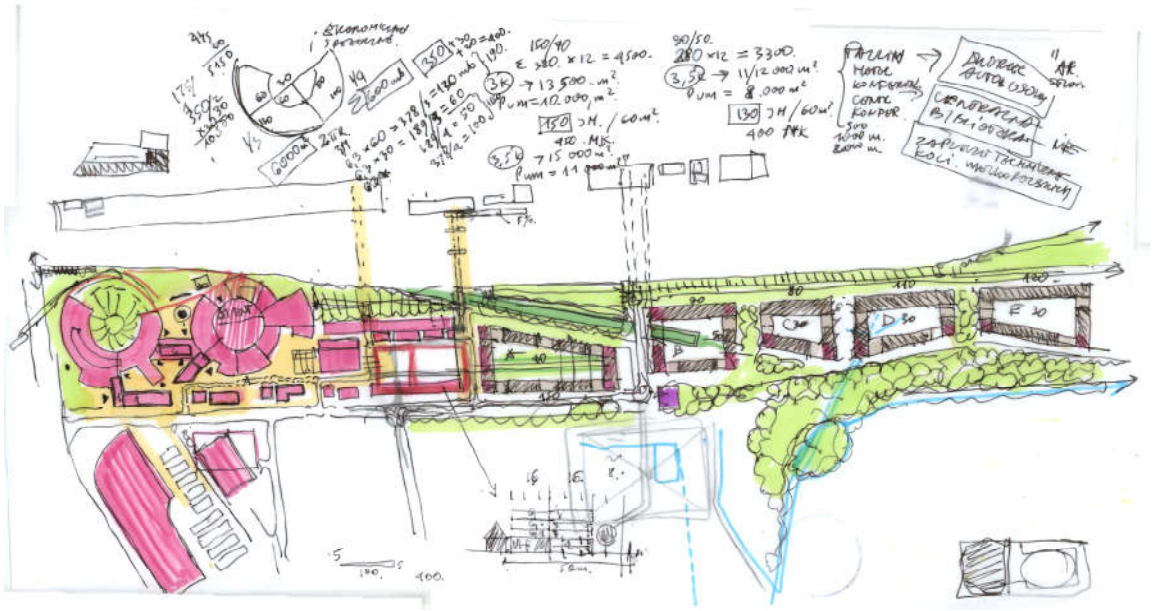


Fig. 45 Michał Owadowicz, sketches for the development project of the roundhouse in Gniezno, made during the charrette workshop, 2017

In order to separate the general matters from the details and not to lose the guiding idea, architects often use small sketches that can be embraced with one glance (Fig. 46). Such a way of working was adopted by Santiago Calatrava (formats A3 or A5), Le Corbusier (format A4 and smaller) or Herman Hertzberger (format A3) (Lawson 2004, 55–56), among others. When designing, it is necessary to think about the functional, formal and structural whole as about inseparable and mutually complementary components. This has been emphasised by Renzo Piano: in his design office, both the detail, the material and the entire building are much thought about at the very initial design stage (Robbins 1997, 131). Drawing is one of the methods which allows such universality and multitude of gazes. The appropriate tool can be adapted to the scale or level of detail relatively quickly. Tracing paper allows designers to layer drawings. The materiality of the drawings provides insight into previous versions of the solution and enables simultaneous work of colleagues by using a common 'language' of communication.

Computer modeling gives the opportunity to look at the object freely from any desired perspective, as well as to show the cross-sections of the object, i.e. vertical or horizontal.

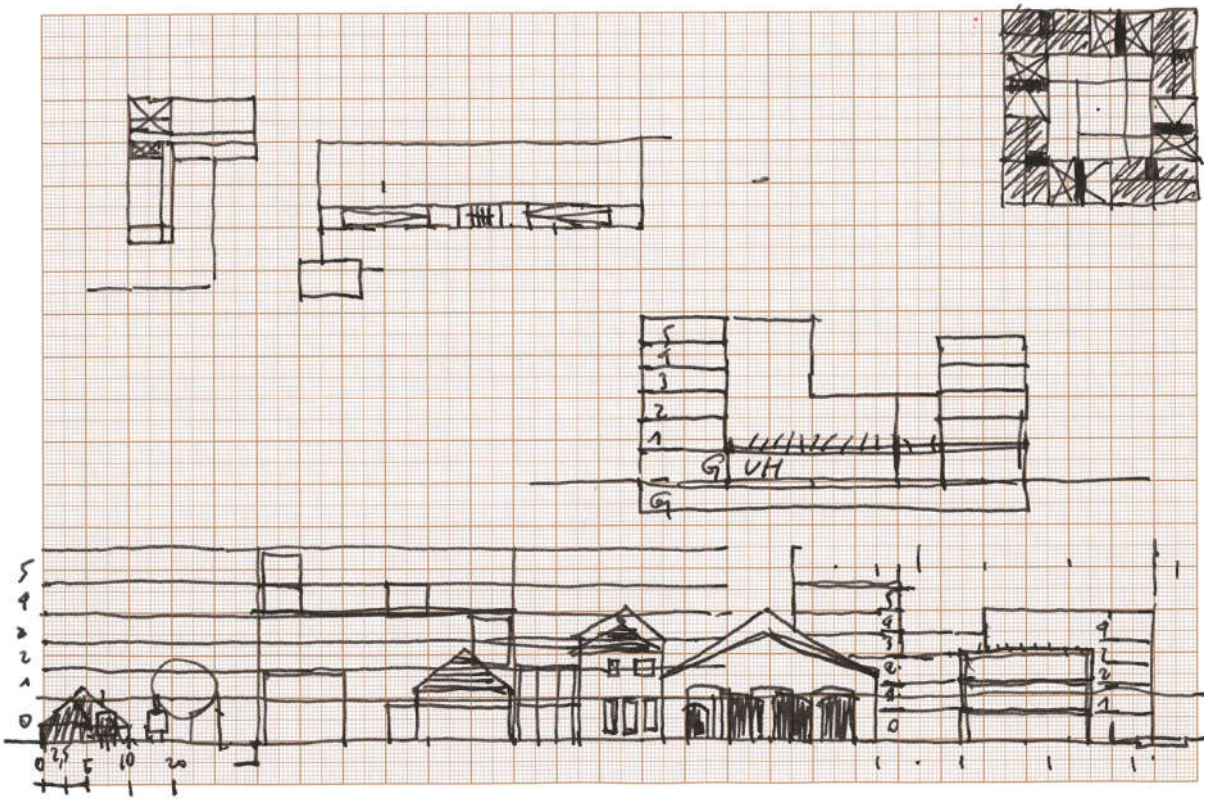


Fig. 46 Michał Owadowicz, sketches on A4 millimeter paper for the development project of the roundhouse in Gniezno made during the charrette workshop, 2017

However, this is not a function which is identical with operating on different levels of abstraction in freehand drawing. Drawing requires the creation of a new representation every time. On the one hand, it slows down the work, but at the same time, at the conceptual stage, it can help the designer understand the object. The designer must imagine the model of a building, and then present the desired cross-section or perspective on paper and coordinate it in his/her imagination with other elements. It requires an intellectual effort which is emphasised by Peter Cook. Also learning to draw, which Peter Cook always regarded as an important skill, required a lot of commitment and effort from him. Cook thinks that this is why he is somewhat contemptuous about the results which do not require any effort (Hayes and Cook 2012, 9).

The architectural drawing always presents one 'frozen' view, which is a big disadvantage compared to three-dimensional models (both digital and physical models). On the other hand, the ability to zoom in and out of a two-dimensional model or drawing in a CAD program has one major disadvantage – it deprives the observer of a sense of the scale of objects, their real size and relation to other elements.[56] It is this property – the ability to view, in a single glance, the entire design structure – which gained preference among the aforementioned authors of small-format drawings. In times past, when designs were done on the drawing board, the architects were able to sketch by hand without the use of an architects' scale e.g. a furnished apartment plan at a scale of 1:100. The depth of the wardrobe, the width of the door or the thickness of the partition wall were so well known to them that they operated freely on various scales and different levels of abstraction of their representations. If it was accompanied by a reference to the real dimensions of objects and space – one could suppose that the architects' suggestions were conscious and took into account the spatial dependencies.

On the other hand, computational design can also support holistic, systemic thinking about the design. It does not assume, at the outset, a specific form, but only a set of defining rules in the form of an algorithm. It focuses on processes describing the functioning of the object and on optimisation which sometimes comes to the fore in the creation process. The relationship between its components becomes more important than the object itself. In traditional design, in which drawing allows a holistic approach, the

[56] Antoine Picon discusses 'the crisis of scale' in the context of contemporary architecture which, along with the loss of designing in scale, characteristic of drawing, and the creation of objects based on irregular planes (the so-called blobs – a term coined by Greg Lynn) lost the traditional sense of basic dimensions (width, height and depth) and tectonics (Picon 2010, 124–133).

inclusion of all dependencies is a complex task, requiring good communication and coordination of work. Building Information Modeling supports a comprehensive approach to the design and a look at the building as a system consisting of interacting parts.

Three-dimensional models reflect designer's ideas not only through static, two-dimensional drawings; they can also describe the thinking processes that take place in a dynamic way, for example with the use of cinematic techniques. Some researchers, like Peter Szalapaj, note the strengthening of the holistic aspect of design which is taking place thanks to these changes. The effects of creative action are visible immediately on the model. Szalapaj quotes Frank Gehry who was suspicious about using the computer, seeing in it a limitation of forms to the symmetrical ones, based on 'simple Euclidean geometry'. Gehry mentions the problem of not being able to transfer to the computer the unrestrained gesture of his hand depicted in the form of a sketch. However, after some time, the architect's office, starting with the CATIA program, began to successfully use software programs which enabled the formation of complex, seemingly undescriptive forms, saved in Gehry's gesture (Szalapaj 2005, 9).

V. 2. 4 Ambiguity

Some designers claim that the idea arises in their mind, and the drawing only represents it; others argue that the act of drawing creates the idea itself. From the documented conversations carried out by Edward Robbins it appears that for those who use drawing at the conceptual phase on a daily basis, drawing is actually associated with the emergence of ideas (Robbins 1997, 32). A similar conclusion can be found in the collection of sketches made by well-known architects on table napkins, which shows that freehand drawing helps in the notation of thoughts arising often incidentally, outside of a strict design situation (Nerdinger 2003, 57). Jacek Krenz calls freehand drawing a catalyst for ideas, which is more than just a means of graphic recording (Krenz 2010, 76). Jack Howe, quoted by Nigel Cross, talks about the beginnings of design: 'I draw something. Even if it's "potty" I draw it. The act of drawing seems to clarify my thoughts.' Cross adds that designing only through internal intellectual processes is a very difficult task (Cross 2011, 12). Peter van Sommers also attaches great importance to the role of graphic recording in the creative process, describing it as a 'graphic engine'. Van Sommers notices that although many artists, in their work, already have a fully developed concept of the work already before the creative act itself (this would correspond to the linear model of design

thinking, see Fig. 27A), still a large part of them needs its physical traces in order to form their idea (van Sommers 1984, 244–246).

On the other hand, there are architects who do not draw in the process of concept clarification. It turns out that this is not just, as it might seem, the domain of the young generation. This group was represented by Adolf Loos: 'My architecture is not conceived by drawings, but by spaces. I do not draw plans, facades or sections… For me, the ground floor, first floor do not exist… There are only interconnected continual spaces, rooms, halls, terraces…' (Fabrizi 2014) adding that 'Good architecture can be written. One can write the Parthenon.' (Wainwright 2009) Valerio Olgiati also works without the use of drawing: 'I don't find the production process so interesting. We sit down and start to talk. Sometimes we talk over several days, again and again. Nobody makes a sketch, it's just talking.' (ibid.) Limiting the use of drawing also results from the increasing complexity of the design projects, as noted by Chris Bagot, founder of Softroom, an architecture and design studio: 'I don't record ideas when I have them. We work with complex three-dimensional ideas that are difficult to sketch – involving effects like transparency and reflection. A visual concept will be tested and developed using sophisticated technology – computer modeling for example.' (Victoria and Albert Museum)

The following is a research study aimed to investigate the actual use of drawing in design and to check whether it actually stimulates creative thinking and whether it is an indispensable tool in the conceptual phase. In the research study, one can notice a large impact of the specifics of the design problem, subject to specification only at the design, and of the limited external feedback; the designer at the initial stage conducts an extensive dialogue with himself. This fact drew attention of many researchers, including Donald Schön.

Schön is the author of the opinion about design as a 'reflective practice' (Schön 1983, 1985). He described the phenomenon of '**reflection-in-action**' consisting in the complementation of two elements: action (activity) and thinking. The activity prevails in practice, it is then supported by thinking, and thinking provides conclusions regarding the results of the action. They mutually set limits. Reflection-in-action is associated with 'knowing-in-action', which manifests itself in the process of performing a given activity when the expert seems to be guided by intuition. Schön emphasises that many professionals are not aware of the knowledge they have; it becomes apparent only in action, when they have to face a unique and unthinkable practical task (Schön 1983, 8–9).

Knowledge-in-action can be compared with the previously mentioned precedent. The designer conducts a 'conversation with the situation' by framing and reframing the problem. This favours discoveries and new reflections-in-action. The problem tries to be solved by trying to change its definitions, which opens up new directions of thinking. 'The situation talks back, the practitioner listens, and as he appreciates what he hears, he reframes the situation once again.' (op. cit., 131–132). Reflection-in-action takes place during sketching, when the designer encounters something that will amaze, bother or intrigue him/her. He/she draws and reacts to the drawing he/she created which seems to 'talk' to the designer. The graphic form preceded by thinking and the use of knowledge-in-action stimulates new ideas (op. cit., 68).

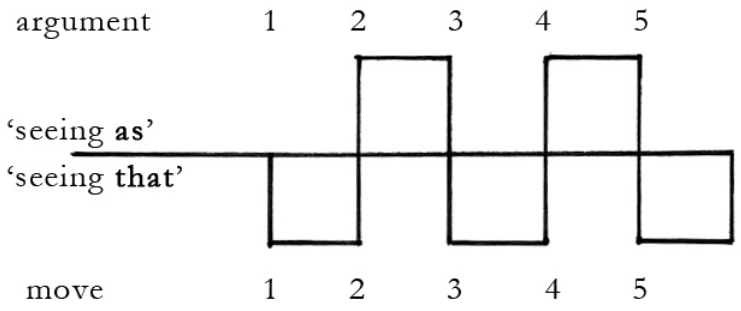


Fig. 47

Gabriela Goldschmidt carried out a significant study in this matter (Goldschmidt 1991). Seven experienced architects and one student took part in it. The task was to design six entries on a schematic plan of the library and determine the functional consequences entailed by their positioning. Goldschmidt distinguished the smallest parts of design reasoning: a move – a coherent proposal referring to the designed unit and an argument – a statement made by the designer regarding the move or other property of the designed object. The designers' activities are distinguished by two interweaving modes. The first one, referred to as **'seeing as'**, corresponded to the argument and always appeared in the form of a sketch. The second one – **'seeing that'** – represented the move and could sometimes be supported by drawing. The following internal dialogue of one of the participants can constitute an example of such a thought sequence:

> Glenda *sees* that the squares could be treated as basic elements. The square-configuration could be *seen as* a puzzle. She *sees that* this metaphor leads to nowhere. She tries another metaphor: *Seeing* the square pattern *as* casbah[57]. She *sees that* in a casbah there are confined territories. (op. cit., 132)

[57] casbah – a traditional, densely built-up district of Arab cities

Goldschmidt calls the sketching process the dialectic between ‘seeing that’ and ‘seeing as’. These periodically interweaving modes (Fig. 47) illustrate the role of graphical representation in design thinking. The results of the experiment showed that designers do not depict the images stored in their minds, but – by creating visual representations – they trigger images of the designed unit.

The designers’ activity consisted in drawing and redrawing lines, shapes and objects until they were able to read something useful from the drawing (a parallel with the formulation and reformulation, described by Donald Schön, arises here). Goldschmidt called this action an ‘**interactive imagery**’. Thanks to it, both the imagery and the image triggered by it are created at the same time. Thus, sketching goes beyond merely representing the idea – the experiment showed that sketching was aimed at searching it (op. cit., 131).

The interactive imagery is associated with the phenomenon of perceptual instability of ambiguous figures. Ambiguity occurs when a single image perceived at the sensory level in the further process of the synthesis of features as well as identification and recognition induces different interpretations (Zimbardo 1999, 273; Mączynska-Frydryszek, Jaskólska-Klaus and Maruszewski 2001, 210–211), as illustrated in Fig. 48. Depending on the glance, one can see a vase or human profiles in the left drawing. The right drawing can be identified as two intersecting triangles, a hexagon with triangles attached to its sides or a six-pointed star. The reading of ambiguity in a drawing can also be influenced by the perceptual set (Fig. 49), mentioned in Subchapter III. 2 (see p. 61).

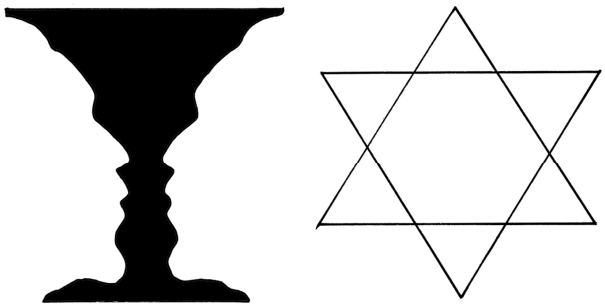


Fig. 48

Simple examples from Fig. 48 have a finite number of interpretations, while in designing, ambiguity can have a very complex form and constitutes a basic feature in creative thinking, which is confirmed not only by Goldschmidt’s study, but also by the below-mentioned experiments.

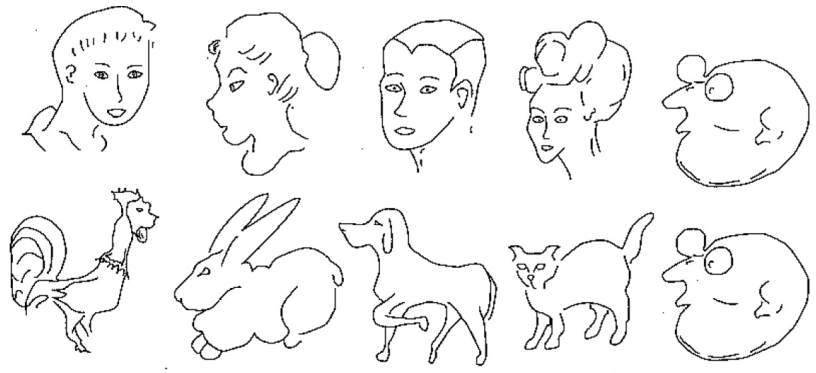


Fig. 49 The last figure in a row is most often interpreted differently,
depending on the drawings that precede it in the row: at the top as a man with glasses, at the bottom as a rat.

Twelve designers took part in the experiment conducted by Vinod Goel: six graphic designers and six engineers. The graphic designers were given the task of creating a poster, while the engineers – of creating two simple objects. Both groups performed the task twice: Once, by using a basic CAD drafting tool (MacDraw 1.9.5), the second time – by sketching. The research results emphasise the importance of the ambiguity of freehand sketches at the conceptual stage. The designers were able to read much less new information from the drawings made using CAD. Goel notices that the ambiguity of freehand sketches does not allow to concretise the solution too early and to block other options (Goel 1995, 193–219). The specific system of symbols, which make up a drawing, has a very condensed character. Its semantic saturation stimulates associations and converting one concept to another – it supports the occurrence of lateral transformations – one of the most important cognitive processes taking place during the first design phase (structuring the problem and preliminary design). In subsequent design stages (design refinement and detail design), vertical transformations occur, i.e. more accurate elaboration of one selected solution (Fig. 26) (op. cit., 125–126, 190).

Masaki Suwa and Barbara Tversky organised a study with the participation of two architects and seven architecture students (Suwa and Tversky 1997). The task, which was carried out with the use of a freehand drawing, consisted in designing a museum on a plot given by the organisers. Designing was filmed and formed the basis for designers' report on their activities. Design moves have been divided into segments, links and chunks. Much more continuing segments and dependency chunks were distinguished in the architects' works than in the students' ones. Architects took a longer time and analysed the topic deeper, probably because they were able to read more information from the sketches. The research shows that architects change the subject of interest in an

opportunistic manner, building corresponding associations (lateral transformations are activated), which affects the order in which related topics are considered. Contrary to the students, the professionals have studied them in a hierarchical order to a larger extent (affecting vertical transformations). The results of the experiment confirm the significance of Gabriele Goldschmidt's 'seeing as', enriching her research studies with categories of information that both architects and architectural students are able to read unintentionally from the drawings.

A similar experiment was carried out by Zafer Bilda and Halima Demirkan (Bilda and Demirkan 2003). Architects, asked to design a residential interior, had freehand drawing and CAD program (AutoCAD in 2D and 3D version) at their disposal. After the experiment, the participants described their actions on the basis of video tapes. Each of them had been assigned the task of using freehand drawing and CAD alternately, in the following order: 1) freehand drawing – CAD – freehand drawing or 2) CAD – freehand drawing – CAD. The research study focused on the 'learning effect', i.e. on checking if there is any change in the design after returning to a given technique in the third step of the sequence. It turned out that in the first case the initial drawing was finally changed; the learning effect was therefore noticeable. It was not observed when CAD tools were used; however, it may be related to the good drawing preparation of the participants in opposition to their poor knowledge of CAD program. The study, as in the case of Vinod Goel's experiment, showed less 'cognitive actions' when using CAD. In the opinion of the authors, the CAD programs existing at the time of the research study contain symbolic representations which do not correspond to those used by designers. As a result, CAD drawings do not evoke creative associations.

The aforementioned research pointing to the dominant role of drawing in the creation process contrasts with the study carried out by Zafer Bilda, John Gero and Terry Purcell (Bilda, Gero and Purcell 2006). Three experienced architects took part in it. They participated in two design sessions. During the first one, after the presentation of the task (a house for an artist and a dancer), their eyes were blindfolded. The participants designed their concepts by describing their thoughts verbally. At the end, after their eyes were uncovered, they had the opportunity to save, but only in one single version, their solution. The second session took place using sketching and concerned a new topic (a house for a large family). The design results were evaluated by a jury of architects who didn't know which drawings were made during which of the sessions. There were no significant

differences between the first and the second session, except for the higher frequency of recall actions reminding the participants of the details of the task in the first session. Designing with blindfolded eyes was based only on imagination and memory, bypassing the 'dialogue' between the designer and the sketch itself, whose great significance was indicated by the previously mentioned experiments. The results showed that sketching is not a tool necessary in the conceptual phase. Interestingly, the participants' comments contradict the results of the experiment – the participants deemed sketching as essential in the initial phase of the design, claiming that in their architectural practice, they would not be able to design without freehand drawing. During the first session, they felt frustrated because of their inability to transfer design ideas onto paper. They added that in the first phase, holding a pencil in their hands, they would accomplish the task much faster and the design idea would have had a different form. The conclusion drawn from the research study is the importance of drawing as an information storage medium that supports the designers' limited memory.

The experiment which also undermined the view that drawing is indispensable for designing was conducted by Ben Jonson (Jonson 2005). The group was composed of five students and five practicing designers from various fields (fashion, architecture, graphic, product, and general design). The tasks were adjusted to the profile of the respondents. The range of design tools they could use included: sketching, building mock-ups, verbalisation (in the sense of a spoken and written word, also using the Internet), CAD programs (2D and 3D; Adobe Photoshop, Illustrator, Macromedia Director, Rhinoceros). The participants themselves reported on the tools they used; interviews were also conducted with them. The results questioned two common opinions that: 1) drawing is the basic tool for creating concepts, and 2) computer-based design is unsuitable at the initial design phase. Drawing was not the most used tool for any of the participants. In each case, reaching the idea was a process combining the use of tools such as sketching and CAD programs, or modeling and verbalisation. Verbalisation turned out to be the most popular. The author of the study emphasises its importance not only as a means of communicating with the outside world, but also as a tool for internal dialogue. According to Jonson, the visual representation of the idea depicts only its 'surface', while its meaning is embedded in the deep structure of the language; similarly, the significance of language – along with the gesture which is the most important primary tool (see p. 23) – has been mentioned by Christian Gänshirt (Gänshirt 2011, 103). Giving meaning to

something is not directly related to a specific tool. The conviction about the inadequacy of CAD tools to the conceptual phase results precisely from the perception of them only as methods of representation, while they go beyond this definition, according to Jonson.

An example of such creative possibilities that CAD programs offer is a new form of processing the information coming from the environment. The record of mathematical rules underlying the proportionality becomes available. It is possible to imitate nature; the imitation of nature can have a visual (drawing) or genetic dimension leading to a deep understanding of the processes of the formation of animate and inanimate nature and its logic of action.

> The transcoding nature of the digital medium enables automatic translation of symbols stored/recorded in different coding conventions. The control of complex algorithms opens access to natural patterns, not at the level of physiognomic observations, but through the simulation of processes (growth, multiplication, selection). The use of programmable building components allows to change the spatial configuration in real time, and thus – to generate messages that are the result of interaction.[58] (Słyk 2012, 126)

The design idea arises as a set of encoded dependencies, and not as an object, as in the case of a traditional approach to design. The new dimension of the imitation of nature builds a deeper level of understanding of the human life environment which goes beyond the observation of visual aspects, and is a rich source of inspiration.

Most of the experiments cited above confirmed that cognitive processes and creative thinking depend on the tool used. It is difficult at this point to assess how these currently available variants of creating the form of an object will affect the architecture which surrounds us; it is worth noting, however, the difference between the traditional process of design thinking and the new one, in which the architect or urban planner appears more as a software developer. Without the software programming, individualisation or modification skills, all the designer can do is rely upon the possibilities of the system created by the IT specialists. In this way, the tool can limit the designer's creative output and may put one solution before the other. The designs of first-year students, who often use cuboid solids in their concepts and rarely rounded shapes and irregularities, are the most blatant examples of the above statement. This is due, among other things, to limited knowledge

[58] 'Transkodujący charakter cyfrowego medium umożliwia automatyczne tłumaczenie symboli zapisanych w różnych konwencjach kodowania. Kontrola złożonych algorytmów otwiera dostęp do wzorów naturalnych, już nie na poziomie fizjonomicznych obserwacji, lecz przez symulację procesów (wzrostu, namnażania, selekcji). Stosowanie programowalnych składników budowli pozwala zmieniać konfigurację przestrzenną w czasie rzeczywistym, a co za tym idzie – wytwarzać komunikaty, będące skutkiem interakcji.' (translation into English: Monika Fryszkowska)

of CAD software which uses the two-dimensional representations, as well as to the use of the software at a too early design stage.

The existence of ambiguity is one of the most important differences between design thinking using drawing and CAD software. In the case of drawing, ambiguity is the basis for reaching the design idea, while in the case of digital tools – ambiguity cannot be accepted, as the computer requires specific data. The first attempts to examine the form do not differ much as to the required degree of accuracy of the record from the final attempts. Premature precision often deters designers from introducing changes at the initial design stage, when a critical look at the design and noticing the need for modification is crucial. Digital tools allow to program irregularities, but not to program the cases which trigger alternative ways of thinking, or 'dead ends' (see Fig. 28) which constitute a permanent element of creative ventures not only in architecture and urban planning. The above cases which should not be understood as 'accidents', but rather as a starting point for further elaboration.

Each medium a designer uses can be compared (albeit with some reservations) to the language. The language created by humans is always full of imperfections and tolerates inaccuracies. It affects reception and interpretation. Inaccuracies and ambiguities of verbalisation are also the essence of drawing, based on the natural human ability to interpret. The computer cannot interpret anything in a creative manner. The language it uses has to be precise. The 'discussion' between the designer and the computer must also be precise, in opposition to the drawing 'conversation', described by Donald Schön.

An attempt to transfer ambiguous freehand sketches to the computer was made by Ellen Yi-Luen Do in her doctoral thesis (Do 1998). The author believes that the ambiguity of architectural drawing can, to some extent, be framed, and that computers can be programmed to read an architectural drawing. Her studies described in her dissertation, as well as in a separate article (Do, Gross and Zimring 1999) reveal four observations. First of all, designers devide, in their design drawings, the universal set of symbols and arrange them in a conventional and coherent manner. In addition, they choose the method of imaging with regard to the context of what they want to convey. For example, designers mark open views on the plan with arrows or an angle of 60° (perceptual span), and lighting issues on the cross-section – with lines symbolising the sun's rays. Thirdly, written comments resemble a password or a label. Fourthly, there is a mutual understanding between designers, when it comes to the symbols in drawing. Based on these results,

Ellen Do managed to create a program which recognises, although to a limited extent, the convention used by the illustrator, the context of the drawing and the intentions of the designer.

An ambiguous character, leaving information gaps that can be creatively used, is not a feature specific only to drawing. It can certainly be attributed to verbalisation and physical models. There are also interesting and creative experiments concerning digital techniques creating ambiguous images, subject to interpretation. The example has been presented by Matthew Austin and Gavin Perin who have modified the digital drawing, by creating a 'glitch'. The glitch is created by changing the binary code of the image, so the conversion takes place at the basic level of data storage. Fig. 50 shows an example of

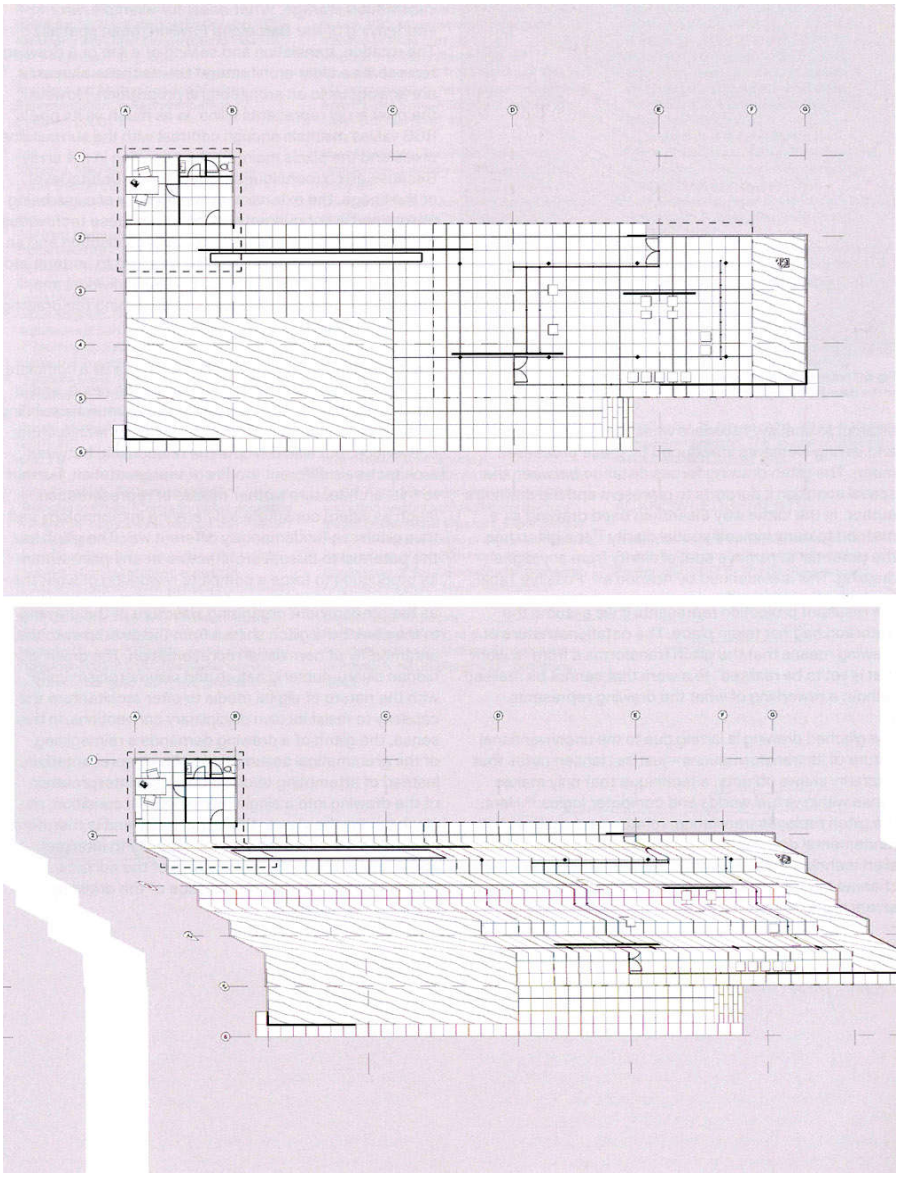


Fig. 50 Matthew Austin, Gavin Perin, 'Glitch'

such an action – the plan of the Barcelona Pavilion designed by Ludwig Mies van der Rohe and its version subjected to the action of the glitch. The lack of unambiguous interpretation of the modified drawing may cause a reaction of rejection or – and here the potential of the glitch appears – force the observer to verify his/her views on the original image. This leaves room for interpretation – the glitch can be seen, among others, as an illusion of three-dimensionality (e.g. as axonometric projection or stairs) or as a two-dimensional plan with a 'crooked' projection. The glitch interferes with the adopted convention specific to the architectural drawing, triggering new ways of thinking (Austin and Perin 2016). It is an example of a programmed case; therefore, it is not characterised by the unexpected events which take place during freehand drawing.

V. 2. 5 Convention and meaning

The architectural drawing uses a specific record convention, which Leszek Maluga describes as a set of rules for the recording of a design idea. Maluga points out that the convention can also be understood more narrowly, with reference to the characteristic style of the author's representation adopted by the artist, to the style of the artist's work or his/her creative output (Maluga 2006, 28–29). In this dissertation, the broader definition of convention will be the subject of debate. The convention is made up of imaging methods mentioned in Subchapter II. 3. 1, mainly of: orthogonal projection, axonometric projection and perspective, requiring the learning of rules. The three-dimensional project is noted through a two-dimensional drawing, based on a concise, linear notation, affecting its largely abstract character (see pp. 52–53). It is necessary to use symbols, being both the line itself and the elements of architectural and urban planning 'language' recorded with it.

Due to these properties, drawing can record the semantic value of the architecture understood as '(…) a set of features expressing specific contents of a given form using signs and symbols'[59] (Krenz 2010, 35). These qualities determine whether the initial content of architecture will become clear and whether it will possess cultural values in space. The latter are contained in the layer that connotes the meaning of a given object (which can be called 'a reference'), including additional contents, thoughts, phenomena

[59] '(…) zespół cech wyrażających określone treści danej formy przy zastosowaniu znaków i symboli' (translation into English: Monika Fryszkowska)

and concepts which are not directly related to it.[60] The author lists the elements that make up this category: prestige and status; ideals and aspirations of the era; time: the past, present and beyond time; metamorphoses, quotes and reinterpretations; sacrum; nature; local identity, localism; moods; art and new means of expression; the energy of shapes and the magic of numbers; illusions, appearances, utopias and chimeras. The connoting layer stands in opposition to the sphere denoting an architectural work, defining its structure and function, being a 'fact' (op. cit., 38, 42–63).

Decoding both architecture and drawing which records it within the connotative layer requires 'thinking in representational terms' (Scheer 2014, 195), which means understanding the non-literal and going beyond what is visible. This applies both to lapidary sketches that combine facts and events seemingly having little in common, as well as drawings using the orthogonal projection convention, assuming an effort to read the symbolism and meaning. Metaphorical language dominates particularly clearly in autonomic architectural drawings (see V. 4). In opposition to such a notation system, there is a record in the form of a three-dimensional model, based on the simulation of the designed object. It shapes a completely separate thinking and communication pattern, because the information received and the information transmitted diverge widely – it has a literal character that does not require any competences from the receiver. It is worth taking a closer look at the phenomenon of simulation itself[61], before it is referenced to the drawing.

Simulation in the general sense is an artificial environment aimed at creating the experience of reality as accurately as possible in the receiver through most accurate imitation. Simulation, addictive and pleasant, deeply engages the mind. The means used to create it are usually completely different from those that gave rise to the simulated reality (op. cit., 31, 34). It does not matter why it triggers a specific reaction and what means have been used to achieve this effect, because it is only the reaction and reception that matter in the simulation. Its presence can be observed in various walks of life, e.g. current marketing activities are more focused on the sale of experiences and emotions rather than specific products; this is how the message addressed to the consumer is

[60] Jacek Krenz, in his didactic work with architecture students, developed the ideographic method of designing an architectural form based on a sketch and an ideogram, and thus a 'synthetic graphic sign which – in the most basic way – expresses simultaneously the shape and the idea.' (Krenz 2010, 77) The ideogram allows not to lose the connoting values of the design, and through its ambiguity – stimulates the imagination and interpretation.

[61] The publication titled *Simulation. Präsentationstechnik und Erkenntnisinstrument* [Simulation: presentation technique and cognitive method] (Gleiniger and Vrachliotis 2008) elaborates on this topic in more detail.

formulated. The widespread presence of this unrealistic mode of perception results from the influence of mass media which have accustomed receivers to take appearance for reality. Society has learned to accept experience without context. Simulation is a spreading cultural phenomenon which touches upon such basic areas as interpersonal contacts, simulated by social networks such as Facebook. Simple examples of simulation are also amusement parks or flight simulators. In the area of architecture, it can be illustrated by shopping centers in which streets with shops on the ground floors are simulated. An interesting example of urban-scale simulation is provided by an identical copy of Hall-

Fig. 51 The town of Hallstatt, photo: Miriam Risager (left) and its copy created in China (right)

statt, a historic Austrian Alpine village located in the Chinese city of Huizhou (Fig. 51).

Drawing is based on symbols which have reference to the real world. Between such a sign and reality, there is always room for interpretation; drawing has neither the ambition nor the possibility to replace or imitate reality. Simulation is based on completely different principles – instead of recognising and using the difference between symbol and reality, it substitutes reality with its superficial copy, with the very experience of perceiving reality and offering nothing more apart from that experience. Simulation has the potential to pollute all reality by rejecting all references to it. Due to the non-literal character of the drawing, the latter acts as the guardian of the deeper meanings in design than just those resulting from aesthetic, functional or structural explorations. It links the world of thought and the world of representation. Simulation disconnects this relationship between the product of the designer's actions and the design itself, because it tries to imitate the building as accurately as possible; it 'becomes' somehow the designed object. There are no further links to external content – the design can only be 'read' within the simulation itself. Drawing as a representation is partial, while simulation is holistic –

there is no need to search for ambiguity and metaphors. David Scheer explains the possible sources of this phenomenon. The comprehensive understanding of the functioning of software programs does not constitute the knowledge available to architects. Architects must trust the authors of such software programs – IT specialists – limiting themselves to operational understanding. Handling tools without understanding how they operate and the general features of the simulation commonly used by them may lead to shallow design thinking. According to Scheer, this also has the potential to change the face of architecture and urban planning by diminishing their impact[62]. The status of architecture as an object of public discourse becomes jeopartised, as the way of practicing it changes, the content it contains change and therefore also the reception (op. cit., 44, 197).

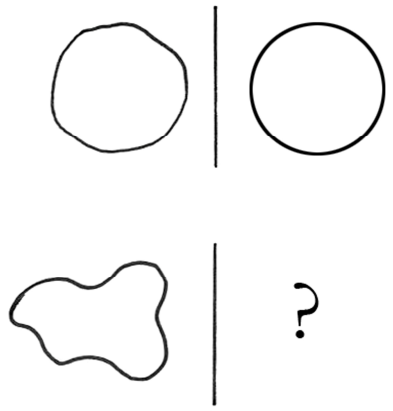


Fig. 52

Robin Evans distinguished three geometries appearing in architecture: compositional geometry, projective geometry and signified one. Their occurrence was associated with the changing concept of space and time, affecting architecture. Compositional geometry is combined with the absolute measure of objects described by Euclidean geometry. Projective geometry is based on the description of a three-dimensional object through its views. The third type of geometry carries the semantic load (Evans 2000, 349). Man-made geometry is based on concepts that, contained in the products of human hands, never reach the ideal image of a geometric solid, but only refer to it (op. cit., 354–355). The mind searches for well-known and remembered patterns (which correspond to, among others, Arnheim's perceptual patterns) and universal concepts, such as the Euclidean axioms. Even a very inaccurate freehand drawing of a circle evokes in our mind the image of a perfect circle (Fig. 52). A form is created from the relationship between the real object of perception and the ideal stored in our mind.

David Scheer suggests adding to the three geometries distinguished by Evans the fourth one – virtual – relevant to computers, corresponding to the digital record. The

[62] Another view is represented by Antoine Picon who thinks that the meaning of contemporary architecture (which he understands as 'digital' architecture) does not involve reading it as an interpretable sign, as Jacek Krenz mentioned. It gains significance either as an event (and thus through all possible interactions it stimulates) or in the form of a 'new materiality' – a concept that Picon combines with technologies that enable the simulation of sensory experiences in the digital world. The idea of sustainable development that gives a deeper dimension to architecture can become the third option (Picon 2010, 110–112).

author argues that the fourth geometry no longer links man with abstract, ideal concepts, because computers cannot process them. They carry out exact operations on numbers. In order to use computers for geometric transformations, people had to transfer concepts to the software program, and somehow translate them. Software programs do not provide evidence for the existence of universal dependencies, they can only save them. According to Scheer, the effect of switching from the representation mode to the simulation mode is the loss of the epistemological function that the geometry once had. Scheer also notes that people cannot think in virtual geometry mode. They must rely on sensory objects or their images – e.g. a graphic representing a solid model, a 3D printed object – that is, on objects generated from virtual geometry. As a result, these objects are 'simulations of simulations, algorithmically generated experiences of algorithmically simulated geometric operations'. Forms defined geometrically as ideal are characterised by symmetry, which facilitates their storage in the mind. The computationally generated shapes most often do not replicate this property, although there are also such that convey the sense of order and ideal without this feature (Fig. 52). Often, the mathematical order is readable by man only after showing its visual layer (Scheer 2014, 145–149).

Computational design has opened up a wide field for the use of complex, irregular forms in design, as Antoine Picon points out (Picon 2010, 60–72). Their previous absence from the architectural code confirms the relationship between the tools and the development of exact sciences, and the architectural expression. In this respect, architectural drawing limited creative freedom. Mario Carpo calls this barrier a 'notational bottleneck' – forms that were difficult or impossible to measure on drawings were excluded from the architectural alphabet (Carpo 2011, 31–34). Robin Evans quotes the struggles of engineers focused on the most accurate mathematical description that reflects the sculptural form of the chapel in Ronchamp created in the form of a freehand sketch. Finally, the roof received a regular shape, although still refined, close to the original drawings of Le Corbusier (Evans 2000, 301–306).

A quite demanding task in design is to achieve a balance between its qualitative and quantitative criteria. The use of BIM technology may result in the determinant of economic viability coming to the foreground (see II. 4). Quantitative indicators such as structure of the object, materials used, spatial programme, thermal insulation requirements, etc. they are objective in nature and easy to implement. Qualitative criteria, such as the meaning discussed or the overarching idea emerging in the design concept phase,

resulting from the designer's sometimes subjective and abstract associations, a reference to the context, social, cultural and emotional impact, or aesthetics are difficult to put into numbers. The dual nature of architecture is a unique feature that distinguishes it from other fine arts. The presence of a drawing at the pre-design stage (including in the context study) and at the moment the concept is created can thus direct designers' attention to non-measurable architectural and urban planning features (see V. 1. 4), to its semantic layer, among others.

On the other hand, the convention used by architectural drawings has been subjected to criticism many times. Bryan Lawson coined the term of 'image trap' reflecting the situation in which the designer focuses on refining the drawing, and not the design solution (Lawson 2005, 229–232). This is the case, among others, when designing gives preference to selected orthogonal projections. If the work focuses on the plan, the architectural expression of the building may be limited only to the function of 'packaging' of the object's horizontal layers. The same problem also occurs in urban planning: 'Thinking about space was often limited to a two-dimensional urban development plan, whose fascinating drawing sometimes became an art in itself, without predicting how space would be shaped on the basis of this plan.' (Wejchert 1984, 6)

A drawing record based on conventions and interpretations carries the risk of misreading the content. Design sketches can be too hermetic and difficult to decipher by someone other than the author, and therefore not useful in a wider group. This applies both to the drawing (which causes financial losses in the design process) and misinterpreted architecture, 'speaking' in a different way than the designer assumed, which should be theoretically eliminated by simulation checking in advance the building's impact. Simulation, as an excellent verification system, may also limit the implementation of unrealistic design ideas based on designers' erroneous and top-down assumptions.

The admiration over drawing skills (but also other, e.g. computer proficiency) may shift the direction of the designer's interests towards aesthetic considerations at the expense of the object's function and structure. Ewa Blau and Edward Kaufman note: 'Instead of form following function, form would continue to follow form, as the architect substituted personal preferences and elitist tastes learned at school and from professional magazines for the real needs and preferences of users'. They see the computer as a remedy for this problem. Information is entered into the computer in a finite and logical form, hence it seems to be a medium exclusionary of ideas arising from personal and irrational

reasons (Blau and Kaufman 1989, 146). One may wonder whether it is possible to have final data in the early design stage (this is in contradiction with the characteristics of the design problem, see IV. 2), however the problem of linking the 'image trap' to the favouring of the object's external conditions does occur.

The convention of the record, i.e. of the perspective, can affect the fragmentariness of the perception of space through the selection of views, and also aspects of the design. This topic has been discussed in more detail in Subchapter V. 3. 2.

Bruno Zevi, quoted by Tom Porter, notes:

> All the techniques of representation and all the paths to architecture which do not include direct experience are pedagogically fruitful; but their function is no more than allusive and preparatory to that moment in which we, with everything in us enter and experience the spaces we have been studying. That is the moment of architecture. (Porter 1997, 129)

Simulations try to match this experience, and their improvement will take place over time. However, they will always be poorer than reality in the metaphorical and non-material features that have been highlighted above.

V. 3 Transfer and presentation of thoughts

Communication in design is one of its most important elements, because the complexity of the project problem requires the division of tasks among team members. Research has shown that the design process, widely perceived as engineering, is in fact more of a social process (Bucciarelli 1994; Murray 1993).

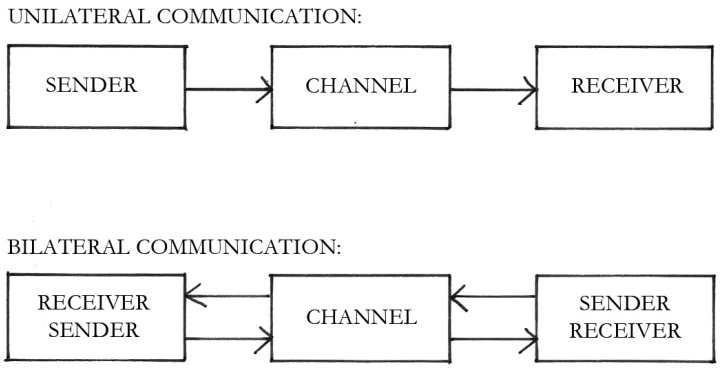


Fig. 53

The architectural drawing appears as a message: 1) among professionals involved directly in the creation of a building (within the design team or on the construction site)

and 2) directed towards a wider group of receivers from outside the professional group. It can therefore have 1) a private form and function more as a transfer of thoughts and 2) a public form – constituting their presentation. Robert Knauer distinguished two forms of communication: bilateral (dialogue) and unilateral (monologue) (Fig. 53) (Knauer 2002, 9). Bilateral communication occurs more often in the first situation – at the moment of discussing design solutions within a group of people involved in the preparation of a building design, and unilateral communication occurs while demonstrating ready solutions to a wider audience. There is a 'channel' between the sender and the receiver, which Knauer defines as 'a material medium that transmits a message from the receiver to the sender'[63] (op. cit., 8). Drawing constitutes such a medium of communication, inter alia. Knauer's message triangle 'sender – communicator – receiver' also appears in an extended form: 'sender – message – encoding – signal – channel – signal – decoding – message – receiver' (Fig. 54). The element encoding and decoding information, which is related to the aforementioned architectural drawing convention, is of particular interest to us. Leszek Maluga lists various forms that drawing codes take: 'elements of art techniques, graphic systems, methods of space projection, symbols containing standardised information, etc.' and points out that the possibility of communication process to take place depends on the condition that both the sender and the receiver have similar

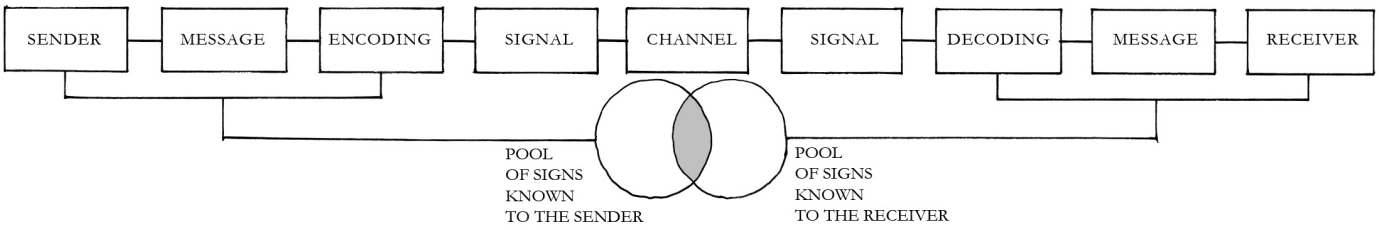


Fig. 54

knowledge of the above (Maluga 2006, 28).

V. 3. 1 Transfer of thoughts within the design team

Drawing is an essential means of communication in the dialogue between design team members. Designers, accustomed to the visual formulation of their thoughts, favour communication in this form. The design team shares not only knowledge, but also the

[63] '(…) das materielle Medium, das eine Nachricht vom Sender zum Empfänger befördert.' (translation into English: Joanna Pętkowska-Hankel)

ability to use the convention of architectural drawing. Sketches for communication purposes within the design team are characterised by a small degree of refinement, conciseness and a high degree of abstraction, which results from the speed of their formation triggered in turn by the desire to receive feedback immediately. This is particularly evident during the design workshops (e.g. charrette), whose main feature is the intensification of design and, as a result, giving a specific time frame. Efficient and fast communication within the team of experts forms the basis for the workshops.

Drawing, which since Alberti's time has shaped the designers' environment, makes it possible to present the design only in a fragmentary form, depending on the size of the paper format. This fact did not constitute a significant limitation in times past, when the majority of buildings were characterised by the symmetry and repeatability of forms and construction systems. Along with the emergence of asymmetrical and atypical solutions, which differed from the canons and patterns dramatically, drawing has become a hindrance to their implementation. The explanation of complicated forms by means of orthogonal projections required the creation of a huge number of drawings of great complexity. In order to deal with these problems, a method of communication was created, which consists in providing by the designers drawings finished to a certain degree of detail to the construction site and 'completing' the missing information by contractors. This led to the consolidation of Alberti's separation of design and construction. Failure to interpret information gaps is the basic factor, apart from misreading, leading to data loss (see II. 4. 3). The elimination of these barriers has become possible thanks to the BIM information management system. The approximation between design and construction by integrating the data about the design project, its implementation and operation stems from the need to eliminate expensive losses associated with the faulty coordination of information. Freehand sketches, which – created by the designer, often directly on the construction site – explain to the contractor the intricacies of detail or the object's form (Fig. 55), are no longer needed thanks to the BIM system. They are replaced by quick access to a three-dimensional model of the object and two-dimensional documentation on a smartphone or tablet, enabled by applications such as BIMx created by Graphisoft.

Drawing strengthens the social aspect of design which, in turn, in the environment of the digital BIM database becomes less important in the sense that the physical contact between designers is not a prerequisite for effective communication, as was the case in the process based on architectural drawing (Fig. 56).

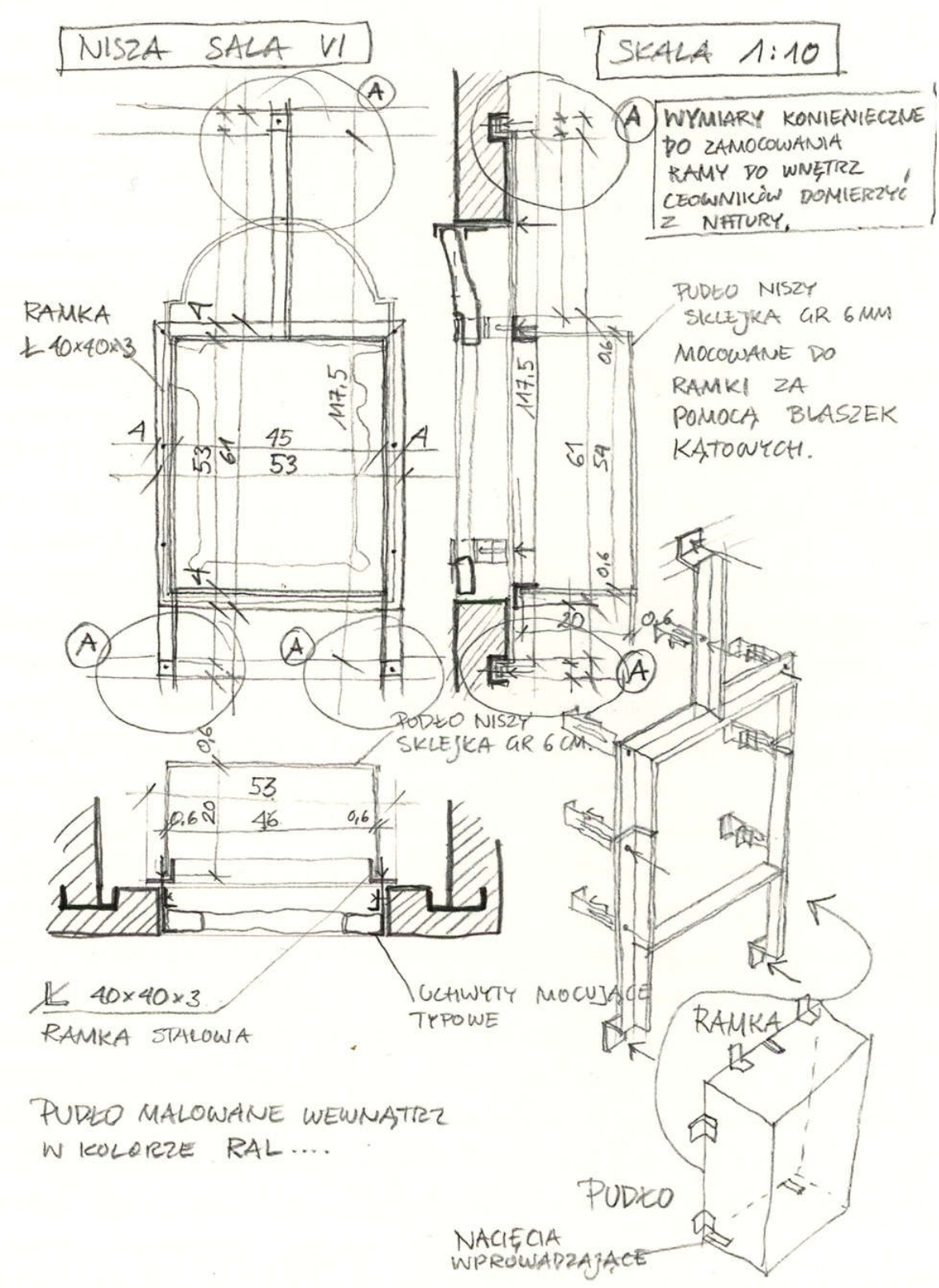


Fig. 55 Mirosław Orzechowski, design sketches for the Faras Gallery at the National Museum in Warsaw

Fig. 56 Architecture students at the École des Beaux-Arts in Paris, around 1930;
The material dimension of the created boards favoured the exchange of information, critique or simple friends' help in labour-intensive sketching, desired in the state education. These phenomena have now disappeared or will disappear, as designs are created in a virtual space on the screen of a laptop, which is more difficult to 'interest the neighbour'.

V. 3. 2 Presentation of thoughts to stakeholders and a wider audience

The drawing code, which is an architectural drawing convention, is often responsible for incorrect communication. Recording errors may appear already in the encoding phase, but it seems that the decoding stage is responsible to a larger extent for the resulting difficulties in the flow of information, especially at the key moment, which is the discussion of the project with stakeholders and presentation of the design to a wider audience. The audience, mostly composed of people who are not professionally connected to the architectural or urban planning industry, does not usually have the qualifications which allow them to read freely architectural drawings. Robert Knauer notices the problem, stressing that the linguistic division into colloquial and high language also applies to architectural messages. The graphic representation has a 'multilingual' character: from

loose, general sketches to complicated diagrams; that results – in the case of the receiver who is uninitiated in the language of communication – in communication barriers (Knauer 2002, 8). Communication is possible only when the set of signs available to the sender has a common part with the symbol resource recognised by the receiver (Fig. 54).

On top of this, there is a phenomenon discussed earlier on the occasion of perceptual processes: the impact of individual experiences, education and the attitude of an individual toward the stimulus reception manifesting itself at the stage of identification and recognition (see III. 2). Leszek Maluga points out: 'Architectural drawing in the case of a designer completes the process of shaping the architectural idea (visualisation in the psychological and graphic sense). In the case of the receiver (client, viewer), drawing only initiates the creation of a mental image – an imagery.'[64] (Maluga 2006, 63)

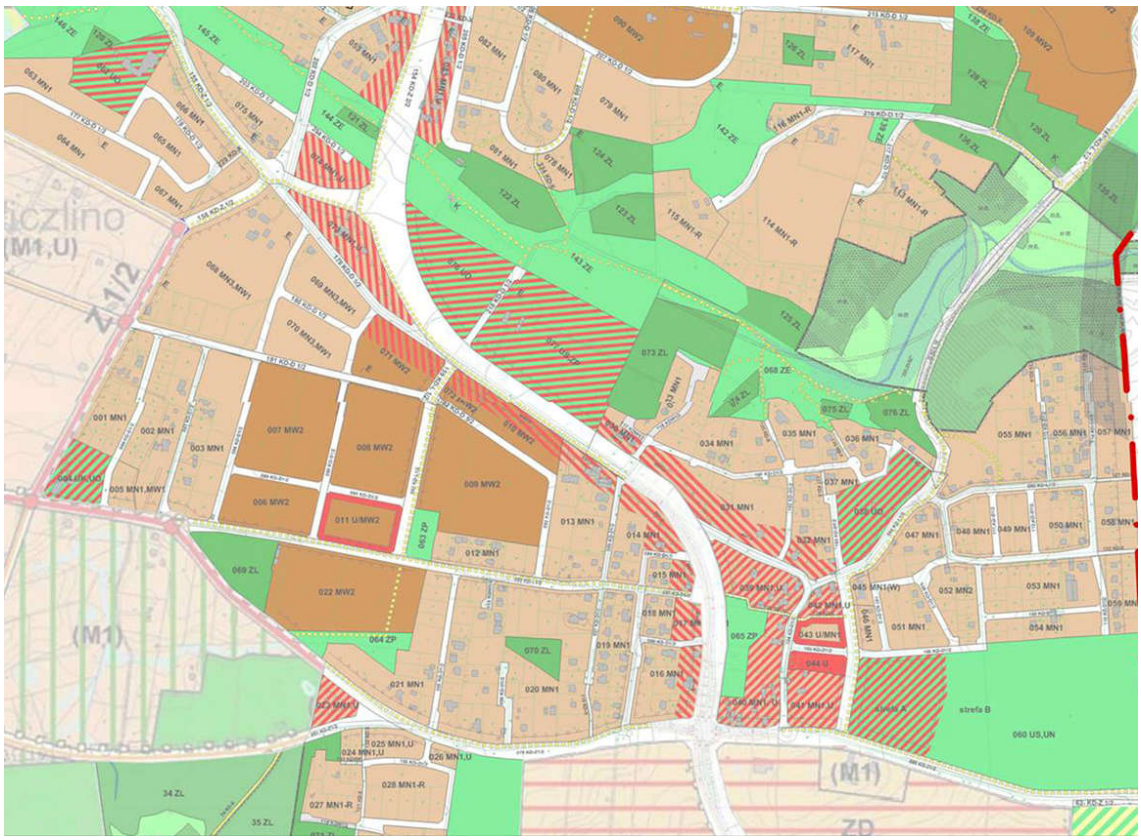


Fig. 57 Fragment of the local spatial development plan
used as a starting material for the 'Gdynia West' design project, 2012

[64] 'Rysunek architektoniczny w przypadku projektanta kończy proces kształtowania idei architektonicznej (wizualizacji w znaczeniu psychologicznym i graficznym). W przypadku odbiorcy (klienta, widza) rysunek dopiero inicjuje powstanie obrazu umysłowego – wyobrażenia.' (translation into English: Monika Fryszkowska)

Fig. 58 Fragment of the so-called masterplan performed during the charrette workshop for the 'Gdynia West' design project, 2012

The level of the receiver's awareness and competence determines not only 'whether' he/she will read the message, but also 'how' it will be read. The dominance of mass culture perpetuates preference for superficial and visual understanding of messages. Similarly, the reception mode is based on simulation which puts the programmed experience before discovering individual interpretations and references (cultural, social, historical and other). This is particularly true of 'immeasurable' aspects of the design, such as the identity of the place or its aesthetics, which often escape the attention of both viewers and creators, also due to the difficult way of recording and transferring them. In this context, Krzysztof Domaradzki points out:

> [U]rban planners, if they want to treat the identity and aesthetics of space as values that should be promoted and implemented in the process of urban development, should find a language for their description which can be used both in design studies as well as in public discussions. It should be a simple language, operating with basic concepts, and devoid of complicated terms that cause terminological confusion in the receiver.[65] (Domaradzki 2013, 12)

[65] '(…) urbaniści, jeżeli chcą traktować tożsamość i estetykę przestrzeni jako wartości, które w procesie rozwoju miast należy promować i realizować, powinni do ich opisu znaleźć język, którym można posługiwać się zarówno w opracowaniach projektowych,

An example of graphical material, which urban residents have to face, is the local spatial development plan (Fig. 57). It deviates significantly from the set of symbols readable even for a layperson. Such plans require taking time to study the legend and refer it to the drawing. At the charrette workshop, efforts are made to ensure that the designed and existing plans are understood as intuitively as possible (Fig. 58). It means referring to symbols that function widely in culture and are easy to decipher, despite the fact that they differ significantly from the realistic representation. This is especially important while presenting the plans that, through the use of orthogonal projection convention, are representations which significantly differ from nature/reality and do not refer to perception. In order to imitate it better, the plans complement the bird's eye view perspectives (Fig. 59–62).

Fig. 59 Max von Trott zu Solz, watercolour, bird's eye view perspective
made during the charrette workshop on the 'Gdynia West' design project, 2012: existing condition

jak i w dyskusjach publicznych. Powinien być to język prosty, operujący podstawowymi pojęciami, i nie zawierających skomplikowanych terminów, które u odbiorcy powodują zamęt pojęciowy.' (translation into English: Monika Fryszkowska)

Fig. 60 Max von Trott zu Solz, perspective attached to the ‘Gdynia West’ design project: version I

Fig. 61 Max von Trott zu Solz, perspective attached to the ‘Gdynia West’ design project: version II

Fig. 62 Max von Trott zu Solz, perspective attached to the ‘Gdynia West’ design project: version III

Their essence is to show the most important design elements with the use of simple language, based on repetitive patterns (colours or symbols). Good visualisations are not aimed at achieving maximum realism, but rather at delivering the clearest message. In freehand drawing, emphasising certain aspects (e.g. a stronger outline or colour) and omitting others (e.g. by slightly shifting the elements or ‘blurring’ their contour and reducing contrasts) is an easy task for the illustrator, hence he/she can neatly guide the receiver to key design solutions.

My experience related to charrette workshops reveals a certain tendency associated with faster and increasingly more accurate models made digitally, e.g. in SketchUp. They are a very convenient tool primarily because of the free choice of views and trigger less need to make drawings from the bird’s eye view perspective, because in this perspective computer models gain an advantage – uniform solid figures and planes can be coloured in order to highlight the most important information (Fig. 63). The physical model contains a similar range of data (Fig. 64).

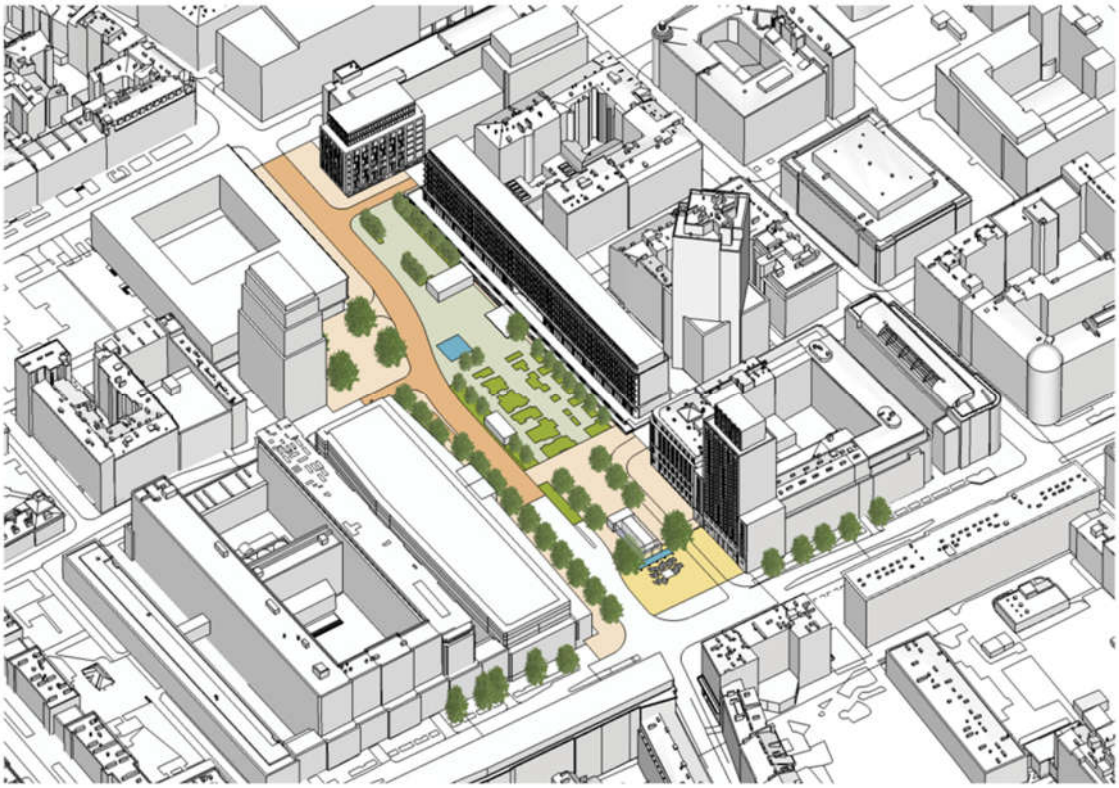


Fig. 63 SketchUp model created during the charrette workshop concerning the Warsaw Uprising Square, 2017

Fig. 64 The physical model created during the charrette workshop concerning the Warsaw Uprising Square, 2017

Fig. 65 Joanna Pętkowska-Hankel, watercolour, perspective drawn during the charrette workshop to the design project of the Warsaw Uprising Square (top), juxtaposed with the same perspective generated from the SketchUp model (bottom), 2017

It is possible to create any number of schematic, digitally generated perspectives, unlike hand-drawn views. The strength of a freehand drawing can be seen most when the mood of the designed space is conveyed, which is best illustrated by the eye-level perspective (Fig. 65). It is rational to use the detail in the case of the eye-level perspective – as opposed to the bird's eye view perspective – and such detailedness should not reduce the clarity of the message. Three-dimensional modeling in order to create street or square

perspectives that simulate what an observer sees, in order to bring out their character, is much more time-consuming. What is more, in a workshop environment with a dynamically changing concept, it is pointless to invest time in the digital modeling of details that do not fall within the range of the study, just in order to create a nice atmosphere in a place. A sketch can easily record in a non-literate way what must be precisely defined in a computer model – for example, the appearance of street furniture or shop windows. At this stage of design, the precision that computers require is not only unnecessary, but can also be detrimental. Final receiver of the design project may be misled, for example by seeing on the printout a suggestion to decide on the form of lamps illuminating the square, a convincing message due to its far-reaching specification and refinement.

The method of fast visualisation of ideas that works well at workshops is also the photomontage compiled from the existing fragments of images (Fig. 66) – especially in situations where the design is outlined in a very general way, and the purpose of the presentation is to stimulate the viewer's imagination. When the design is already refined,

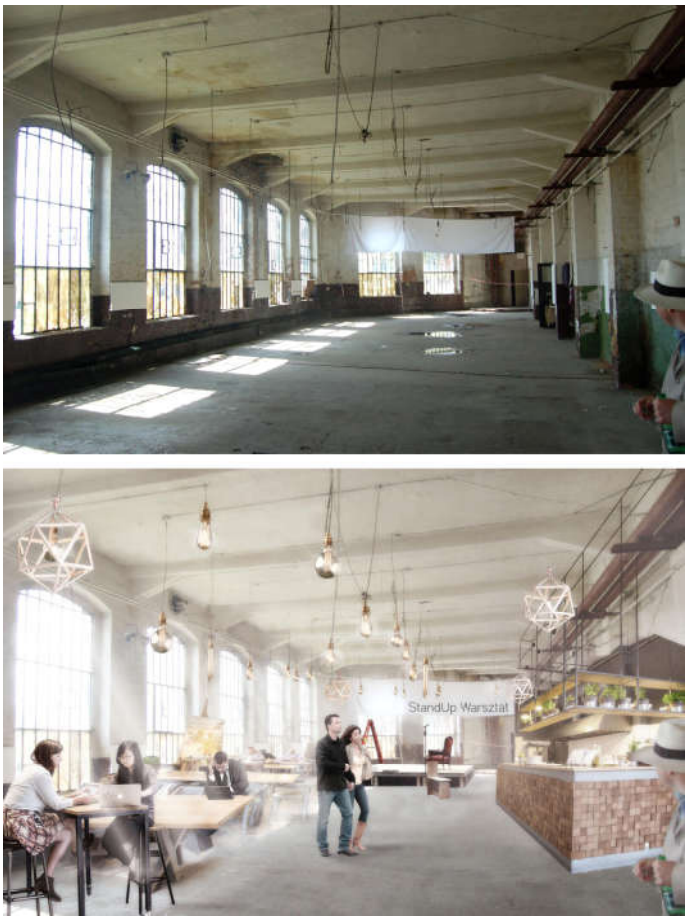


Fig. 66 Daniel Piotrowski, existing condition (top) and photomontage (bottom) made during the charrette workshop on the roundhouse in Gniezno, 2017

it is more difficult (without modeling a new, fixed form) to make a good photomontage – one that does not falsify the design proposal and does not go too far in its concretisation. It is worth noting that such visualisations do not have such a value of personal, artistic expression as in the case of a freehand drawing; they are aimed at expressing the maximum reality possible.

The consequence of the ambiguity of hand-drawn representations which is desirable during the workshop is the sensation of still existing field for discussion on the design. The sketchy nature of hand-drawn visualisations makes the designs pictured by them not have the form of ready-made solutions. They seem like proposals where there is still a wide margin for introducing changes. In this perspective, freehand drawing works well during workshops based on social participation. Such 'sketchy' (also in the colloquial sense) proposals generate comments and stimulate dialogue among participants.

The reverse situation takes place in the case of computer visualisations suggesting the decisive character of the solution and the closure of the discussion. It seems that the design of a given plot has been completed. Meanwhile, in the case shown in Fig. 67, the land owner is only looking for an investor for a given area – plot of land undeveloped so far. The visualisation was intended only to stimulate the imagination of a client potentially interested in the possibilities of land development. This led, however, to misunderstandings at the time of publication of graphic material in the media. Receivers of the design project, convinced that the construction would start soon, ask questions to the owner about the appropriateness of the project which in fact does not exist yet. Such a situation does not occur when the digital visualisation is swapped for a hand-drawn one, because the sketch has an inherent character of the suggestion, and not the final presentation. It is true that the digital drawings give credibility, but it constitutes a disadvantage in the above case.

Fig. 67

It is worth noting, on the other hand, that sometimes a drawing may turn out to be unnecessary or even detrimental in the communication process. The verbal description, both in written and oral form, gives rise to individual ideas and interpretations. The audience or charrette participants have a chance to focus on extra-visual aspects of the design, without being distracted by images. Also, while working within a design team, too quick graphical instantiation may disrupt alternative ways of reasoning. The convention of record, which is an architectural drawing mentioned in Subchapter V. 2. 5, affects, through its linear perspective, the ability to choose the desired views, and thus to distort the message. In addition, visualisations with high aesthetic qualities carry the risk of favouring the visual aspects of the design and underestimating its substantive layer. Manipulating views may distort the real properties of the designed space. The perspective record itself carries distortions resulting for example from the straightening of lines that actually run along an arc. The illustrator can also freely extend or narrow down the perceptual span, which in a single view should span approximately 60 degrees. The illustrator has the ability to introduce or ignore the effect of the third vanishing point. He/she

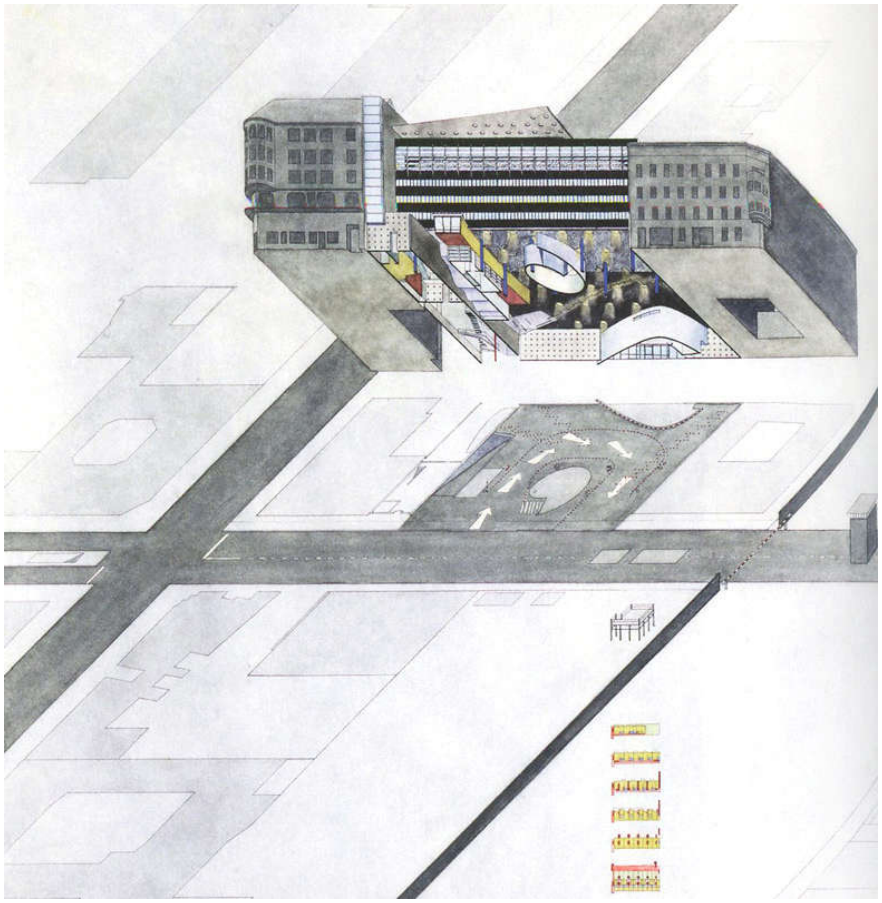


Fig. 68 Matthias Sauerbruch, Elia Zenghelis (OMA), watercolour,
house design at Checkpoint Charlie in Berlin

can also consciously choose the framing to mask the reality. The knowledge of perceptual processes – responsible, for example, for perceiving depth of field through the overlapping of objects – is helpful here. Visualisations also allow the designer to show the building from the perspectives that would never be accessible to the human eye (Fig. 68). Many of these 'tricks' make that freehand perspectives should be treated with a certain distance as to the accuracy of the message. It is worth noting, however, that vigilance should be exercised when using visualisations in general – as the digital visualisations can be adapted to the needs of the message, if necessary.

Static drawing perspectives show only a fragment of reality, which does not correspond to the natural visual perception. Although the human eye exhibits visual fixation, maintaining the visual gaze on a single field of view, the spatial and temporal integration process is the basic one. The elements observed within the field of view change very often. The process of linking visual information from subsequent phases of fixations leads to the creation of a coherent spatial context by combining separate images (see III. 2).

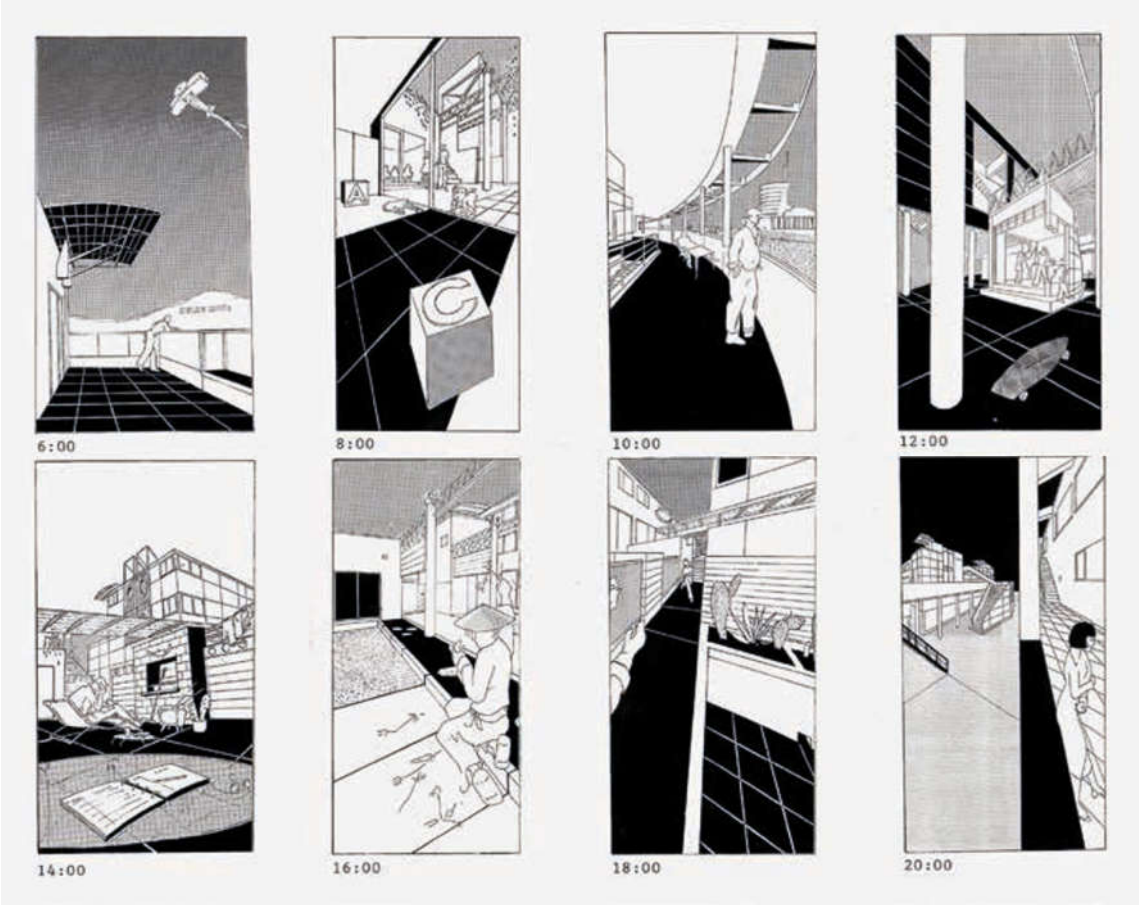


Fig. 69 Hsinming Fung, drawing with ink and a pen as an illustration of the competition design; the storyboard language was used to create a story about low-budget apartment houses.

This effect would have been created only by – quoting Steven Holl – ‘an infinite number of perspectives projected from an infinite number of viewpoints [which] could be said to make up the spatial field of the phenomena of a work of architecture’ (Porter 1997, 118). Designers try different methods, including drawing, to reflect this type of sensation (Fig. 69). It is in part possible thanks to the use of films for presentations. Recent years have brought about the option of presentations with the use of virtual reality, or in other words an artificial environment created with the use of information technology, based on the simulation of stimuli occurring in the real world. Therefore, the BIM system, originally created for the management and coordination of information about the object, has also great potential as a tool for social participation. The presentation of the design based on simulation does not create barriers related to the need to have the competence to read the message, as is the case with architectural drawing.

V. 4 Autonomic architectural drawings

Leszek Maluga defines the autonomic architectural drawings as follows: ‘Among the drawings made by architects, there are images of architectural ideas that arose out of a creative process; however, they only document it and will not be used for the consecutive implementation in real space.’ (Maluga 2006, 9) The author points out that the essence of this type of drawings should be sought in the architect’s intentions at the time of their creation. Autonomic architectural drawings include images that constitute a graphic experiment or a visual record. The usable drawing documentation is not the architect’s intent when it comes to this type of drawings; nor are the designs created on paper, but never implemented due to conditions and reasons which lie beyond the author’s sphere of control (op. cit., 41). The autonomic drawing stands out and gains importance in the context of the above-described changes taking place within the design tools, which is emphasised by Hsinming Fung who coined the name ‘Drawing’, written with a capital letter. In opposition to it, there is a ‘drawing’ which contains in its meaning a graphic documentation of strictly usable value, which was replaced by digital tools. The division is therefore of hierarchical nature. Hsinming Fung gives examples of this type of freehand ‘drawings’, with unprecedented precision which, however, gave way to a more efficient digital tool. Fung contrasts ‘drawings’ plunged currently into a usable non-existence with ‘Drawings’, describing them as the instrument of speculation, exploration and conjecture, especially valuable in the era of digitisation (Allen and Pearson 2015, 208).

The starting point for considerations is the recognition of autonomic drawings as an element of architectural or urban creativity, which may raise doubts as to the lack of direct reference to their content in the constructed object. The rationale behind their important position in the design process is Alberti's separation of design and construction and the recognition of his argument about the superiority of the design (original) over its implementation (copy). The above entails an assumption that the design shows an ideal captured by the language of geometry, which might never be found physically in the building. Robert Evans, among others, claims on that basis that the essence of architecture is not the actual physical object, but its intellectual layer – the design. The record using the orthogonal projection convention, i.e. the geometry used in architecture, serves as a bridge between what is imagined and what is real (Evans 2000, 354). Maria Misiągiewicz discusses the relationship between the building and the record representing it:

> If the accomplished creation is discussed when there is a close correlation between intention and implementation, then, in practice, it should mean that the building's idea is consistent with the intention of the design. It should be noted here that in the case of architectural works, this satisfaction is extremely hard to achieve, due to the specific differences in the subsequent "construction" stages. (…) The recognition for 'drawn architecture' has to do with the fact that the architect has been repeatedly deprived of the possibility to bring about the intended final form of objects. (…) Drawing allows architects to capture and consolidate what is the most valuable in the proposed idea and what can be lost in architectural consumption.[66] (Misiągiewicz 2003, 28–29)

The last sentence clearly shows the significance of the already mentioned intellectual layer of the design, saved thanks to a drawing. For this reason, Misiągiewicz calls not only for the completed objects to be labelled by the term 'architectural works' but also 'those objects created on a drawing' (op. cit., 31).

It is worth taking a closer look at the reasons why autonomic drawings play and will play an important role in the work of architects and urban planners. Leszek Maluga points out that they may complement the design practice (theoretical or aesthetic development), the equivalent of implementation practice (specific solutions to spatial problems not intended for implementation), visions of the future, poetic visions, experiments and forms of contestation and criticism (Maluga 2006, 101–138). All these functions are based on the

[66] 'Jeśli o spełnionym tworzeniu mówi się wówczas, kiedy istnieje ścisła zależność pomiędzy intencją a realizacją, to w praktyce powinno to oznaczać zgodność idei budowli z narysowaną intencją – projektem. Trzeba tu zaznaczyć, że w przypadku dzieła architektury spełnienie to jest wyjątkowo trudne, z racji specyficznych odmienności kolejnych etapów "budowania". (…) Uznanie dla architektury rysowanej ma związek z faktem, że architekt wielokrotnie pozbawiany jest możliwości doprowadzenia do ostatecznego uformowania zamierzonej rzeczy. (…) Rysunek pozwala więc utrwalić to, co w zaproponowanej idei jest najcenniejsze i co może być zagubione w architektonicznej konsumpcji.' (translation into English: Monika Fryszkowska)

fact that drawing enables architects and urban planners the freedom of creation and expression, without restrictions related to the construction process. For this reason, many breakthrough ideas were created only in the form of drawings. Autonomic architectural drawings illustrate 'visionary architecture' (Burden 1999; Thomsen 1997) – objects created in the author's imagination, often going beyond the standards applicable in a given era. Innovativeness visible in these types of drawings often had a significant impact on the transformation of architectural or urban thought, despite the lack of physical objects which could testify to it. Studying this type of drawings in retrospect offers an insight into the then way of perceiving the world. In the twentieth century, the role the visionary drawings played in shaping tendencies in architecture and urban planning was particularly manifest. Their subjective and modest selection (due to the only indirect reference to the subject of the dissertation) is presented below (Fig. 70–74).

Drawing in this sense constitutes a research apparatus, based on associations and references to cultural patterns. Autonomic drawings fulfill, in the highest degree, the role of a cultural act and therefore the second function of drawing, besides the social act, situating the design within the cultural context (Robbins 1997, 5–8, 32–35). As a social act, however, visionary drawings allow discussion about new ideas without the necessity of their physical emergence. Misiągiewicz writes about the importance of experimenting unburdened by the unsuccessful construction project, stressing how important the possibility of thought-imaging is, which can be 'both discovery and disappointment' (Misiągiewicz 2003, 69).

Modern technologies open up wholly new possibilities for implementing this type of visions. They offer tools capable of modeling complex forms. Thanks to information architecture, architects and urban planners can perform experiments, the results of which are subjected to immediate perceptual and utility assessment. The activity of the 'Hyperbody' group which expands the range of creativity to activities taking place directly in space, being the result of human body movement, may constitute an example of the above.

The moment, in which the notion of the autonomy of architectural drawings as individually treated works of art was formed, is also notable. The public opinion bestowed a strictly aesthetic value on them in the 1970s and 1980s; that was the effect of the economic recession of the 1970s and resulted in the creation of design projects 'kept in the drawer'. At the same time, the number of publications on architectural and urban

topics increased, primarily those where freehand drawings were presented (CAD tools were not yet widely disseminated). Galleries, institutions and private collectors of art, looking for alternative ways of investing capital contributed to elevating architectural drawing to an art form. Jordan Scott Kauffman's doctoral thesis is devoted precisely to this topic (Kauffman 2015).

Fig. 70 Stanisław Noakowski, Renaissance Town Hall, 1917;
architectural fantasy showing what an object could look like in a given era

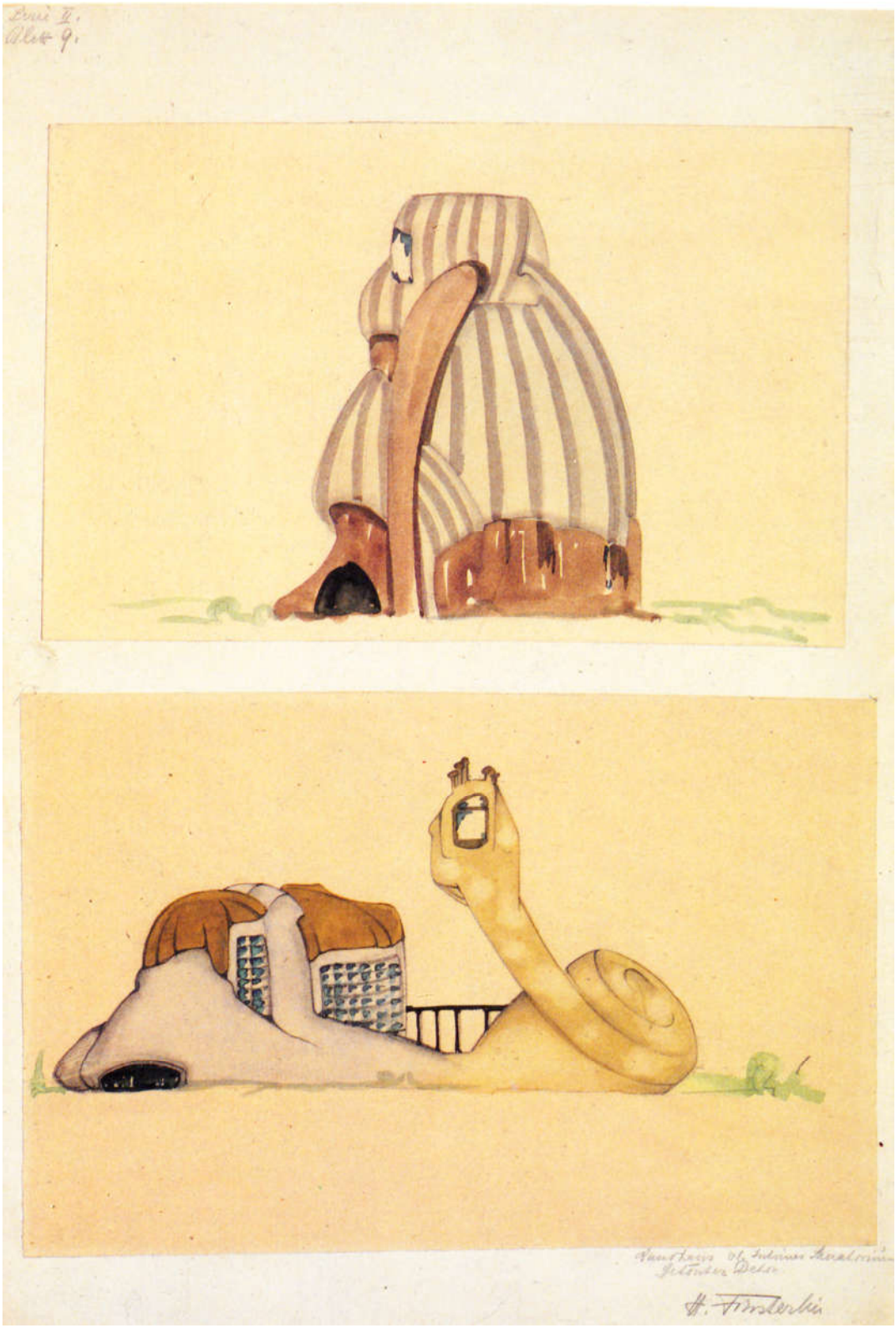


Fig. 71 Herman Finsterlin, ‘A cottage house or an intimate sanatorium’, 1919, architectural fantasy; Finsterlin’s Expressionist works never implemented had a significant impact on the later organic architecture.

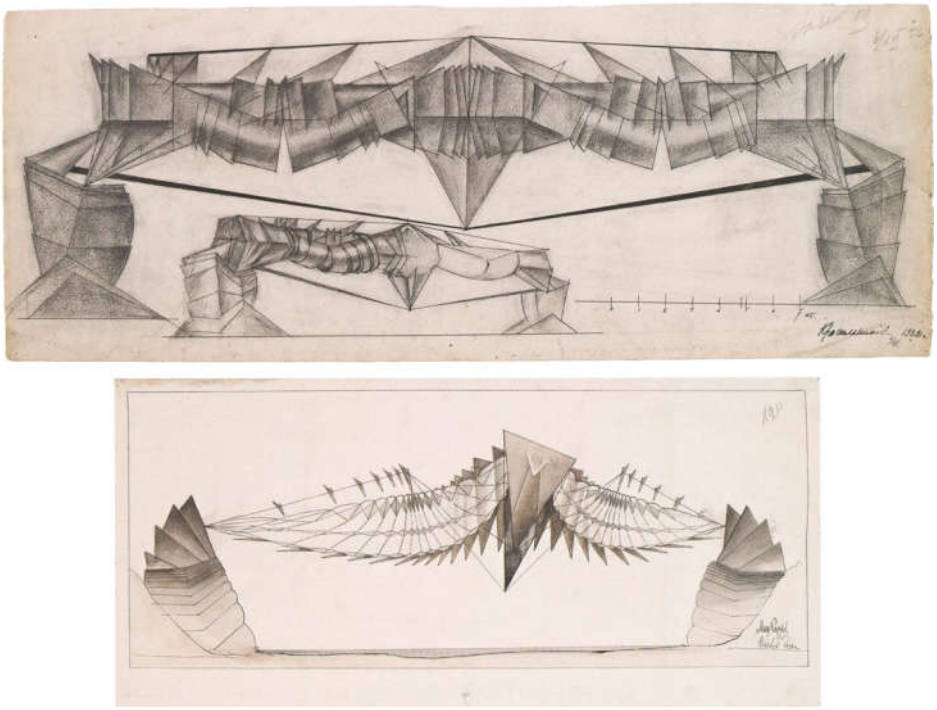


Fig. 72 N. Krassilnikov (top), M. Korshev (bottom), bridge designs of students created as part of the activities of the Higher Artistic and Technical Workshop Vkhutemas, 1922; Russian constructivism

Fig. 73 Yakov Chernikhov, architectural fantasy, 1929–33; Russian constructivism

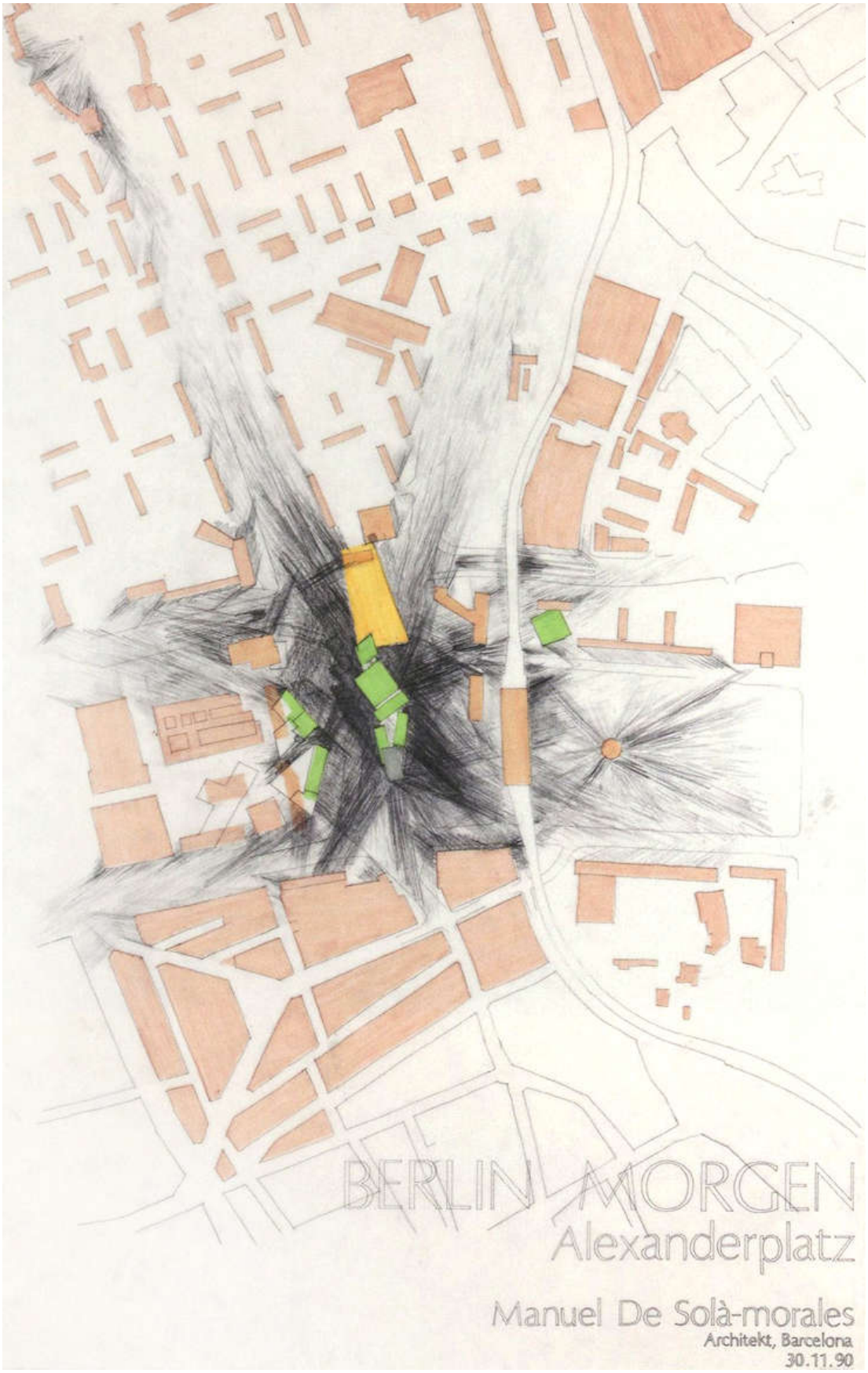


Fig. 74 Manuel De Solà-Morales, 'Abstract City', drawing from the exhibition in 1991, gathering drawing visions not meant for implementation titled 'Berlin of tomorrow, ideas for the heart of a big city' ('Berlin morgen. Ideen für das Herz einer Großstadt.')

V. 5 Drawing and the place of an architect and urban planner in the design process

Freehand drawing is not only a designer's tool of trade, but also an element distinguishing the designer from other participants in the design process, identifying him/her professionally and placing him/her inside a cultural discourse, including through the graphic convention used. A high level of the craft of drawing is an element contributing to gaining the investor's respect and keeping the architect's status of an author – the object's creator. With regard to the changes taking place within the design tools, two issues come to the fore: 1) relation between a drawing and the design's authorship and the consequent hierarchy concerning persons involved in the design process and 2) values dominating in it.

Re 1)

The awarding of the object's authorship to its designer took place along with the separation of design and construction constituted by Leon Battista Alberti. At the time, it was based on two issues: trust in the construction trade which resulted in the lack of need to specify precise construction solutions in design and a limited need to defend the validity of formal design solutions, rooted strongly in antiquity and established in templates, disseminated thanks to the invention of printing.

Nowadays, in contrast to Alberti's times, the separation of the documentation creation from the act of building has largely remained unchanged. The scope of the architect's responsibility and the complexity of the task he/she is confronted with have significantly increased. Despite the complexity of the design project and many parties involved in it, the architect still remains its author. In the traditional design process based on freehand drawing, it is this communication tool that gives the designer control over the flow of information, placing him/her at the centre of events, so that he/she is the only one who gets a full picture of the situation. The drawing also helps to create relations with the client by building the authority of an architect – the 'director' of the entire undertaking.

The distribution of drawing tasks shows the position of a given person within the design team. In most architecture and design studios, the knowledge of who actually creates conceptual sketches and who only draws and elaborates them, allows to set up team hierarchy. The drawing thus has an impact on the preservation of the **vertical** task structure of architecture and design studios.

Digital tools, such as BIM, try to integrate the design and the construction site again, so as to reduce the low efficiency and losses resulting from such a separation. This change, limiting the drawing as the main communication medium for the sake of the digital model containing all the necessary information, may lead to the architect losing the central position of the artist-creator and main information manager (Picon 2010, 163). In the traditional design process based on drawing, the contracting entity employed the architect to develop the initial design concept. After it was completed, consultants, specialists and other parties were involved in the design process (Fig. 25). It was instrumental in building a relationship between the investor and the architect before other people entered the design project, which gave the designer an advantage and control over the further progress of the process and built his authority in the eyes of the contracting entity. BIM as a technology enabling production, processing and communication of information integrates specialists on one level, in a common model, enabling access to information and information flow for the widest possible group of people involved in the design project. Therefore, not only the spectrum of available data changes, but also the range of skills required from the team of designers. Thus, the architect who is involved in the design process based on drawing as the dominant party, may lose its current position. The organisation of work becomes more **horizontal** (Carpo 2011, 117–118).

Collective decision-making can blur the boundaries or even cause the inability to determine the authorship of the object. It is noticeable during charrette workshops – the authorship of hand-drawn visualisations is always made public. However, this is not the case with the labour-intensive digital model which always accompanies such workshops. This situation is sometimes caused by the multitude of the model's authors, but above all, by the audience's admiration for the products of human hands and the elevation of freehand drawing to a craft of high aesthetic value, if not an art form.

Mario Carpo notes that along with the development of digital tools, a specific type of authorship has slipped into obscurity, the one based on the production of identical, repetitive copies replicated from the designed original and resulting from the separation of design from the construction. At the same time, parametric design brings about two new forms: the programme's authorship – a general and generic object – and the authorship related to the specification of the individual final object based on a generic object. Carpo compares the second author to the player of a video game designed by the author of the first type (op. cit., 126). The architect in the first case would be equal to a software

developer, while in the second case – only to a creative user of a system programmed by someone else.

Re 2)

Authorship in architecture is associated with the idea created by the architect, and the building itself gains cultural importance as the embodiment of the architect's concept. Before the building was designed, it was traditionally transferred onto a sheet of paper in the form of a drawing. Thus, the drawing was even closer to the idea than the building, as the most direct expression of the designer's intentions. The prevalence and primacy of ideas in design remains a key element in both teaching and architectural and urban practice.

The automatic favouring of the performance criteria, which are crucial in running a business, may become a negative aspect of BIM technology. The architect traditionally stands guard over another value system, with elements such as aesthetics, functionality and respect for context. In the relation 'owner – investor – architect', the latter keeps a watchful eye on the idea behind the design, while the contracting entities are most often focused on maximising profits. There are tensions (both positive and negative) taking place during the implementation of the design project. BIM, by allowing the design project to be delivered on time and within the budget limits, reduces conflicts, but at the same time weakens the ability to defend criteria other than economic viability (Scheer 2014, 185). Reminding about them can be an important role (or even a mission) of an architect and urban planner in a BIM-based process, in which freehand drawing can be helpful.

VI. CHARRETTE IN CHICAGO – CASE STUDY

The charrette method has not yet been reported in any study related to the use of freehand drawing. The following report on the progress of the project – a case study – has been drawn up using the participant observation. The chapter also presents the specific way of designing, i.e. the charrette workshop. This description seems especially valuable for the milieu of Polish designers, as this method, widely applied in the United States and present also in Europe, is used in Poland only to a small extent. Overall, the charrette aims to reduce the negative aspects of the specific design problem (see IV. 2).

VI. 1 Charrette Method

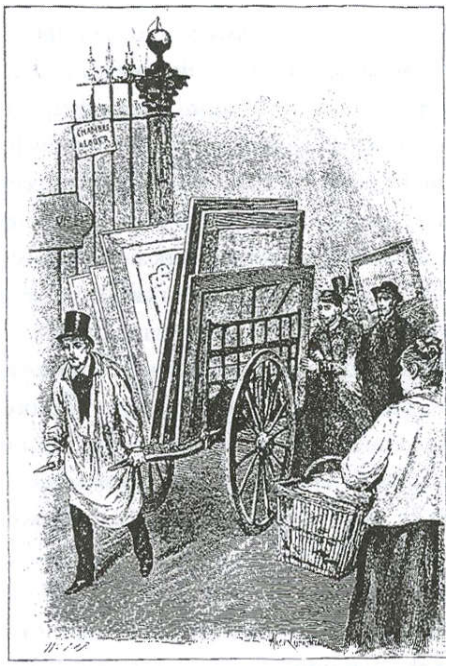


Fig. 75 ‘Charrette’ (in French ‘trolley’) was used in the 19th century to collect drawings from the students of École des Beaux-Arts in Paris; the definition reflects the intensity of workshops, the need to meet deadlines and striving for the best results.

The charrette is ‘a multiple-day collaborative design and planning workshop held on-site and inclusive of all affected stakeholders’ (Lennertz and Lutzenhiser 2014, V). Due to a great number of stakeholders, this method is mainly used in urban planning projects which often offer, however, proposals for architectural solutions

The elements which distinguish the charrette from other workshops are: an intense and holistic character, based on close cooperation of the parties, and a specifically defined course, containing three phases (Fig. 77). Therefore, the charrette should be specified more widely – as a complex system – part of which is the workshop itself (the second stage).

According to the National Charrette Institute (NCI), the first phase of this system – the preparatory one – focuses on gathering information and developing output materials, as well as on the first meetings with stakeholders. It is primarily an introduction to the second phase – the charrette workshop itself, which lasts on average from four to seven days. During this phase, a project’s concept is developed, usually an urban plan (the so-called masterplan), which can be implemented mainly thanks to the involvement of all interested parties in the process of the concept development. The project team, composed of specialists from various fields, mainly urban planners, architects, transport engineers and technical infrastructure engineers, landscape architects, economists, etc., is responsible for the concept development, taking into account the incoming comments. In the charrette process, the design team should be understood even more broadly, as it also includes all the people who came to the workshop and are interested in changes, with a special emphasis on future users (see IV. 1). The design studio is located not far from the place where the design project is to be implemented, in a large public area, such as the town hall, school or library. The charrette workshop’s basic structure includes three feedback loops from stakeholders (Fig. 76).

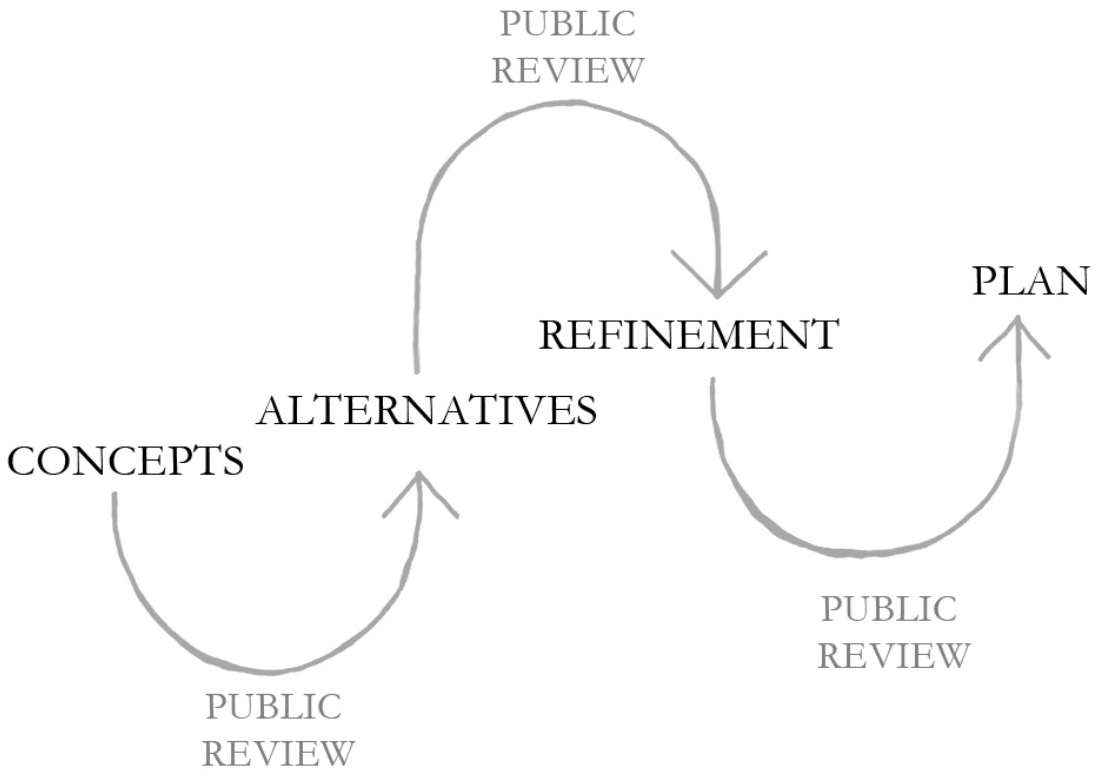


Fig. 76 Three feedback loops; gathering comments and data from stakeholders takes place primarily during meetings and public presentations. It results in gradually reaching the final design project.

They make decisions during arranged meetings, public presentations and conversations possible within the framework of a design studio open throughout the workshop. The personal invitations to all charrette meetings are sent to the main stakeholders for organisational purposes.

The collected data will be used by designers to develop the design concept. In addition to the aforementioned meetings and conversations, the most common are three presentations open to all interested parties: at the beginning (introduction to the topic), half-way through the workshop (verification of the first proposals) and at the end of the workshop (final presentation and solution). Stakeholders, therefore, consider themselves co-authors of the project, which makes them more likely to support its implementation (the post-charrette, i.e. third phase of the charrette system). It consists of testing for feasibility and improving the concept developed during the charrette workshop. The final version of the project is presented in the final report.

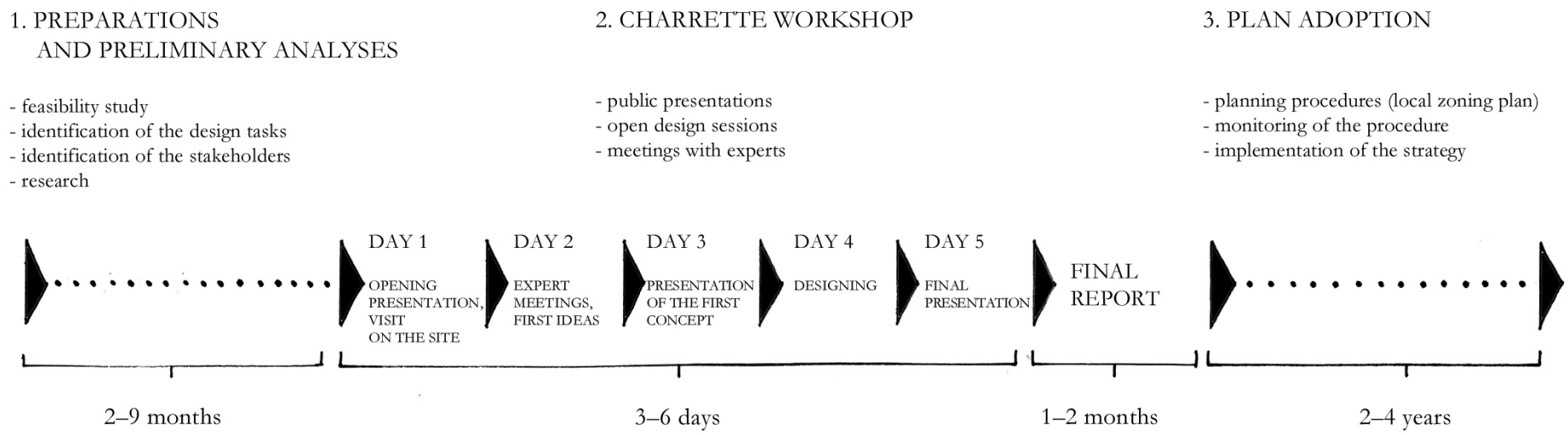


Fig. 77 The course of the charrette workshops encompasses a three-stage process; the second phase is devoted to proper workshop.

VI. 2 ‘West Town Healthy Community Visioning’ project

VI. 2. 1 Target results

How, in the face of the health care that is growing and going beyond the hospital walls, can the effective cooperation with the local community be achieved in order to improve and maintain the health condition of the residents of the West Town district?

The above question was the major issue during the workshop. The Presence Saints Mary and Elizabeth Medical Center (PSMEMC) has involved many parties: local authorities, entrepreneurs, people involved in health care, clergy, teachers and residents (including children) in order to develop a shared vision of health and well-being of the West Town neighbourhood.

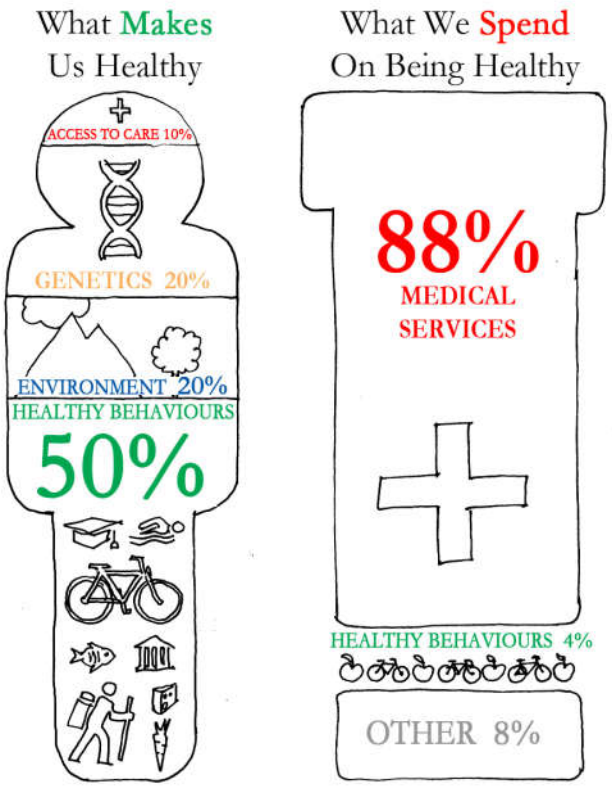


Fig. 78 On the left: What makes us healthy?
On the right: What we spend on being healthy?

Fig. 78 shows the reasons for a broad approach to the issue of modernisation of the hospitals. The individual’s health is half dependent on their behaviours, 20% on the environment they live in, 20% on genetics, and only 10% on health care which in turn absorbs most of the health-related expenses (88%).

Bearing in mind this disproportion, the Community Visioning project aimed at improving the environment of the West Town residents by improving the architectural solutions of hospitals, the surrounding urban tissue, as well as by improving education: promoting good healthy behaviours, also related to conscious perception and inhabitants’ involvement in the life of the community they live in.

The workshop was of urban planning character, with small architectural elements.

VI. 2. 2 Design process

The assumptions made by the institution organising the workshops – Presence Health – required an appropriate project approach. The workshop which was held from 2 to 10 October 2015, as an intense project method catalysing the dialogue between the involved parties, was well embedded in the process of creating the Community Vision (Fig. 79). The design idea was to result from its multiple verifications during meetings, interviews and presentations with the participation of people interested in the project, made possible among others thanks to the use of quick freehand sketches. This method benefited from the diversity of the neighbourhood, whose inhabitants (ethnically, culturally and linguistically diverse and with a different standard of living) had a very multifaceted approach to the presented issues. At the same time, an opportunity was created to educate the local community on the subject of health care and spatial planning.

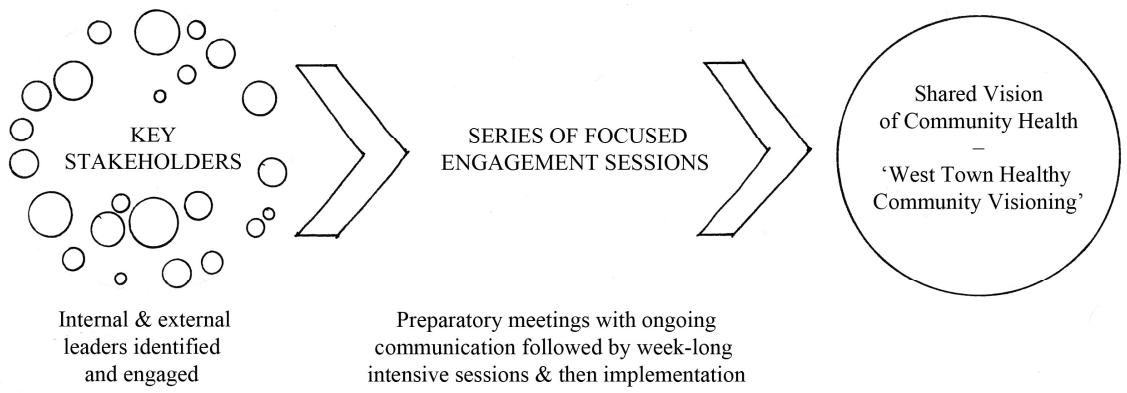


Fig. 79 The accepted rules according to which the design process was carried out.

VI. 2. 3 Organisation of the charrette workshop

All of the workshop schedule presented in Tab. 5 was carried out as planned. The tasks were divided into categories by colours, as described in Tab. 4.

	Tasks
	Pin-up – internal meetings of designers, next to the pin-up boards displaying drawings, possibly with the participation of an investor
	Meetings with invited experts and main stakeholders
	Presentations of drawings being created on an ongoing basis, pinned to the boards, for doctors and other Hospital employees
	Formal presentations for the investor and main stakeholders
	Formal presentations open to the public
	Design
	Free time
	Travel

Tab. 4 The Charrette Workshop Schedule – tasks

West Town Healthy Community Visioning
October 2nd to October 9th, 2015

	October 2nd Friday	October 3rd Saturday	October 4th Sunday	October 5th Monday	October 6th Tuesday	October 7th Wednesday	October 8th Thursday	October 9th Friday
	Team Arrivals: PM of 1st		**Morning Off**	**Meeting #5** *Seniors/PLC* 8:00-9:00 NFC Studio	**Meeting #7** *Police/Fire/EMS* 8:00-9:00 NFC Studio	**Pin-Up** *Physician Breakfast* 7:30-9:00 East Café		
8 am	Breakfast	Breakfast					Breakfast	Breakfast
9 am	**Studio set-up** 9:00 - 10:00	DPZ Team Meeting 9:00-10:00		DPZ Team Meeting 9:00-10:00	DPZ Team Meeting 9:00-10:00	DPZ Team Meeting 9:00-10:00	DPZ Team Meeting 9:00-10:00	Production (Studio Closed)
10 am	**Team Meeting with Presence Leadership** 10:00-11:00	**Meeting #4** *Neighbors & Youth* 10:00-11:30 NFC Studio		Design	Design Feedback **Hospital Employees Open House** 10:00-11:00 East Café	Design	Design	
11 am			Team Meets at Hotel-Departure for Studio 1:00					
NOON	**Team Briefing** 11:00-12:00	Design Feedback			Design Feedback			
1 pm	**Meeting # 1** *Lunch-City Staff* 12:30-2:00 NFC Studio	Lunch In 12:30-1:30	Design	Lunch In 12:30-1:30	**Meeting #8** *Faith Communities* 12:00-2:00 Ukr. Cul. Ctr.	**Meeting #10** *Local Businesses* 12:00-2:00 St. E Pavilion	Lunch In 12:30-1:30	
2 pm	Design Feedback	Design		Design	Design		Production (Studio Closed)	
3 pm	**Meeting #2** *Developers/Realtors* 3:00-4:00 NFC Studio		**Wknd Hospital Emp. Open House** 3:30-5:00 East Café	**Meeting #6** *Transportation* 2:30-4:00 NFC Studio	**Meeting #9** *Behavioral Health* 3:00-4:00 NFC Studio	**Meeting #11** *Pop. Health Partners* 2:30-3:30 St. E Pavilion		Presentation Set-up 3:30-4:30
4 pm		**PSMEMC Campus and Neighborhood Tour** *Walking and Bike Tour* 4:00-6:00		Presentation Set-up		Design Feedback	**Leadership Preview** 4:30-5:00 NMPRAC	**CLOSING CELEBRATION** 4:30-6:00 *Klausner Auditorium*
5 pm	**Meeting #3** Civic Engagement Salon 5:00-7:00 NFC Studio		Design	**OPENING PRESENTATION** 5:30-7:00 *NFC Gym*	Design	**Meeting #12** *ResU/Education* 4:30-5:30 St. E Pavilion	**Design Reception** 5:00-7:00 National Museum of Puerto Rican Arts & Culture	**PM of 10/9 AM of 10/10**
6 pm								
7 pm	Dinner out	Dinner out	Dinner in	Dinner out	Dinner in	Dinner in		
8 pm								
9 pm								

Tab. 5 The Charrette Workshop Schedule

In accordance with the principle of charrette workshops, the design studio was located as close as possible to the project site – the team worked in the hall of the Saint Mary Hospital.

The composition of a ten-person project team is presented below (the symbols of individuals are given in brackets in order to facilitate the identification in the text):

- Project Manager (PM) – Elizabeth Plater-Zyberk – making the most important decisions, approving the final shape of the project, responsible for contact with the investor, gathering comments from stakeholders, controlling the work of designers and assigning them tasks, presenting the final project; also a designer herself,
- Project Director (PD) – Xavier Iglesias – deputy project manager (similar tasks), controlling the organisational side of the charrette,
- Landscape Architect/ Planning Advisor (absent),
- two Senior Designers (SD1 and SD2) – Senen Antonio and Matt Lambert,
- two Designers (D1 and D2) – Paul Genovesi and Daniel Morales – also responsible for hardware, server, scanning and printing,
- two Illustrators (I1 and I2) – David Carrico and Joanna Pętkowska-Hankel – making freehand perspectives and quick sketches,
- Communication Specialist,
- Health Care Specialist, advising on the restructuring, location, needs and hospital functions.

It is worth recalling that the notion of ‘project team’ stands for – in the context of a workshop – a wider group, because the basic charrette principle is to involve all interested parties in co-designing. The team outlined above collects data and transforms them into a specific solution, with the use of course of their own inspirations and ideas.

VI. 2. 4 Location

In the preparatory phase, materials were collected about the investment site covering many areas: existing projects, population, national minorities, the local community needs, infrastructure, communication, etc. These topics are not a direct subject of this study, but it is worth presenting the location of the project to outline the context of the drawing creation (Fig. 80–82).

Fig. 80 Hospitals (marked in red) in the context of Chicago's West Town

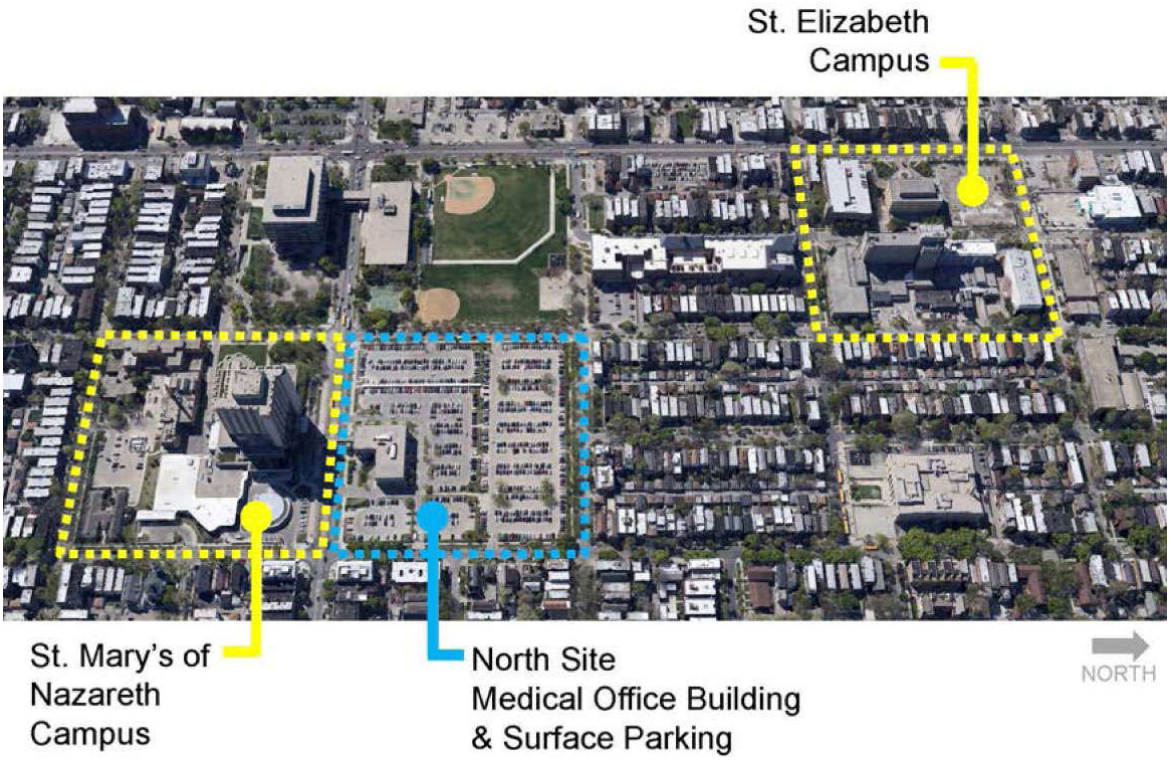


Fig. 81 Quarters covered by the project: campuses of Saints Mary and Elizabeth Hospitals (in yellow) and a parking lot with an administrative building (in blue) connected to Saint Mary Hospital

Fig. 82 Two distinctive buildings – symbols of each of the Hospital: on the left – Saint Mary Hospital, and on the right – Saint Elizabeth Hospital; two horizontal pictures on the right show administrative buildings.

VI. 3 Drawings made during the charrette workshop

All drawings from the charrette workshops can be divided into two categories, based on the tools used for their creation: freehand drawings and drawings created with the use of digital techniques. Although in this study freehand drawing is the main area of interest, the use of digital techniques has been also briefly described. Without such a contrast, it would be difficult to obtain a proper research perspective in relation to traditional tools.

VI. 3. 1 Freehand drawings – the adopted categories

The freehand drawings created during the charrette workshop were divided into categories based on the level of abstraction of the recorded information and their functions, and definitions were established based on the analysis of all collected graphic materials. This classification is aimed to make it easier to get acquainted with the collected material and to facilitate the description of the role of particular types of drawings, which was made in the chapter containing the conclusions of this doctoral thesis (see VII. 1). The division is not universal – it represents specific sketches created during the described workshop – however, in any design process based on freehand drawing, similar graphic representations can be found. The boundaries between different categories can be blurred sometimes (such as between initial and conceptual sketches). Tab. 6 presents the schedule of tasks with drawings presented or being created during their execution (in conjunction with Tab. 4 and 5).

Tasks (see also Tab. 4 and 5)		Presented freehand drawings	Generated freehand darwings
	Pin-up – internal meetings of designers, next to the pin-up boards displaying drawings, possibly with the participation of an investor	– initial sketches – conceptual sketches – final conceptual drawings	– sketchnotes – communicating sketches – corrective sketches
	Meetings with invited experts and stakeholders		
	Presentations of drawings being created on an ongoing basis, pinned to the boards, for doctors and other Hospital employees		
	Formal presentations for the investor and stakeholders		–
	Formal presentations open to the public		–
	Design	– initial sketches – conceptual sketches – final conceptual drawings	– initial sketches – communicating sketches – corrective sketches – conceptual sketches – final conceptual drawings

Tab. 6 Workshop schedule – tasks and prevailing drawings presented or created during the performance of tasks

A **sketchnote** is a record of information coming from outside in order to better understand it, remember it or pass it on to others. It is a graphic illustration of a written note (example in Fig. 87 and 102).

An **initial sketch** is a record of the first design thoughts, for example in the form of a projection (Fig. 97, 98, 100 and 101) or perspective (Fig. 103–106, 111 and 112).

A **communicating sketch** is intended to convey design ideas or discuss another project-related issue (Fig. 121A and 132B).

A **corrective sketch** is created to convey to the other person what changes should be made to his/her drawing or design (example in Fig. 114I, 115A and 116A).

A **conceptual sketch** is a record of design ideas already undergoing evaluation of the project team members (Fig. 108, 109, 117–119). In Fig. 108B, D the example is shown where it was juxtaposed with the preceding initial sketch (Fig. 108A, C).

The **final conceptual drawing** is the record of the final version of the concept design. It can be hand-drawn, made in part using graphics software or made digitally. The final conceptual drawings also include the final versions of three-dimensional perspectives (Fig. 138–145). Plans are presented in Fig. 135–137.

VI. 3. 2 Drawings made with the use of digital techniques

In the preparatory phase for the charrette, documentation was created, which included available maps, analyses of the building plot and its nearest neighbourhood, photos and extensive textual studies concerning, among others, health care, social and economic conditions, used and verified during the workshop. All these introductory materials, made using graphics software such as AutoCAD and SketchUp, do not belong to design drawings understood as depicting the changing creative design idea.

Examples are presented in Fig. 84 and 85. Due to the fact that they were based on digital maps and required only simple graphic operations, it was natural to continue their digital elaboration.

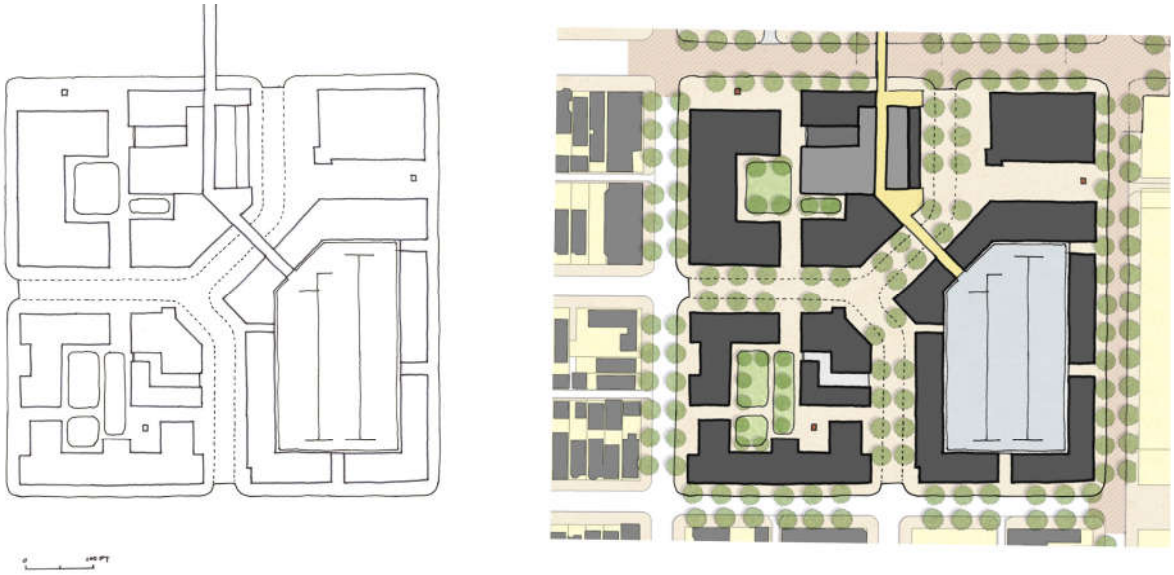


Fig. 83 Drawing of a fragment of the final concept – on the left, a part of the freehand linear sketch is shown, while on the right – the final graphic form of the plan. All elements that distinguish the right picture from the left one have been added using digital techniques (Adobe Photoshop).

Apart from the drawings of analyses made before the workshop and modified during it, digital techniques appeared in the final conceptual drawing, but to a very limited extent. The characteristic feature of designing during the charrette workshop was the combination of techniques – the linear sketch was made both digitally (maps with the existing buildings) and manually (hospital buildings and other designed accompanying facilities) (Fig. 83).

Fig. 84 Hospitals' context analysis: map showing existing outpatient clinics (left) and supermarkets (right)

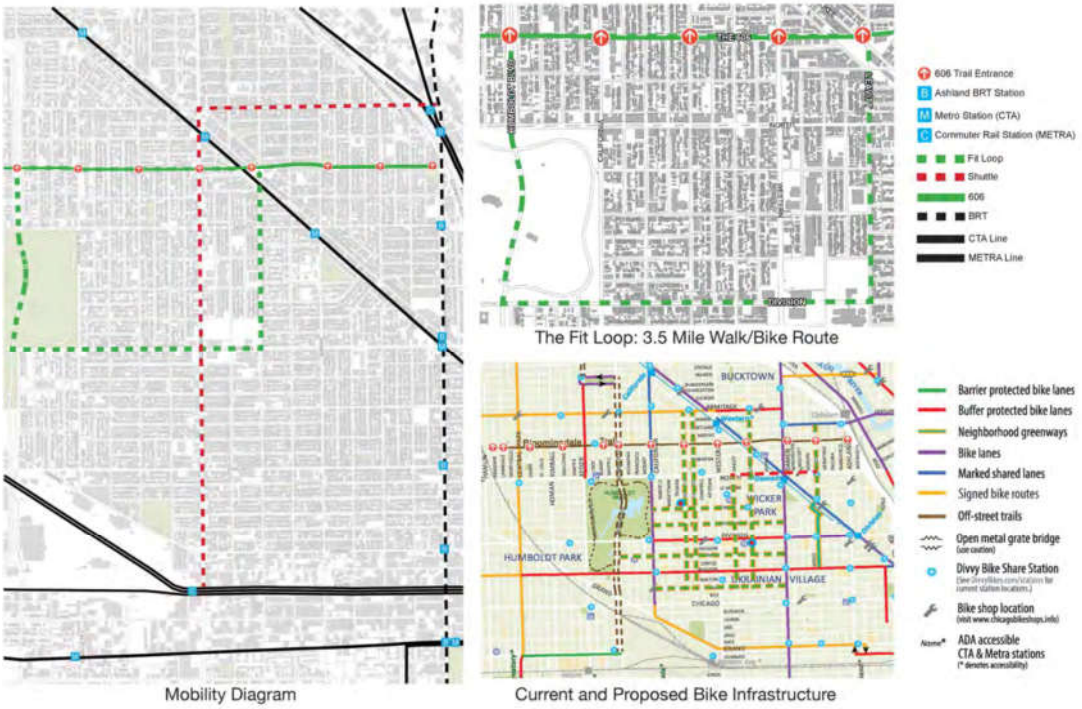


Fig. 85 Communication analysis of the area adjacent to the hospital

VI. 4 Progress of the project

VI. 4. 1 **First Day** (2 October 2015)

Upon arrival, the project team prepared a studio for work in a public room in the St. Mary Hospital, which was divided into separate spaces used for:

- designers' work (desks with good lighting),
- presentation of drawings (boards for pinning drawings),
- conversations with participants (large table).

Fig. 86 A multi-functional room for a charrette workshop: in the foreground working designers can be seen, in the background – there is a meeting with stakeholders.

Then, the project team was presented to the investor's representative and the people organising the workshop. Later that day, some designers began to work, while the remaining participants, together with the group representing the investor, took part in three official meetings with city representatives, property developers, real estate agents and urban activists. Each comment made by the participants was written down for later consideration about the emerging concept.

Already during the first meeting, the importance of the drawings made at the end of the charrette was highlighted:

> IR (investor's representative): (…) I'd also like us to talk about the final images, it is a little bit early to do that but at least if we had a sense of what perspectives at the end you'd like to see, that will be good.
>
> PM: … to represent our effort.
>
> IR: Right. Because there are some iconic perspectives of places that we might want to talk about.

Final perspectives should have presented the most important symbols of a given project, because they had a marketing dimension, and served not only to explain the project, but also to 'sell' it and create its visual identification.

The first perspective for which the investor's representative expressed their demand was the view from the intersection of Lewitt and Division streets into the Division, with a view of the tower (icon of St. Mary's Hospital – a landmark), a pedestrian walkway – link between buildings over the street and a corner that was supposed to be rebuilt (after the liquidation of the existing helipad). While listening to the recommendation, I made a quick and careless sketchnote, in order to remember what part of the city it was about and what elements should it contain (Fig. 87). In the subsequent course of the project, this perspective was performed by the other illustrator (I1) present at the workshop (Fig. 140).

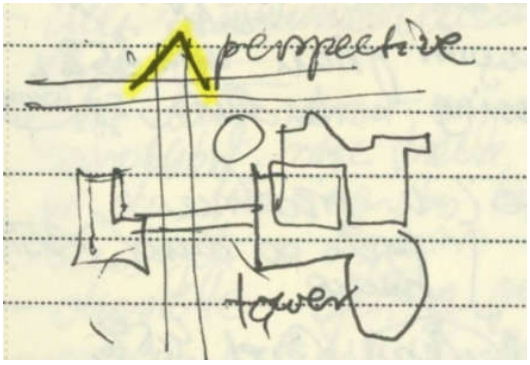


Fig. 87 Joanna Pętkowska-Hankel, sketchnote

At the next meeting, participants were asked to choose one word best describing the West Town district. Their proposals were collected graphically in the so-called 'word cloud' (Fig. 89), from which it appeared that the designers were confronted with the task of facing a district of diverse character, under transformation, full of challenges, but also opportunities.

From the first three meetings and presentations on energy, planning, transport and social issues throughout the city of Chicago made by invited experts, a number of issues related to the West Town district emerged, such as the need to connect the Saints Mary and Elizabeth Hospitals in the organisational, urban planning and symbolic sense (visual identification), neighbourhood integration (great avenues dividing the city and not encouraging people to walk), lack of stores with fresh fruit and vegetables, insufficient parking spaces, location of hospitals on the border of the poor and rich districts, clear social inequalities and the problem of gentrification.


Fig. 88 Meeting with invited stakeholders

Fig. 89 'Word cloud' was created from the names assigned to the district by its residents. The size of words reflects the frequency with which they were used.

Another interesting aspect regarding the functioning of social participation was the experience shared by the organiser of the design workshop regarding the park in the West Town neighbourhood. According to her account, paid representatives of some parties involved would come to the consultation meetings on city transformation, and not local residents upon whom depended the sense of the consultation meetings. Thus, an event promotion campaign was organised among the residents of the neighbourhood of various nationalities (including among African Americans who were absent during the consultation meetings). Thus, it is clear that the principle of social participation requires vigilance from the organisers and an extensive information campaign.

The rest of the project team, not taking part in the consultation meetings, gathered data about the context. The summary of these activities was provided the next day during the internal pin-up presentation.

In addition to many photographs of the project area taken during the first two days of the workshop, urban planning and transport analyses were carried out. These materials were created using digital techniques and complemented the pre-workshop documentation.

VI. 4. 2 **Second Day** (3 October 2015)

The second day, apart from the design work, consisted of a drawing workshop, a cycling tour of the project team in order to better understand the surroundings of the project area and the internal presentation of the initial ideas.

Youth Session drawing workshop

All parents with children who could potentially be interested in changes taking place within the district were invited to the morning workshop. The workshop was organised in a PE hall belonging to the Saints Mary Hospital, where a dozen or so round tables were set up with drawing sets, district maps and stickers. The guests were asked to do the following three tasks.

1. Design and draw how they imagine a healthy society.
2. Pin up their answers to questions on a board or add their own comments using stickers (Fig. 90B).

Fig. 90 A – satellite image of the studied area with marked green points, expressing acceptance and red – no acceptance; B – boards with residents' answers to questions about the district

The questions on the boards were as follows:

a. what do you love about your community?

b. what is one thing you would change in your community?

3. Indicate on the maps the places you like with a green dot and the ones you dislike with a red dot (Fig. 90A).

Guests were offered refreshments, there was a playroom for the youngest children, and several people were watching over the course of the programme, encouraging participants to take an active part in the meeting and were ready to answer their questions (Fig. 91).

Fig. 91

During the workshop, the project assumptions were presented with the participation of the investor's representative and the project manager. Interviews with residents were also carried out, also in the form of a video for the local television. The person who was elected at each table summarised the remarks of the rest of the group regarding the expected changes and the drawings created during the workshop. At the end of the meeting, a lottery for the youngest children was organised.

The most interesting drawings made by children are presented below (Fig. 92–96).

Fig. 92 The drawing expresses graphically the common needs of many residents: access to green space, sport venues, bicycle paths and a health food store.


Elliot
Dickinson
park
dog park
boulevard
division

Fig. 93

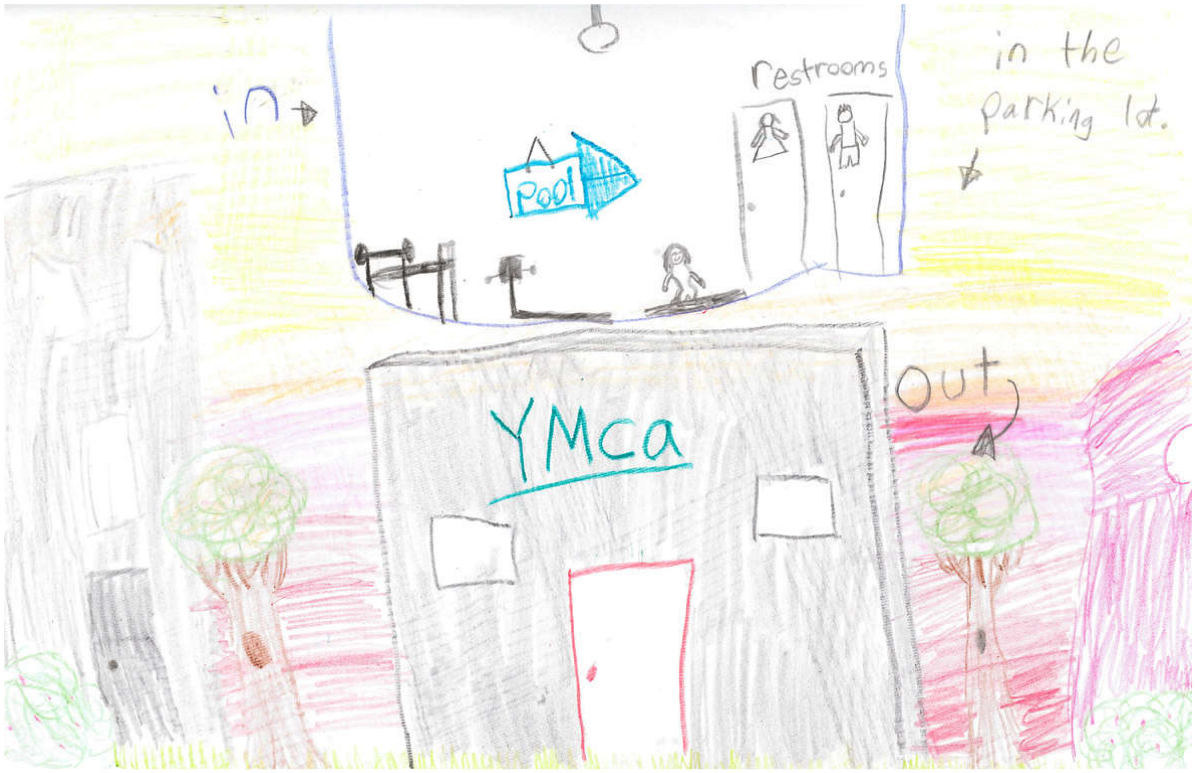

in
Restrooms
in the
parking lot.
Pool
YMca
out

Fig. 94

Fig. 95

Fig. 96 At a later stage, this drawing proved to be an inspiration for the design of new entrances to hospital buildings (Fig. 139).

Drawing was for the youngest children one of the easiest media to convey their thoughts and needs. During the workshop, children's unspoken observations about the living environment found an outlet in their emotional and meaningful drawings. The very act of drawing was also an attraction for them. It would be harder to receive verbal information from them, also because of their shyness, typical for the youngest children. The fact that children's observations and proposals were taken seriously triggered their willingness to continue to participate and create more drawings; the fact that their parents also took part in the workshop was an additional incentive for them.

Through drawings, communication between the participants of the Youth Session workshops, who are culturally and ethnically diverse and for whom English was often not their mother tongue, was facilitated. Thanks to drawings, these barriers disappeared: lines and dots were a universal language for everyone.

Drawings, maps with red and green dots, as well as notes on stickers written at the workshops gave the project team an opportunity to understand the residents' needs and to get to know them personally.

Sketches made by children were also inspiring for the project team. Some of the ideas for new services and buildings have been directly incorporated into the project's programme – a store with fresh fruit and vegetables, a place for sports and for spending time after school. A drawing advocating for the creation of Apple store (Fig. 96) was used as a surprising inspiration. Later, this suggestion was used to establish the shape of new entrances to the hospital buildings – Apple stores are characterised by simple, geometric designs, using glass and translucent materials.

The Youth Session workshops have become a signal for the residents that they – too, and perhaps above all – can have a say about their own neighbourhood. The workshops resulted in the residents' positive attitude and increased confidence in the organiser, i.e. both hospitals in this case.

From the above-mentioned children's drawings, composed of the comments written on stickers and maps containing green and red dots valuing various elements of the district, emerged the map of the residents' needs. They were written down and largely included in the emerging concept. They overlapped in many respects with the conclusions of the presentations and meetings on the first day; new needs include creating a more friendly frontage of the Division street, the need for psychological assistance for children in schools

and a larger number of extraschool centres and institutions providing assistance to addicts, a wider offer of housing for people of various levels of wealth.

After the workshop, a bicycle tour was organised, during which, apart from the nearest neighbourhood of the hospital, the project team took the ‘606’ route, which is a cycling and walking route created on the site of the former railway viaduct.

At the end of the second day of the workshop, the project team met among themselves to discuss the first drawings created during the workshop. Fig. 97 shows a preliminary initial sketch made by the senior designer (SD1) on tracing paper layered on top of the maps. It is hermetic – its inaccuracy limits the understanding by an external receiver, while triggering at the same time lateral transformations (see p. 66 and Fig. 23 and 24).

The smaller scale (Fig. 97) allowed SD1 to capture general forms – two diamond-shaped squares, one of them highlighting the street leading to the Saint Elizabeth Medical

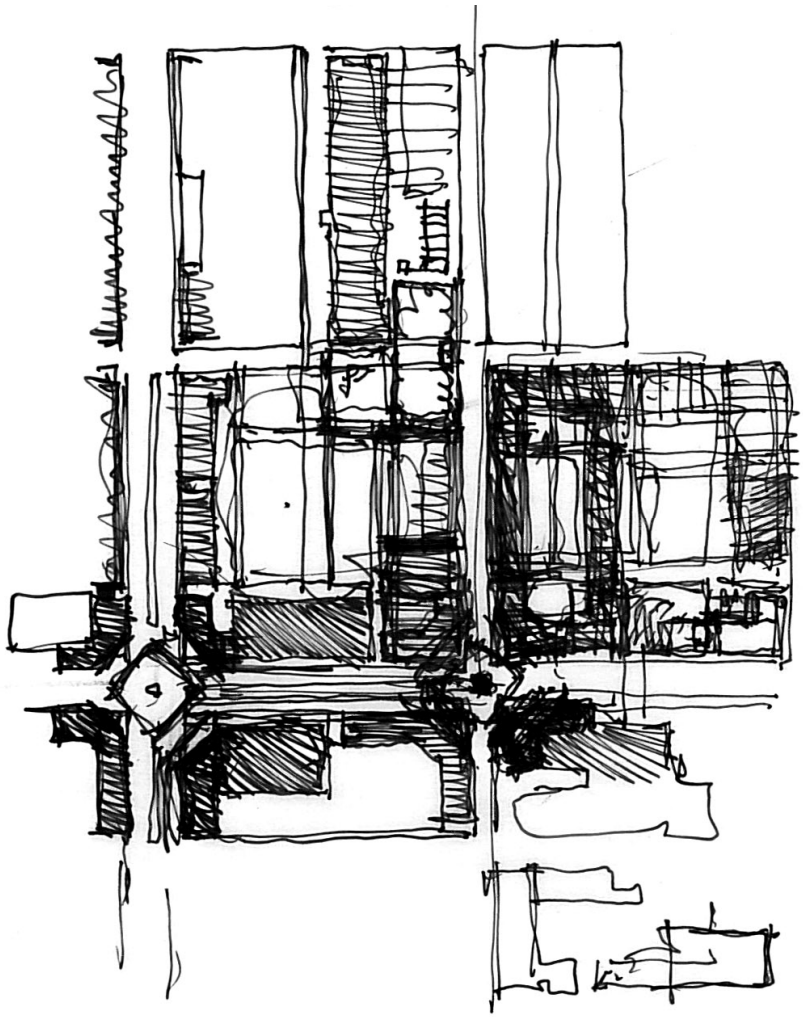


Fig. 97 Senen Antonio, initial sketch

Center – Oakley Boulevard. At a later stage, on a larger scale, two options of the design solution can already be seen, concerning the same neighbourhood, with a much clearer and more detailed form – vertical transformations are activated (Fig. 98).

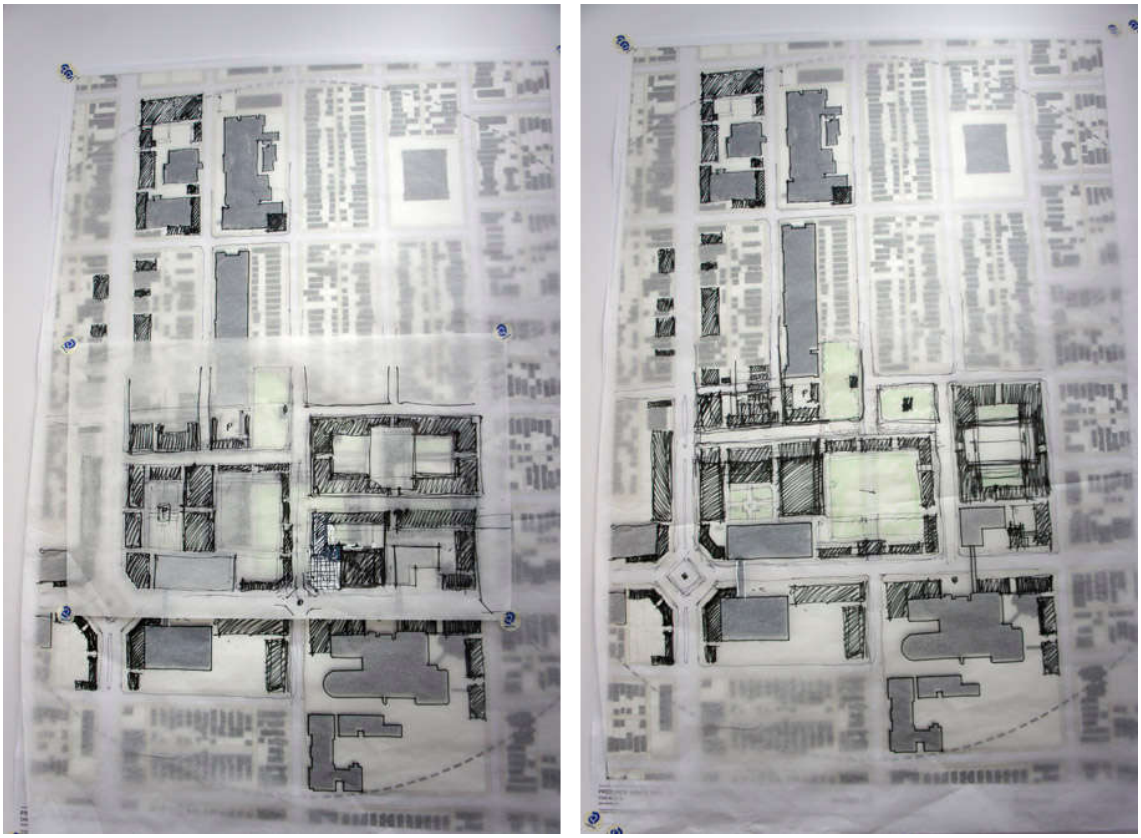


Fig. 98 Senen Antonio, initial sketches

VI. 4. 3 **Third Day** (4 October 2015)

On the third day, free time was planned before noon. Towards evening, an exhibition was organised in the hospital café presenting the assumptions of the Community Visioning project, the context analysis, the first initial sketches and materials from the Youth Session workshops. Probably due to the day of the week, i.e. Sunday, and a small number of employees, the exhibition was not very popular.

VI. 4. 4 **Fourth Day** (5 October 2015)

The fourth day began with an internal presentation within the project team showing the first design concepts.

PHASE I – first concepts

After the above-described first sketches by SD1 appeared, other designers' proposals followed (Fig. 101A–F). Despite the use of various freehand tools by each of the designers, the drawings of the plans remained clear and legible for each member of the project team. An important fact to note is therefore that within the architectural drawing convention, there was a certain degree of flexibility when it comes to graphical representtation, which did not affect the understanding of the message by other designers. It could have had, however, a negative impact on the reception by people who unrelated to architecture or urban planning. Initial sketches were usually intended for the first review of ideas by the author and the team, and less for the presentation to a wider public; hence, at this stage, a certain graphic freedom was allowed. However, the more advanced a project became, i.e. already at the stage of discussing the conceptual sketches with the interested parties, the more attention was paid to the selection of graphics and colours, so as to obtain consistency and clarity of drawings.

The variety of drawing techniques and methods of their use, which carried the danger of communication difficulties, gave the designers the opportunity to manifest their individuality and personality.

Fig. 99 Morning presentation within the team – pin-up

The surveys addressed to designers point to the significant, positive role of freehand drawing at the first design stage in the process of transferring thoughts to a sheet of paper and transforming them into a form (Tab. 7, PM–B[67], PD–B, D1–B, D2–B). The Senior Designer (Tab. 7, SD2–B) emphasised also the intuitiveness and naturalness of the use of drawing and the freedom from restrictions which, in turn, may be imposed by digital input devices, such as a mouse.

[67] The designation of persons (PM, PD, D1 etc.) can be found in Tab. 7 in the first column from the left; letters A, B, C, D and E indicate the questions asked to them in the questionnaire, located in the top row of the table. The explanations of acronyms (e.g. PM – Project Manager) can be found on p. 160.

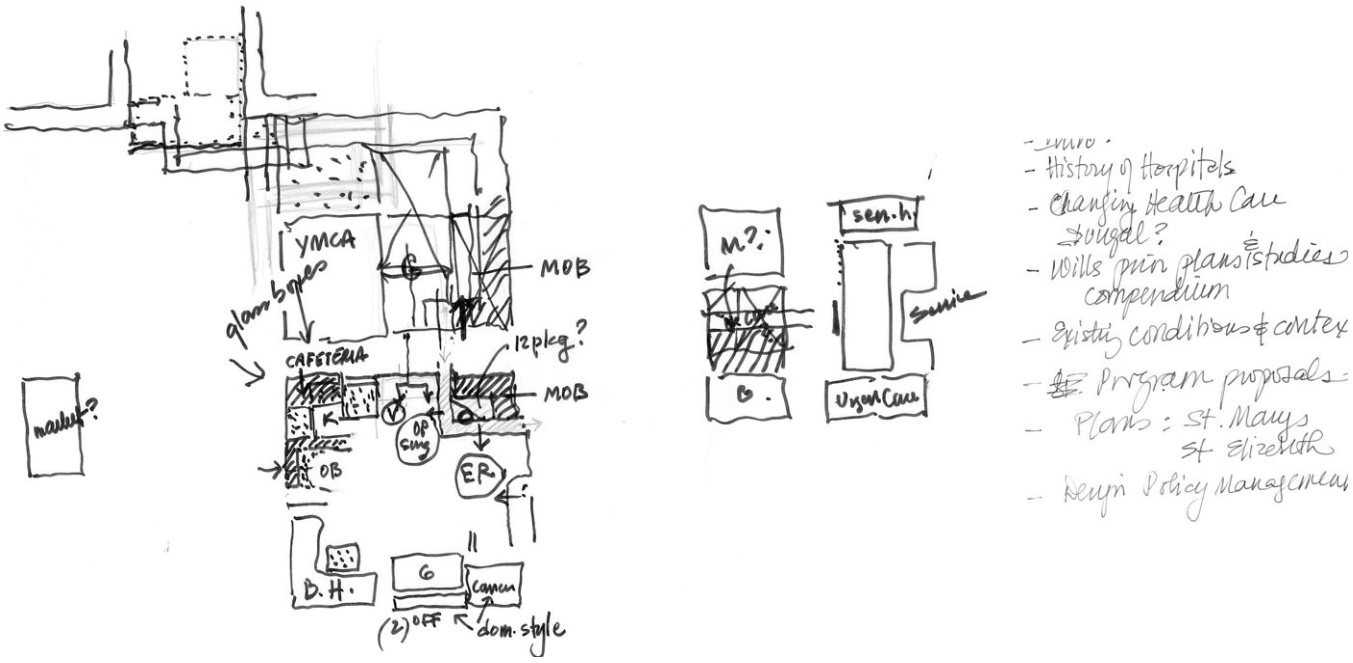


Fig. 100 Elizabeth Plater-Zyberk, initial sketch

At this first stage, the sketch also served as a record helping to remember the fleeting associations and solutions, not only as a sketchnote. The initial sketch in Fig. 100 made by Elizabeth Plater-Zyberk shows the internal dialogue that the designer conducted with herself, asking herself questions, casting doubts, proposing solutions and verifying them. It is a graphical representation of the interwoven processes of 'seeing that' and 'seeing as', described by Gabriela Goldschmidt, and reflection-in-action phenomena (see pp. 113–114). This drawing as well as drawings in Fig. 101A–F document a certain stage of the thinking process that has evolved further, but to which one could always return – because it was written on paper. This materiality of traditional techniques allowed to automatically preserve the successive stages of the thinking process (of course, provided that the designer – dissatisfied with earlier drawings – did not rip them up or throw them away, which would not be well regarded during the charrette). In digital techniques, the above is also possible, of course, although there is a risk of overwriting previous files, thus losing them; there is also a limited number of steps backwards available. Apart from that, the next stages, if not printed, are still immaterial – they do not lie on the desk and there is no visual, tangible access to them, reminding of old ideas.

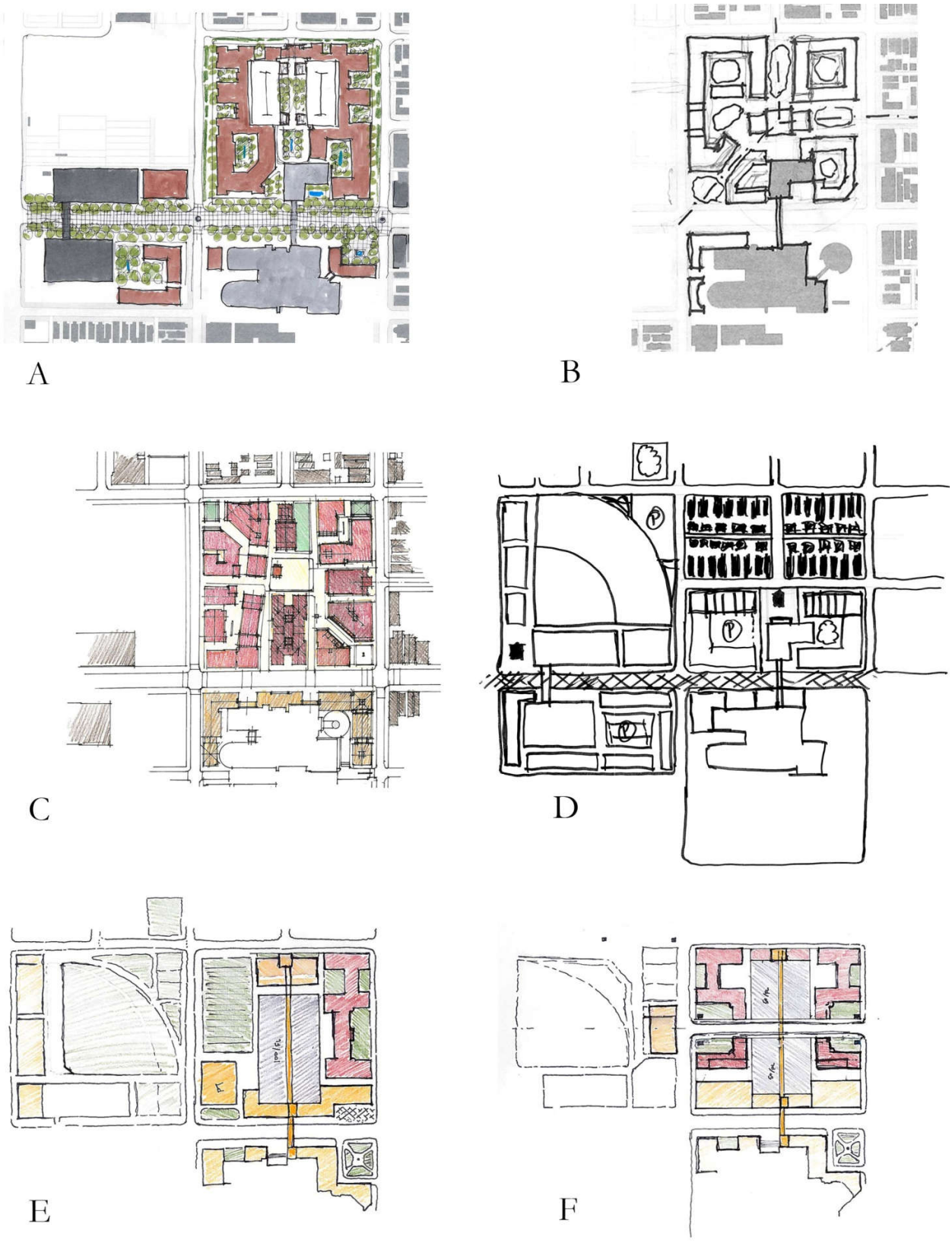


Fig. 101 A – Xavier Iglesias, B – Daniel Morales, C – David Carrico, D – Paul Genovesi, E, F – Matt Lambert;
Initial sketches. The variety of freehand recording techniques at the first stage of the design project reflects the multiplicity of ideas and personalities. Drawing techniques used: A – black fineliner and coloured markers, B – pencil and black felt-tip pen, C – black fineliner, crayons, D – black felt-tip pen, E, F – black fineliner and crayons.

Fig. 102 Matt Lambert, sketchnote which records the number of storeys in graphical form (left), combined with an initial sketch (right)

Fig. 102 presents the use of a drawing in the form of a sketchnote for both the analysis of the height of buildings in the complex of the Saint Mary Hospital (left drawing), as well as for design (right drawing), where the parts to be transformed are marked in yellow. The analysis was made in the first place, and later on, on its basis, a drawing proposing a design concept was created. In this case, the author, who already knew differences in height from experience and from many photos, summarised his knowledge in the form of a simple schema. The thinking process that took place while drawing a note was active; the author of the sketch was already able to make preliminary design decisions. Thus it was an active, creative process of learning the context of the project by analysing information.

The first perspective sketches of illustrator I1 (Fig. 103–106) were primarily aimed at searching for frames for future perspectives as well as the project's key themes. As was the case earlier with orthogonal projections, perspectives can be called initial sketches, because the illustrator did not limit himself only to frames, but also proposed his own design solutions presenting them in three dimensions.

Taking into account the limited time of the workshop, the challenge was to find such 'takes' that best and most fully present the design ideas – only those which were made as final perspectives. Therefore, quick, preliminary initial sketches, which could be corrected and modified, were extremely important.

This speed of creating a drawing is another controversial feature that should be noted. A few-day workshop abounding in daily concept changes would not be possible without a technique thanks to which one can efficiently modify the project. Especially that some changes could mean starting to design from scratch. Undoubtedly, the speed of drawing at the workshop was relative – it all depended on the efficiency of the tool usage which – in the designers' self-assessment made for the needs of the questionnaire – turned out to be diversified (Tab. 7, column E). This connection, of course, applies to every medium. Perhaps, along with technological progress, a tool to speed up the design process will appear, as it has happened in the history of the charrette workshop several times so far. But the observations indicate that the digital tool for drawing line (an input device – a mouse in this case) did not match the comfort of a pencil, crayon or fineliner at the workshop and did not allow an immediate representation in material form.

During the internal presentation, a short dialogue was established in which the technical detail of the work on the project was shown:

> PM: So I think that is a question, Senen, about how much time we spend on the long term plan versus the short term plan and… so maybe what we ask you to do is to hurry up (…) so pull that long term plan (…) so it exists and then move back to the short term (…).
>
> SD1: In terms of production, can I just draw the new pieces and can that be scanned and completed on the computer? I don't want to have to draw every block, I just draw the pieces that change.

The graphic presentation of the concept was therefore the effect of a combination of the use of traditional and digital techniques resulting from the time pressure and limitations associated with the single nature of the products of freehand tools. This was particularly the case when the maps or basic drawing needed to be duplicated, to make changes on it later or when it was necessary to quickly and uniformly colour the plans (Fig. 83 and 137). During the charrette in Chicago, computer programs were limited to graphic processing software and to drafting software to a small extent, not to the creative process itself.

Fig. 103 David Carrico, initial sketch

Fig. 104 David Carrico, initial sketch

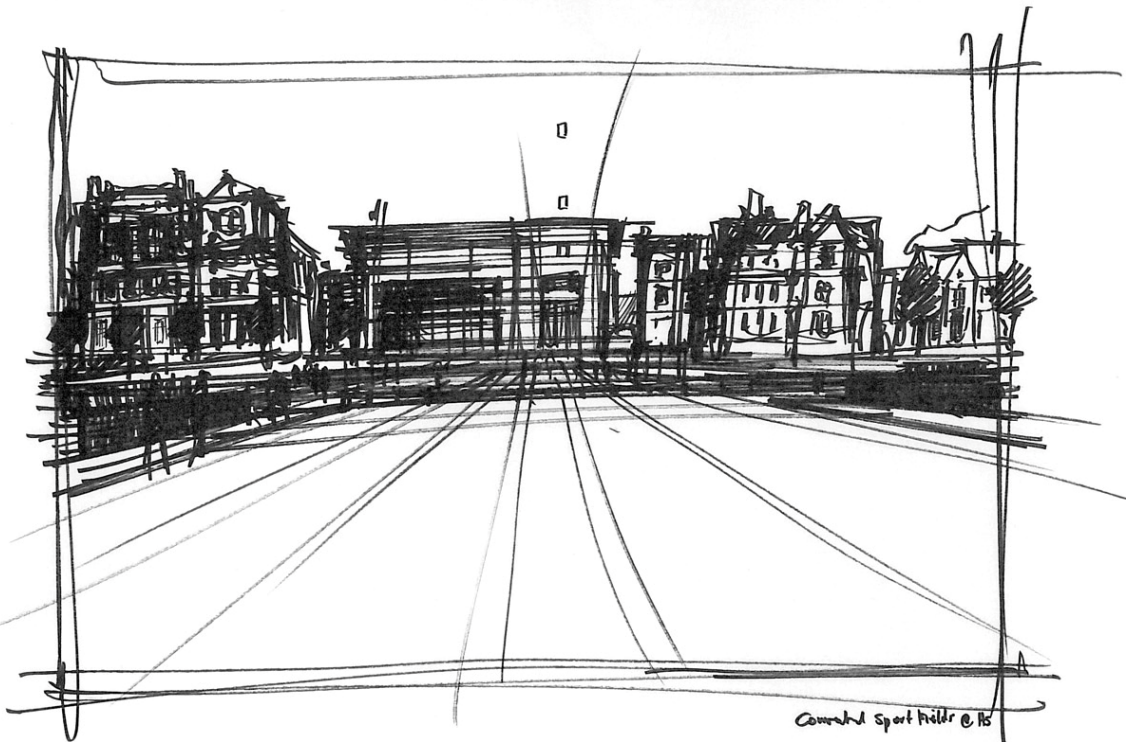


Fig. 105 David Carrico, initial sketch

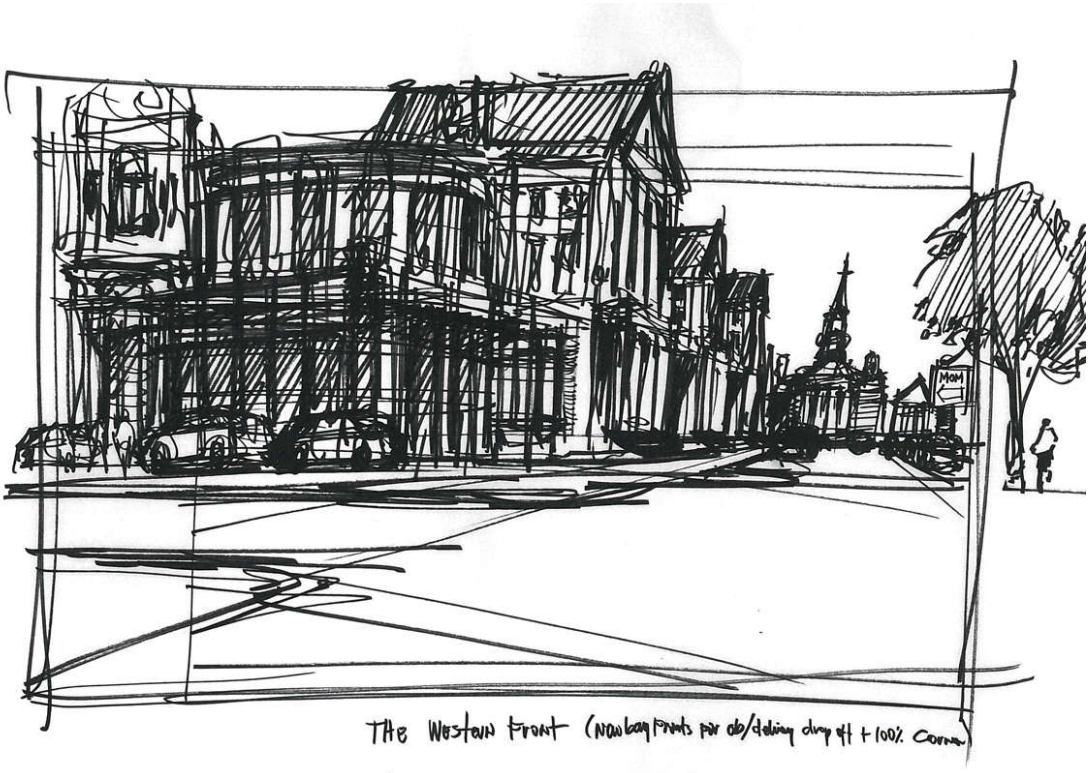


Fig. 106 David Carrico, initial sketch

Two formal meetings with main stakeholders and communication experts were held during the day.

Fig. 107 During the presentation opening the workshop, comments from the residents who came to the meeting were gathered.

In the afternoon, there was an opening presentation at the workshops. The project assumptions and goals – that the organisers hoped to achieve by the end of the week – were presented to the public at an open meeting. At each of the round tables where residents and other stakeholders were seated, there was a person from the project team who collected the residents' remarks and comments (Fig. 107).

VI. 4. 5 Fifth Day (6 October 2015)

PHASE II – Evolution of the Idea

Fig. 108 and 109 illustrate the gradual evolution of the first initial sketches characterised by ambiguity and a high degree of abstraction in comparison to the conceptual sketches which are more precise and accurate, also when it comes to the drawing technique (with the use of a ruler). It was precisely the need for accuracy that caused the use of the ruler, as well as the necessity to use digital techniques, which appeared after completing the thinking process associated with the design concept, when making the final drawing of the plan and in the post-workshop studies phase. Too early use of the computer carried the risk of entering into too much details unimportant at the initial stage of the design project, especially at the workshop, when there is a high risk of a complete change of the original idea – then, the laboriously drawn details would become obsolete after the change of the idea and would have to be deleted. The problem with the sense of scale in regards to freehand sketches (often related to the use of CAD (see p. 111)) was not noted in this case study.

The gradual refinement of the proposals illustrated the ongoing line of thought – it is worth recalling the PM's statement on the role of drawing as a medium for triggering the process of learning and self-improvement by noticing and correcting one's own mistakes which – in manual drawings – is achieved labouriously (Tab. 7, PM–B). This prompted designers to think deeper about the line drawing.

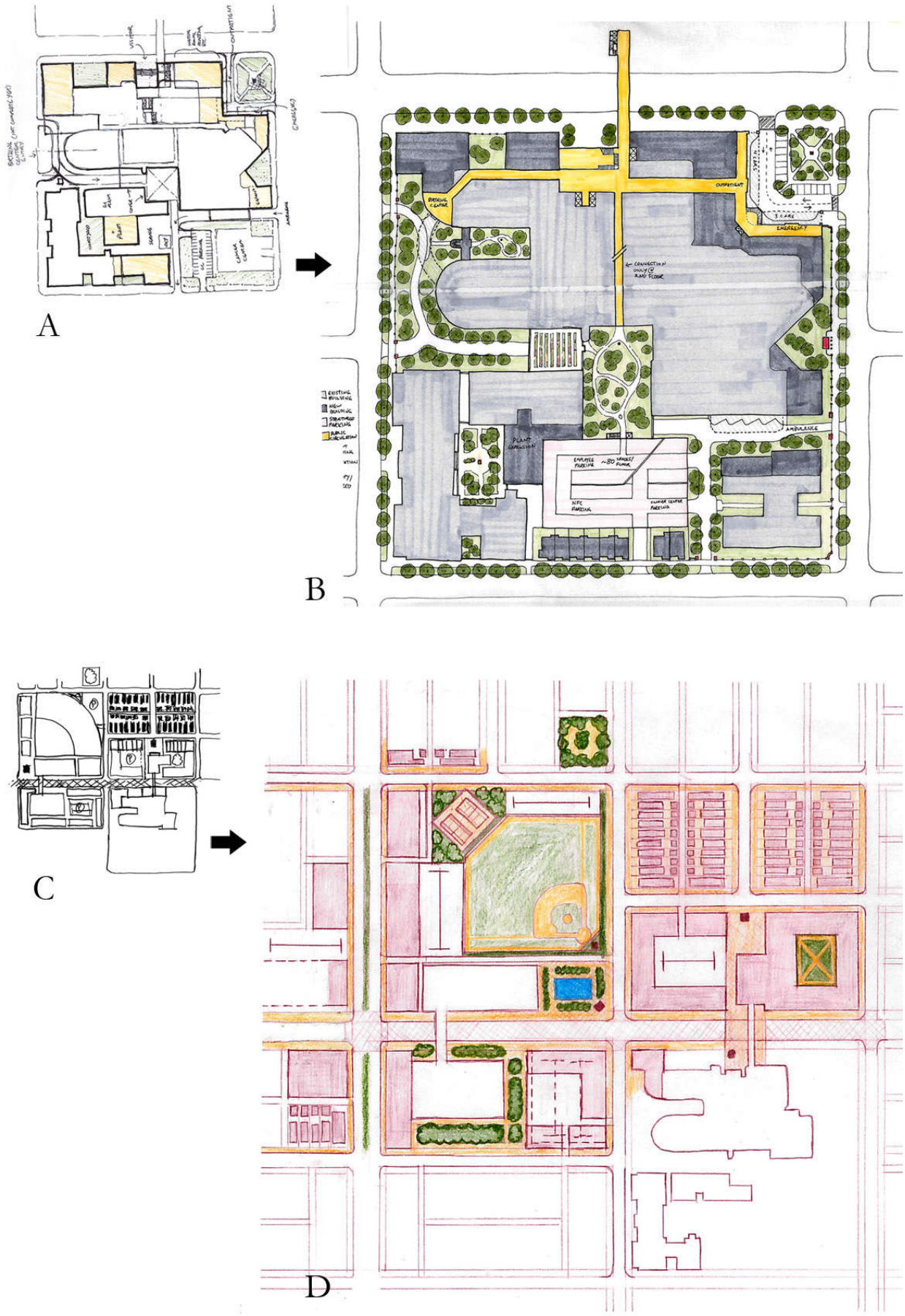


Fig. 108 A, B – Matt Lambert, C, D – Paul Genovesi,
evolution from initial sketches (A, C) to conceptual sketches (B, D)

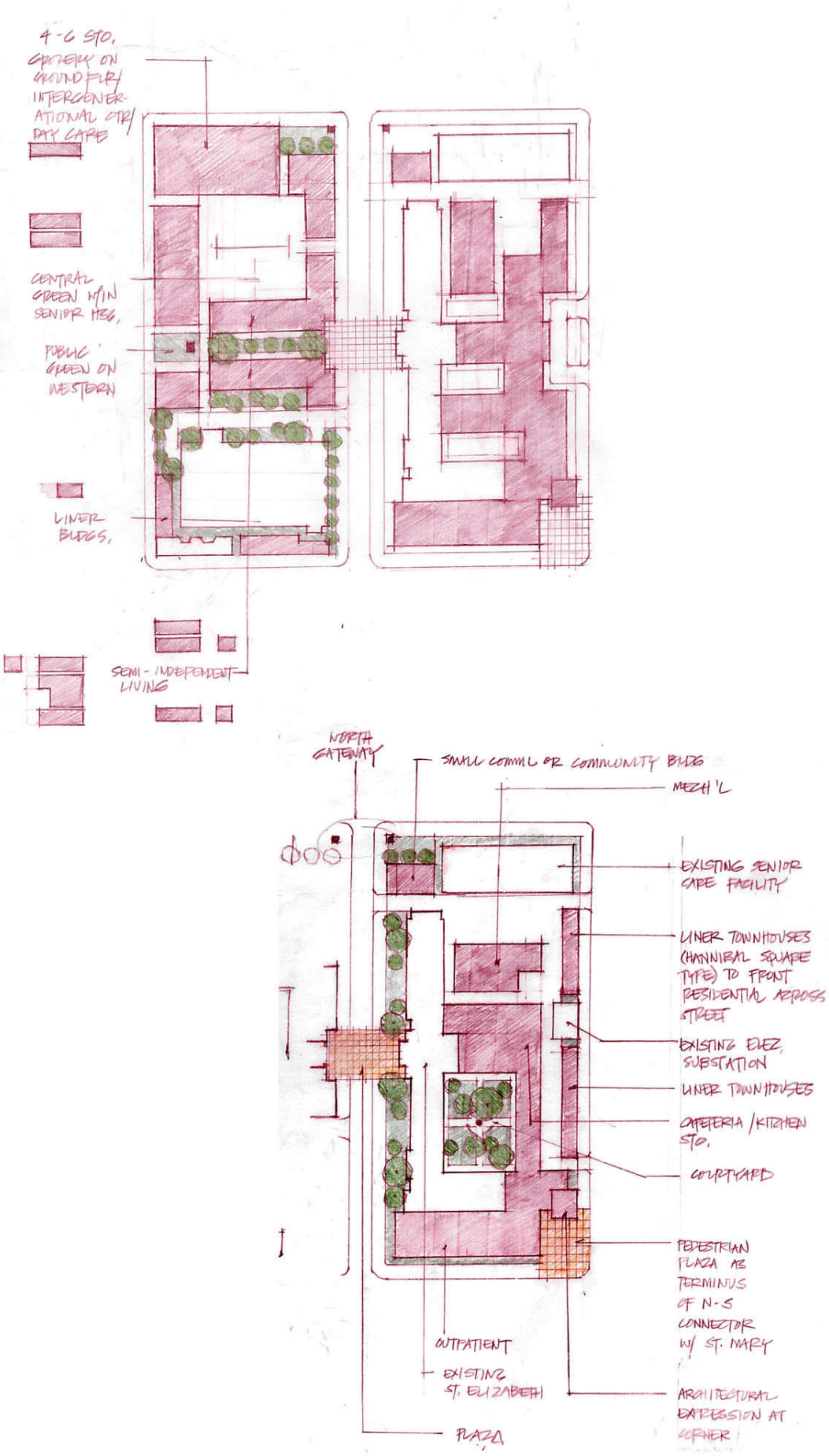


Fig. 109 Senen Antonio, conceptual sketches

In Fig. 110–114, a step-by-step work on the perspective is presented, showing the changes in the architectural form of the entrance to the Saint Mary Hospital.

At the beginning I1 made a preliminary drawing (Fig. 110A) based on the photo (Fig. 110B), which is the basis for subsequent initial sketches, showing the entrance to the hospital devoid of the original lobby. The theme of this part of the project was to transform the existing entrance to the hospital and adjust it to the patients' needs, as well as to create a recognisable element which could visually connect both hospitals.

Fig. 111C illustrates the beginning of the proper design. An initial sketch was created on the tracing paper layered on top of the initial drawing, characterised by the clear lack of precision, as well as free and unrestricted drawing lines. Fig. 111D was its continuation, and along with Fig. 112E showed how, as a result of lateral transformations, the process of searching for the shape of stairs in the glass entrance space took place. The fact worth noting is simultaneous work on the perspective and on small drawings of orthogonal projections and schemas (shown at the bottom in Fig. 111D and 112E). Therefore, reaching the final conceptual sketch constituted a line of thought requiring a well-developed spatial imagination – operating on many levels simultaneously – how the project looks from the front, on the ground floor plan and on the first floor plan, and how in perspective.

Fig. 112F – the redrawn and cleared version of the previous sketch – did not add much new information, but more precision, resulting from vertical transformations. A small schematic sketch of the spiral staircase, which has already appeared in Fig. 112E, was refined.

Fig. 113G presents a sketch from Fig. 112F, layered on top of the Fig. 111C. Further evolution of the design solution from Fig. 113H was discussed by PM. Her comments were layered on top of the drawing (Fig. 114I) by I1. The final, linear version of the perspective is shown in Fig. 114J. It was coloured already in the post-workshop phase (Fig. 139) – as PM preferred to organise the illustrator's work at the charrette workshop so that more linear perspectives would be created rather than less of them but in colour version. The transmission of as much information as possible was therefore more important than the attractiveness of the perspectives.

From the quick and seemingly careless sketches, the final result was slowly emerging, resulting from the fact that the comments gathered at the meetings from all stakeholders were carefully considered and taken into account.

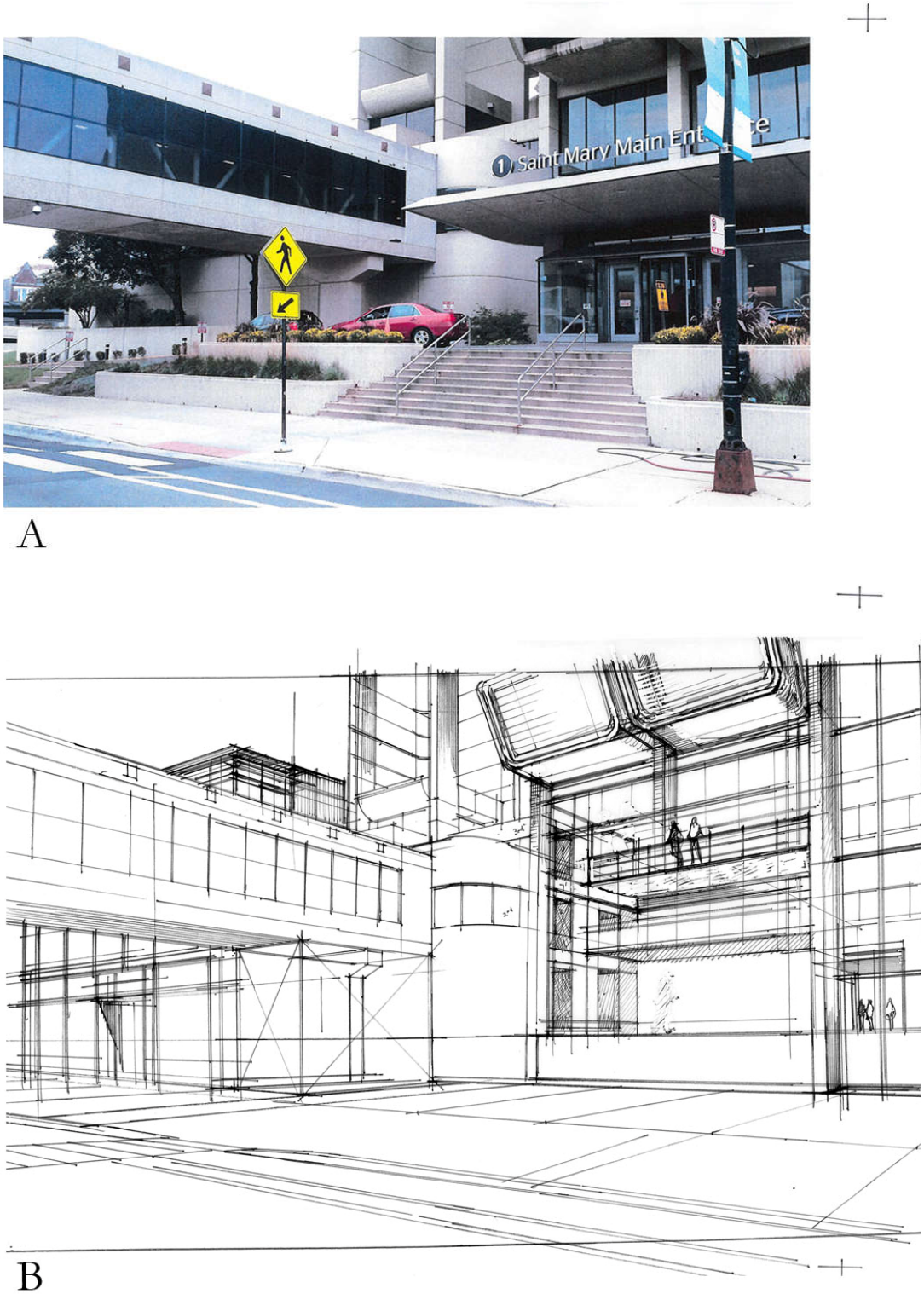


Fig. 110 David Carrico, initial drawing (B) based on photo (A), which is the basis for further initial sketches – the author 'stripped' the building of the staircase and of the current entrance to create space for a new design.

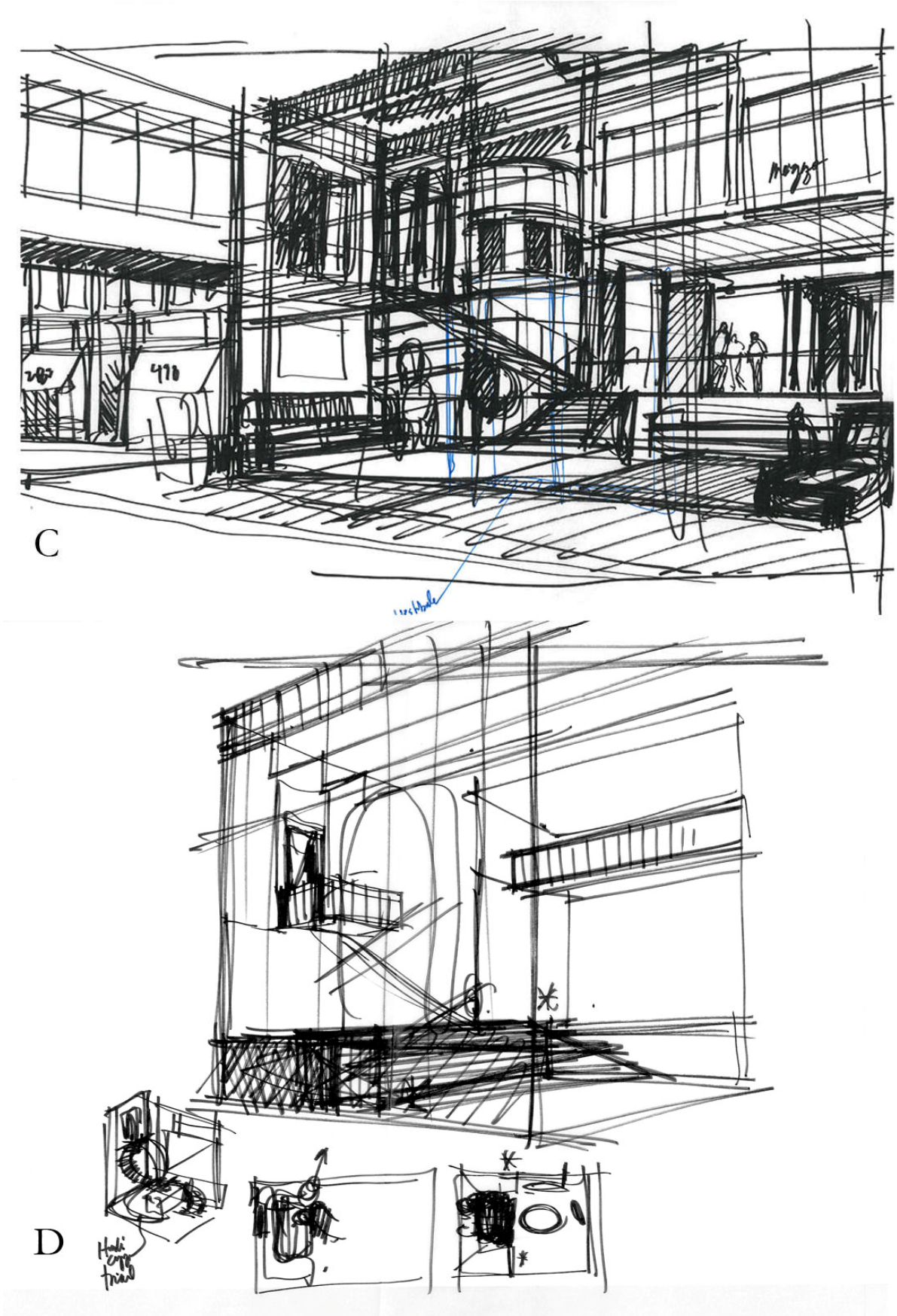
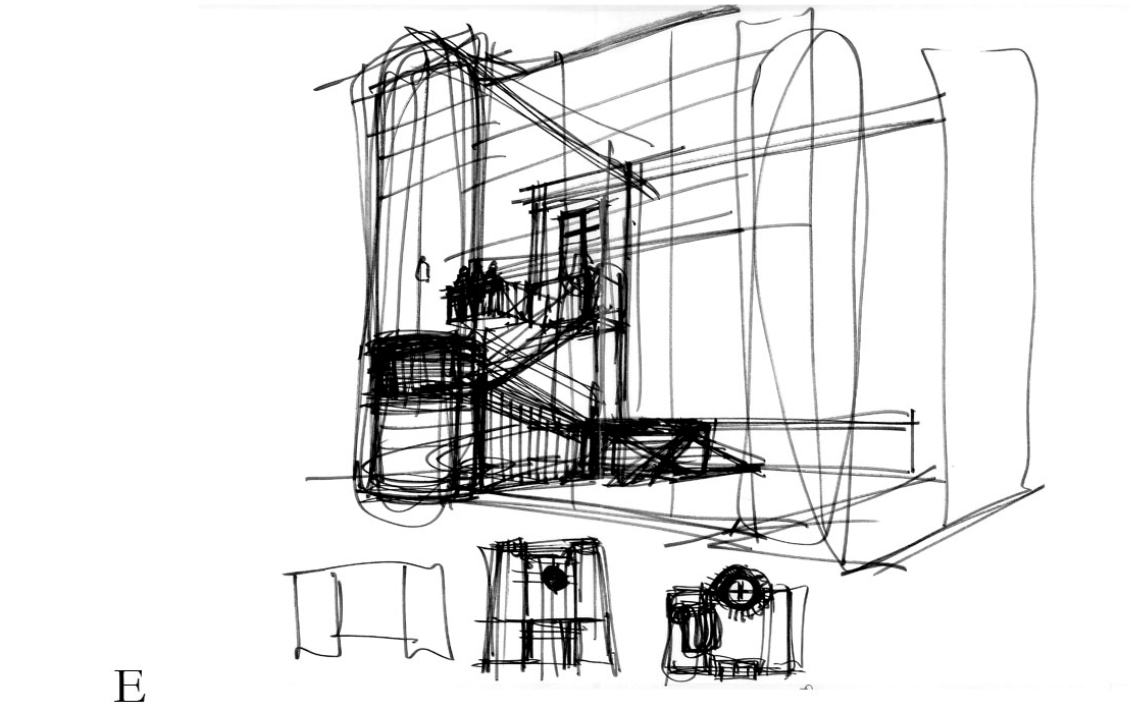
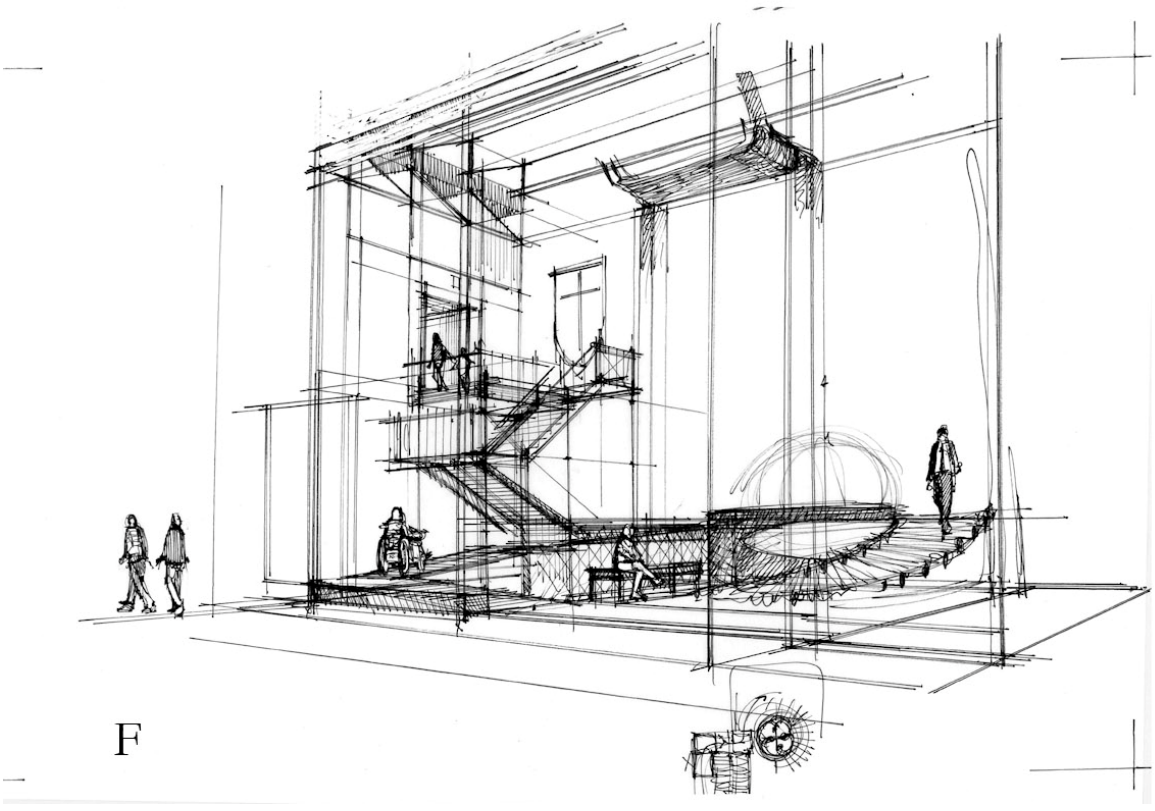


Fig. 111 David Carrico, the first initial sketch (C) and modification of its fragment (D) – below the projection schemas created simultaneously with the perspective view can be seen.



E



F

Fig. 112 David Carrico, in Figure E, another modification of the idea and elevation and projection schema – it shows the attempt to refer the projection of spiral stairs to their complex spatial form. The issue has been fine-tuned in Figure F.

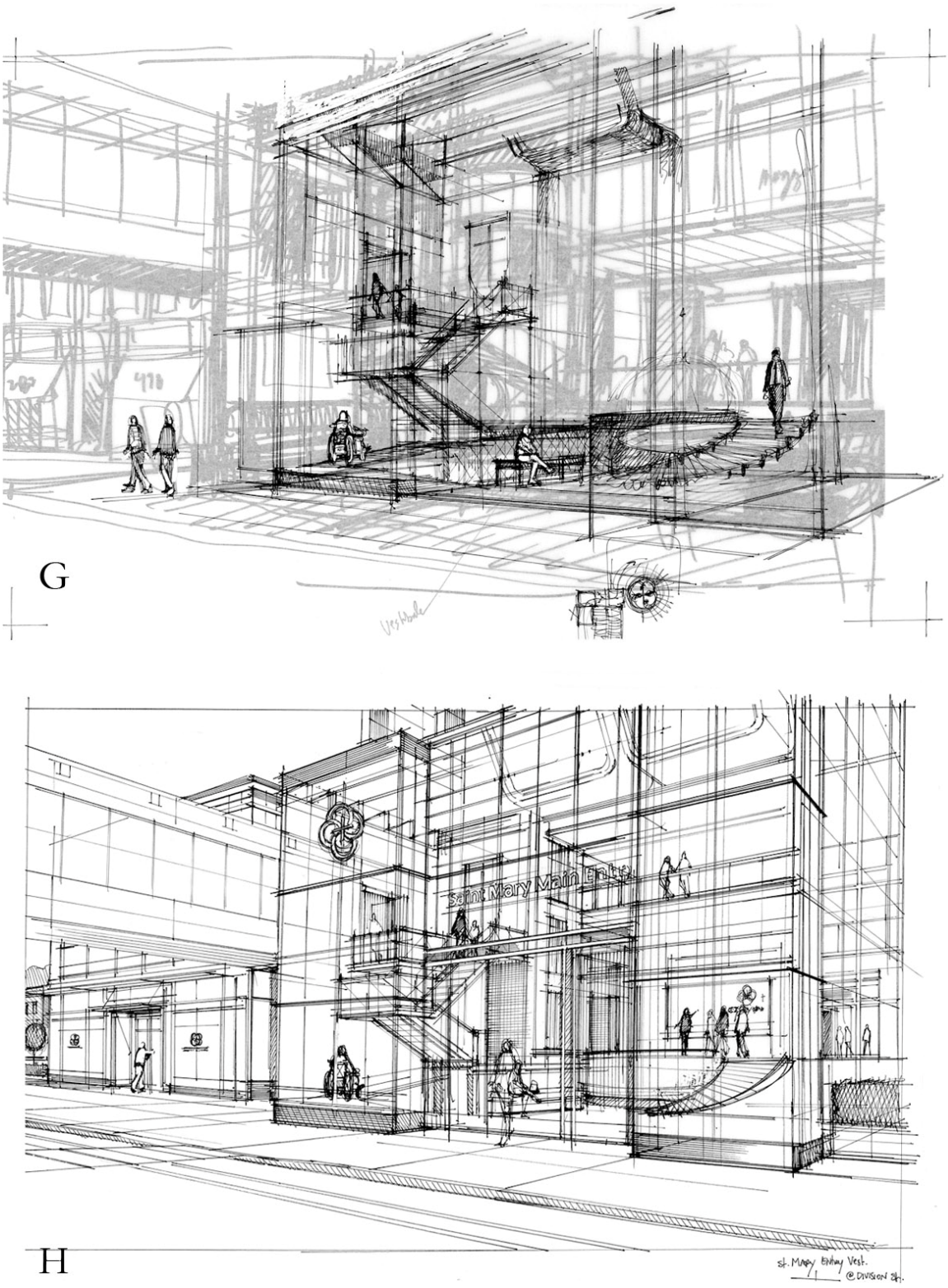
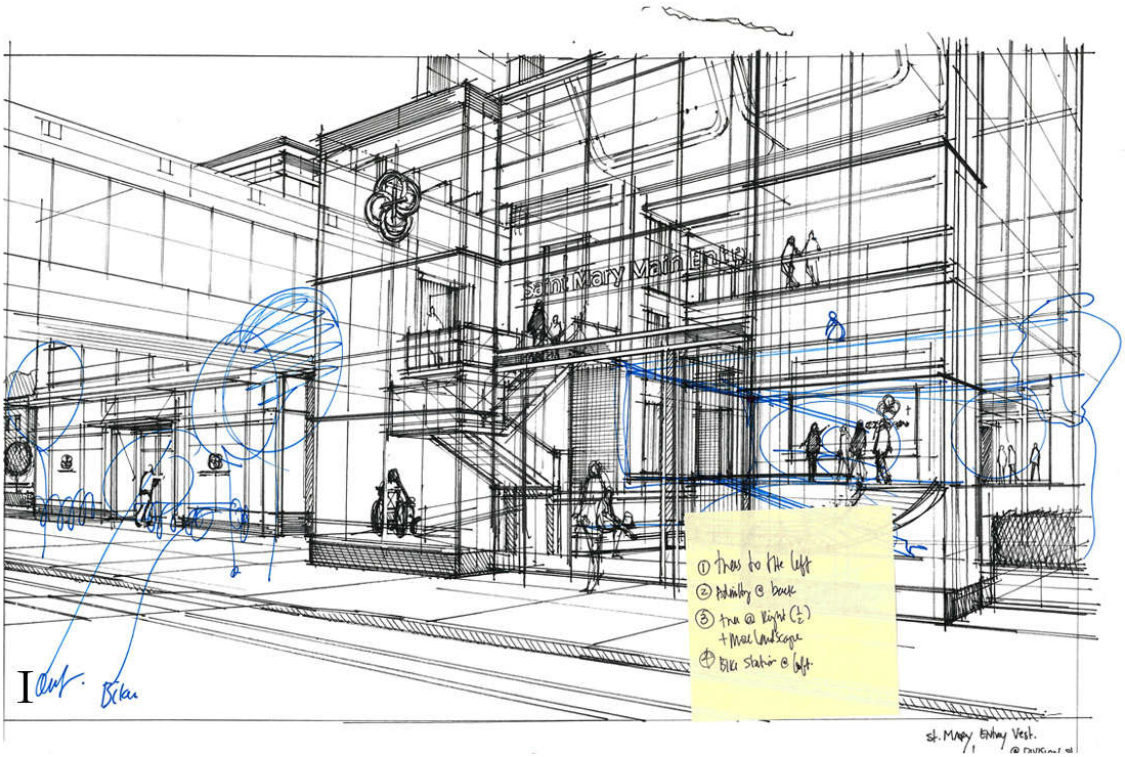
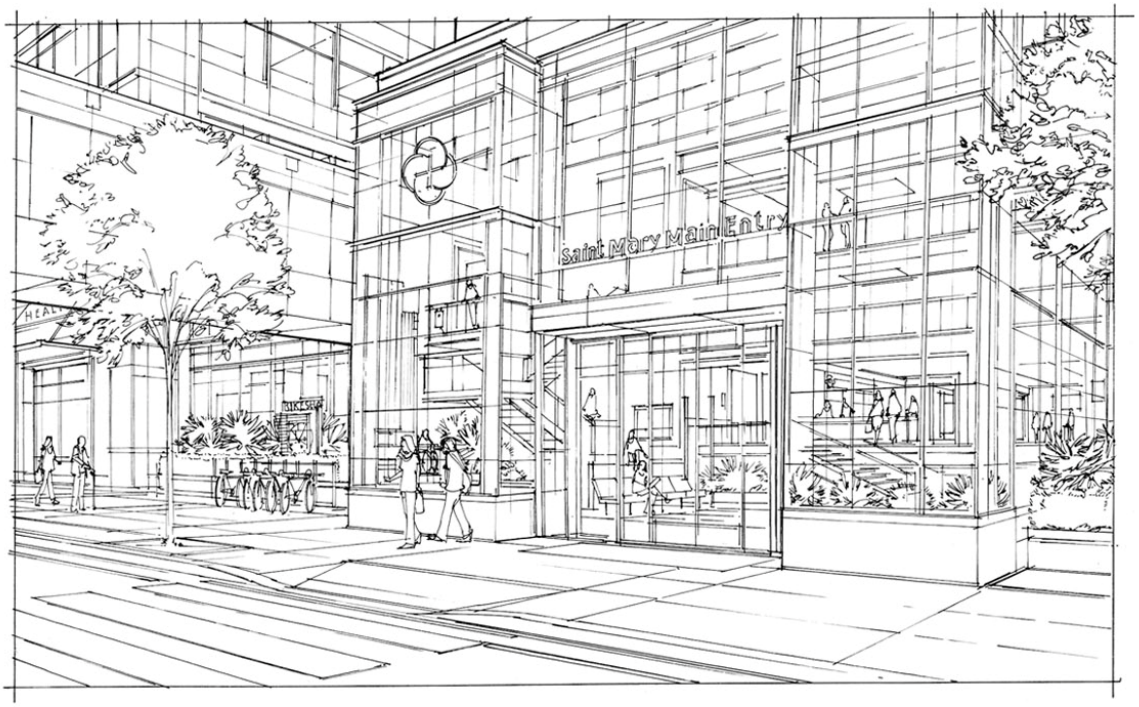


Fig. 113 David Carrico, sketch from Fig. 112F layered on top of the sketch from Fig. 111C (G) and the combined and redrawn version (H)





J

Fig. 114 David Carrico, Figure I is a corrective sketch, which was made on the basis of PM's corrections. In Figure J the final version of the linear perspective is presented.

Fig. 115 and 116 show the corrected perspectives. The corrective sketches marked with the letter A made on tracing paper by PM (Fig. 115A) and SD2 (Fig. 116A) explained what changes should be introduced. These drawings illustrate the role that freehand drawing plays in the communication process between architects and urban planners who prefer a graphic message to a verbal one. The same correction but without the use of the drawing would take longer and would deprive the message of its accuracy and unambiguity.

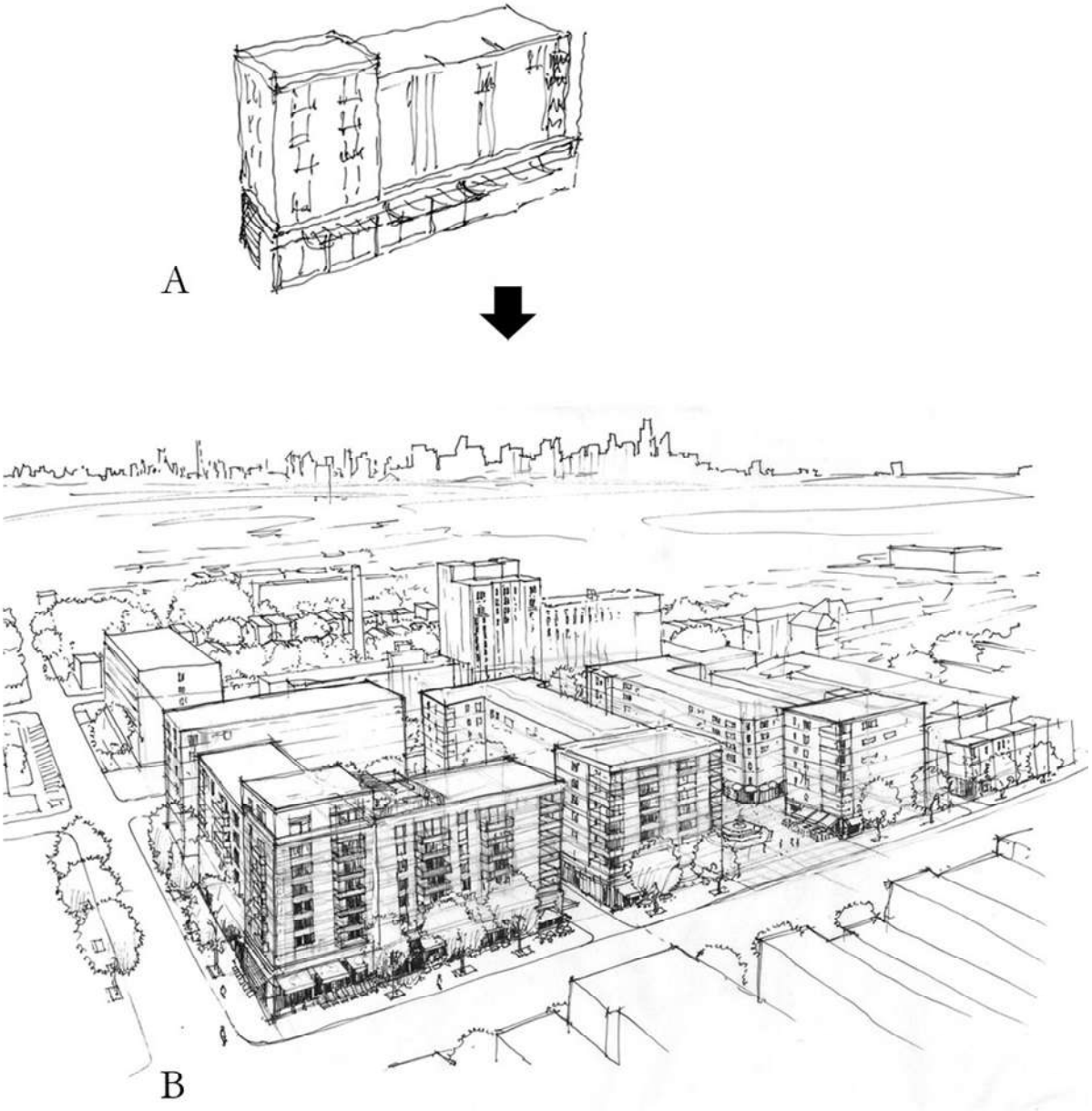


Fig. 115 A – Elizabeth Plater-Zyberk, B – Joanna Pętkowska-Hankel,
corrective sketch (A) and final conceptual drawing after correction (B)

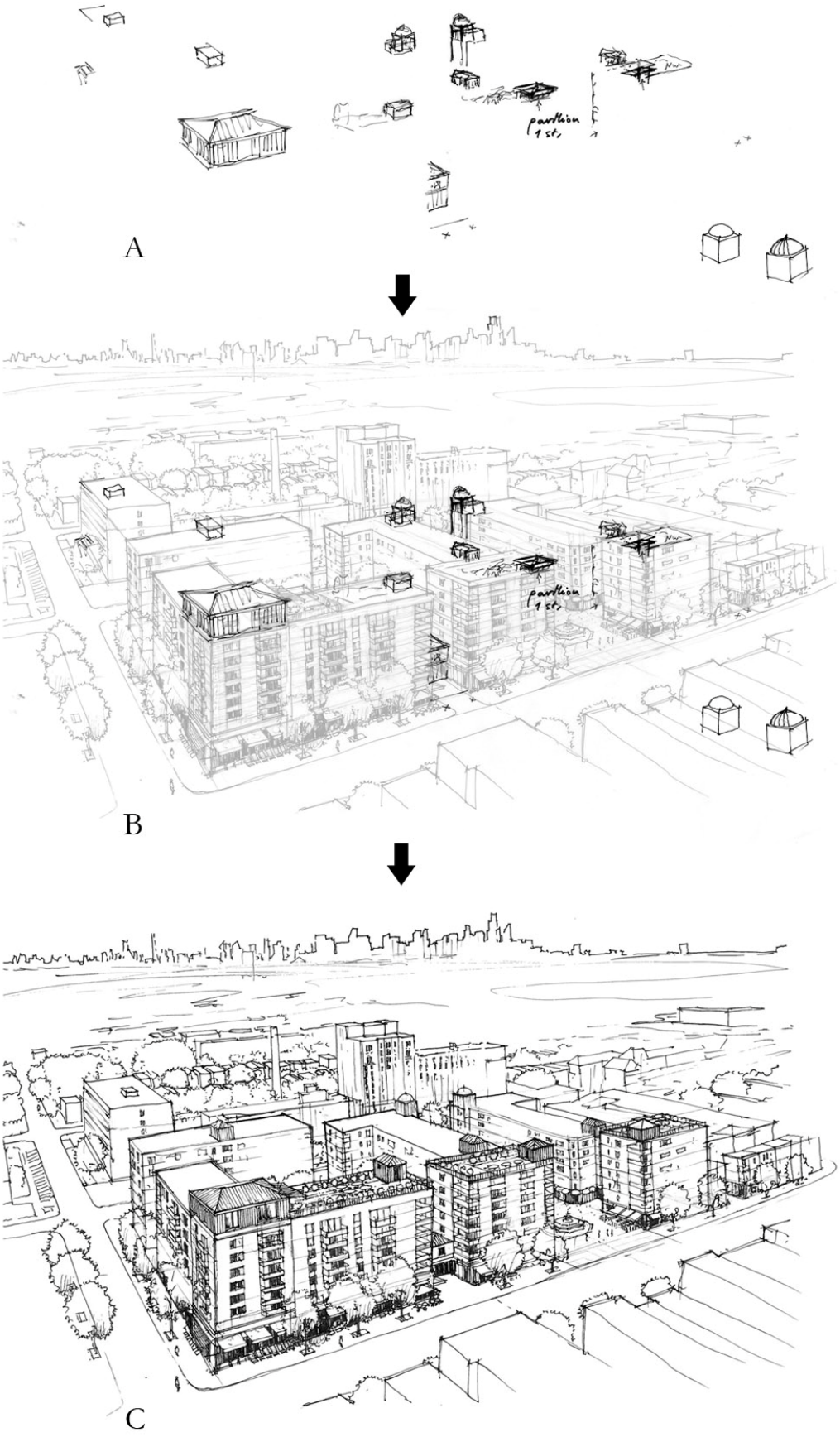


Fig. 116 A, B – Matt Lambert, C – Joanna Pętkowska-Hankel,
corrective sketch made on tracing paper (A), layered on top of the perspective drawing (B).
In Figure C, the perspective after correction.

VI. 4. 6 **Sixth Day** (7 October 2015)

PHASE III – The crystallization of the final concept

In Fig. 117 are presented separate layers of tracing paper, which the designer (SD2) positioned one on top of another, wanting to keep some information apart. This method, known to architects and urban planners for a long time, was adapted directly to computer programs (e.g. Photoshop), in the form of the file's editable layers.

The schema in Fig. 118A was aimed to show the communication in the building as clearly as possible, therefore the author (SD2) gave up more details to bring out the most important information. The same technique was used in Fig. 118B, where the viewing axis focusing the viewer's attention upon the tower of the Saint Elizabeth Hospital was highlighted.

Fig. 119B shows the functional schema of the Saint Mary Hospital, and its development is shown in Fig. 119A, which also contains information on the height of buildings, the number of residential units, parking spaces, square metres, entrances to the building, etc.

Fig. 120 presents the seed of the final plan. The initial diversity of freehand recording techniques has now been unified. It was mainly the effect of combining individual separately designed quarters and merging them into one single drawing. The linear sketch was made manually with the use of fineliners with different tip sizes.

In Fig. 120B, which is a colour test made with felt-tip pens, one can see that freehand techniques can also be used to quickly test the final version of computer-coloured graphics. The later digital variant was basically the same as on the trial, only passageways for cars and pedestrians did not remain white, but yellow and brown.

The formation of perspective step by step is shown in Fig. 121 and 122, starting with a small communicating sketch drawn by PM (Fig. 121A), and ending with a linear sketch ready-to-apply colour (Fig. 122E). PM's drawing, extremely symbolic and brief, could only be read by the author and the direct receiver. Despite its concise character, however, it contained a lot of information.

In the course of drawing this perspective, at the request of IR, the historical tower of the Saint Elizabeth Hospital has been shifted slightly to the right – it was a procedure aimed at putting emphasis on the investment's symbol and its compositional axis.

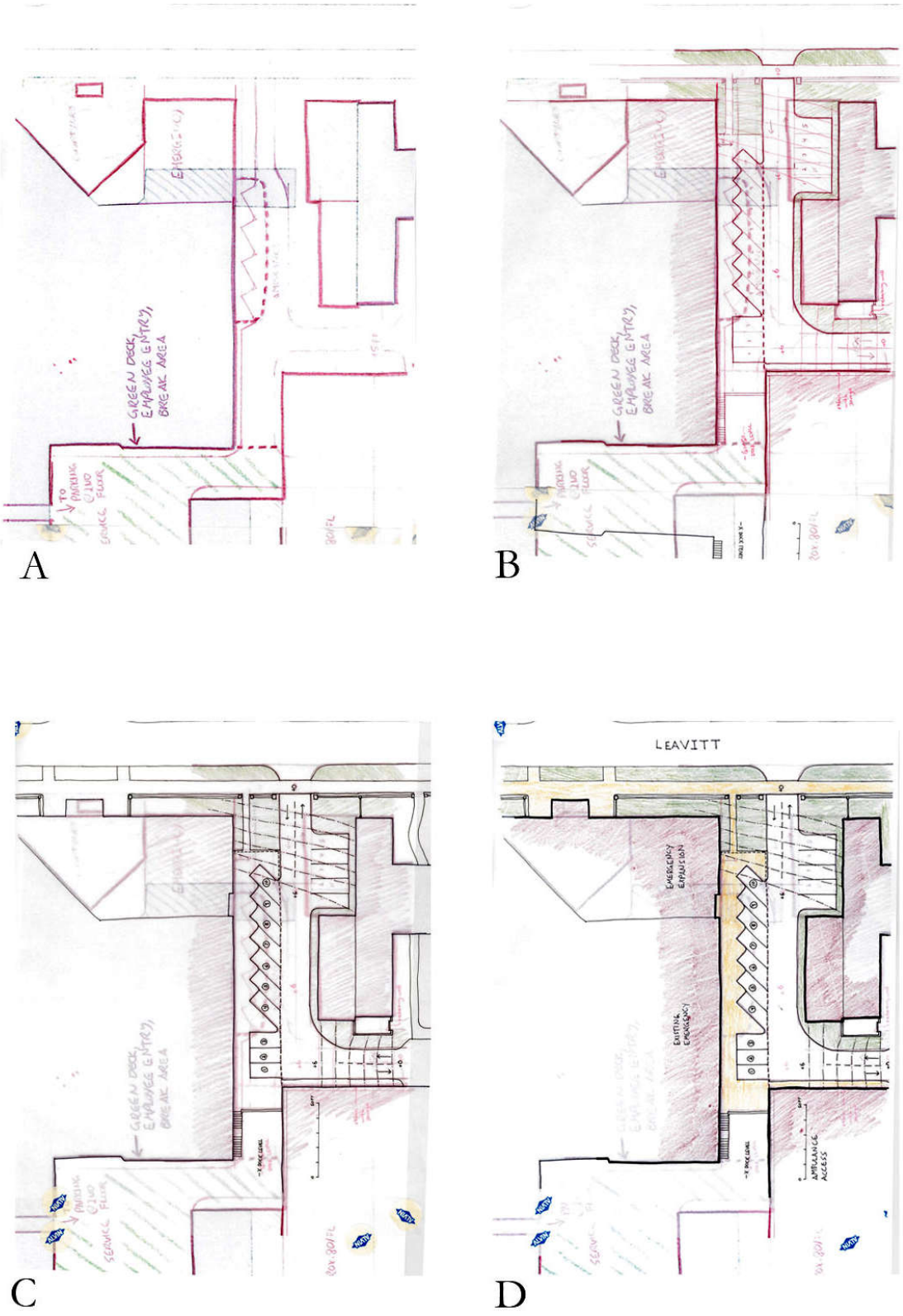


Fig. 117 Matt Lambert,
the drawings show tracing paper with individual elements of the design,
layered on top of each other, starting with A, ending with D.

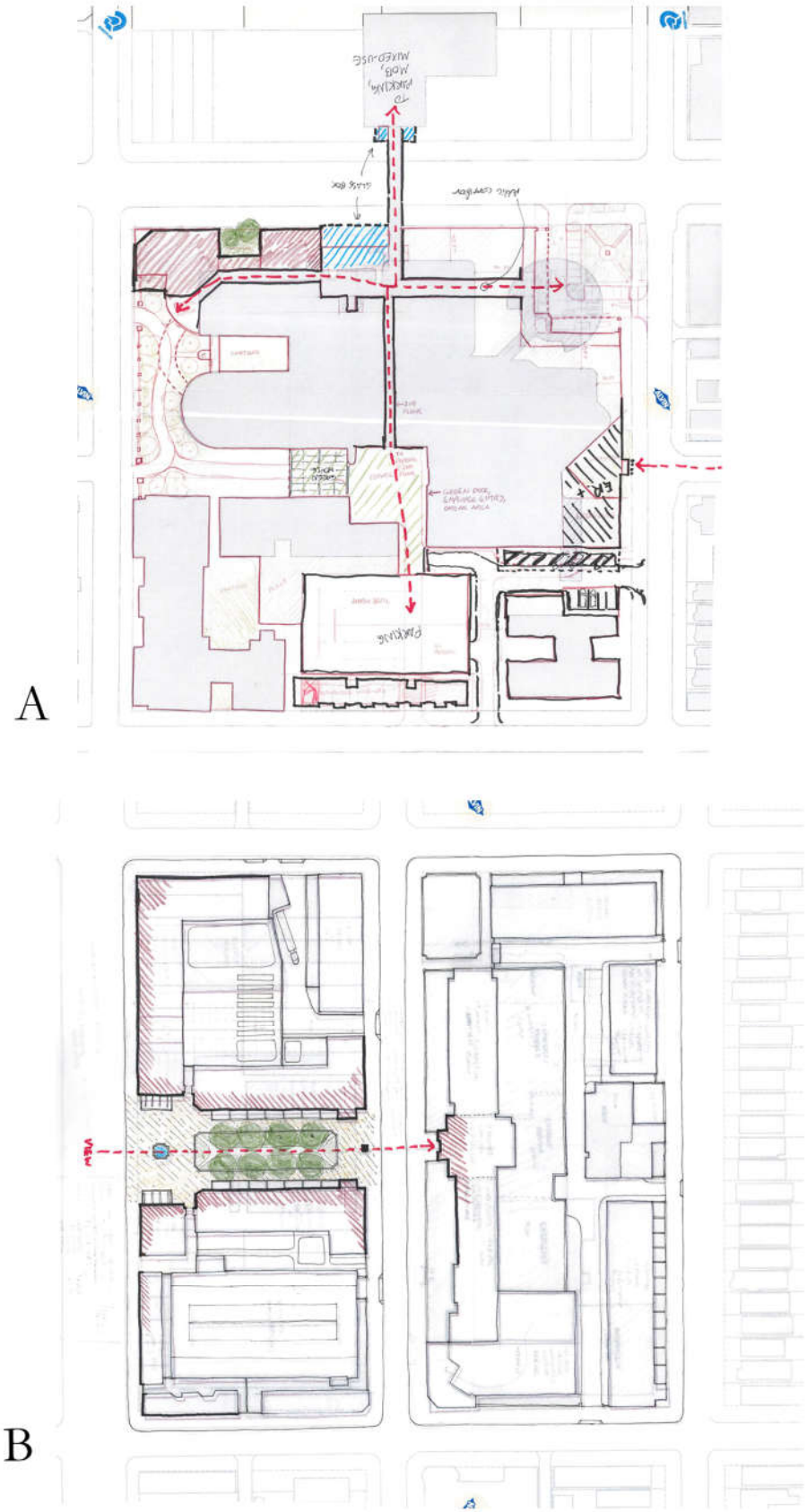


Fig. 118 Matt Lambert,
diagrams: transport and composition (A) and composition-design closure in the form of a landmark: the highest building of the St. Elizabeth (B)

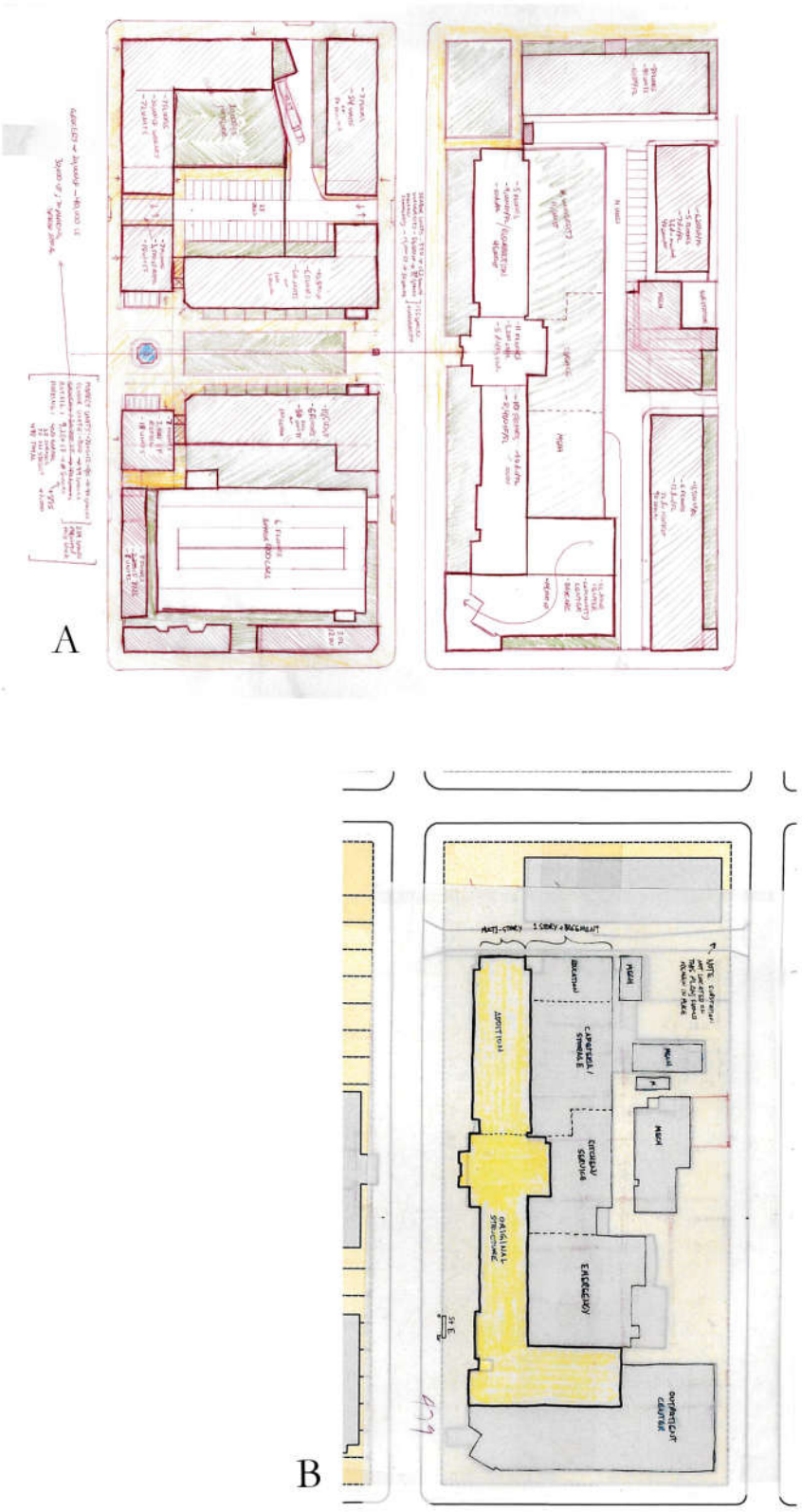


Fig. 119 Matt Lambert,
drawings showing functions (B) and containing information on the height of buildings,
the number of residential units, parking spaces, etc.

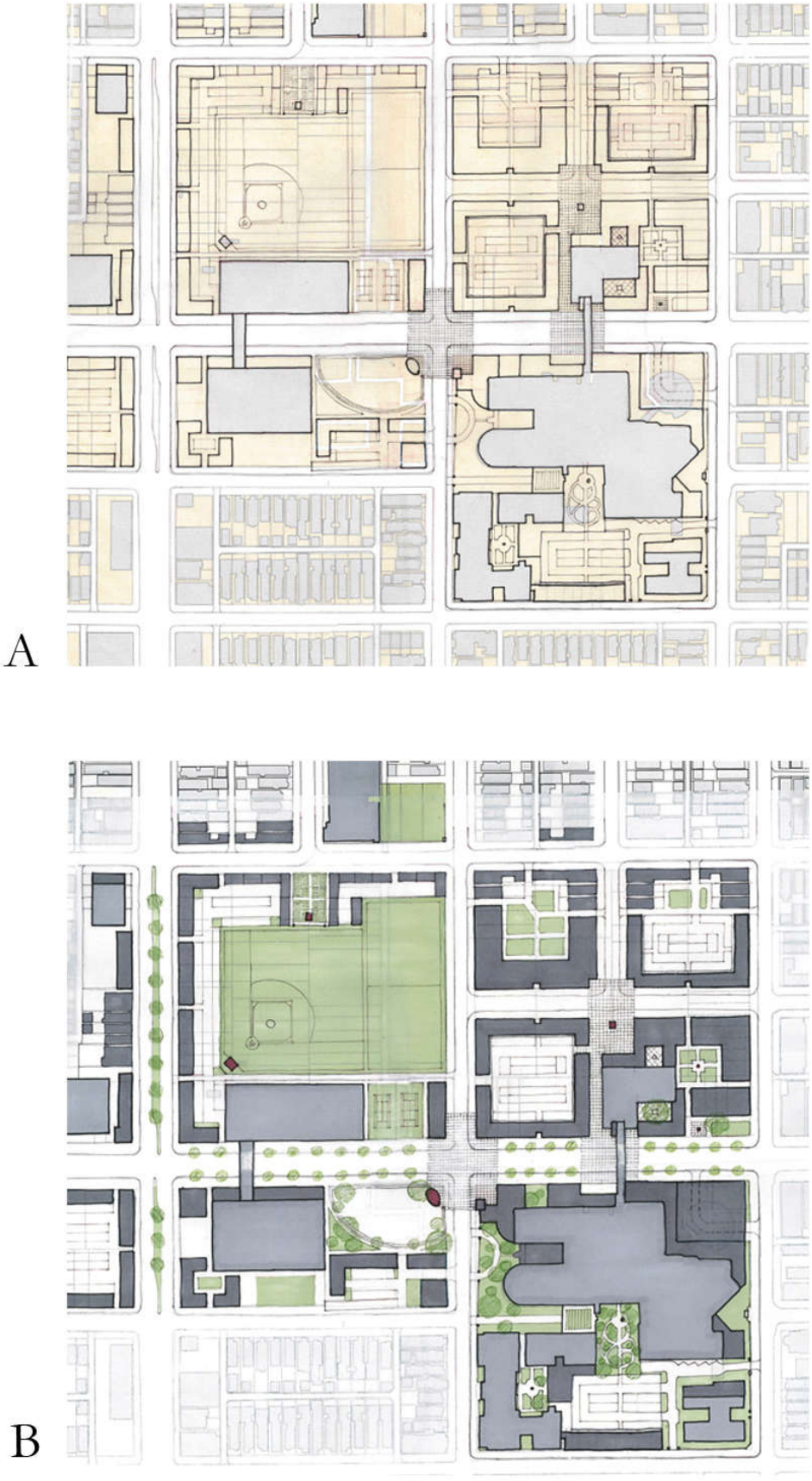


Fig. 120 Senen Antonio,
tracing paper with a hand-drawn plan of buildings – black and white linear sketch,
layered on top of the map printout (A); below the same linear sketch coloured with markers – colour attempts (B)

Freehand drawing made it possible to manipulate the message, precisely because of the ease of emphasising the most important features of the project, highlighting or even overstating them (see pp. 142–143). This was fostered by a certain imperfection and understatement contained in the sketch which made the introduced changes seem not as conspicuous as in the case of precise computer-generated renders which are a photorealistic representation of the designed project.

The ambiguity of the drawing, mentioned earlier in the dissertation (see V. 2. 4), launched the dialogue which was of paramount importance in the charrette method. The stakeholders, both at the meetings and the drawing boards, were open and willing to talk about freehand drawings made on the basis of their comments; they seemed to them only a suggestion, and thus something that is still subject to comments. This aspect was also convenient for designers – freehand sketches seemed more 'non-committal' than, for example, a ready computer drawing which gives the impression of being completed, even if it is just a certain stage of the design project. The participants, when they look at digitally generated images, it is more difficult for them to believe that there is still room for discussion. They may have the feeling that too much time has been devoted to the creation of designs, to still change something (and that does not have to be true). Visualizations that look like a photo can cause the workshop's participants to expect such a picture of the design in reality. This, in turn, is difficult to guarantee at an early stage of the conceptual design. In the case of freehand drawing, there were no such expectations – the stakeholders realised that traditional techniques rarely achieve realistic accuracy, so they had some kind of 'built-in' tolerance for the lack of precision and understatement. The choice of freehand drawing as the dominant design tool during the workshop was therefore a conscious strategy for controlling the flow of information.

The limited time of the charrette workshop and its scope, not going beyond the concept, involved – at the moment of drawing perspectives – the need to complete the missing data and invent the architecture and details of the project being implemented. Perspective, the drawing of which is shown in Fig. 121 and 122, showed a fragment of an urban complex in which architecture was not specified in detail. The illustrator had to create its image on the basis of perfunctory, general information provided by the rest of the team, building on their own knowledge and experience. The same applies to creating a specific atmosphere in a drawing by inserting characters, greenery, small architecture,

etc. The illustrator did not have to model or give technical parameters to all these extremely detailed elements, for it was enough for him to imagine.

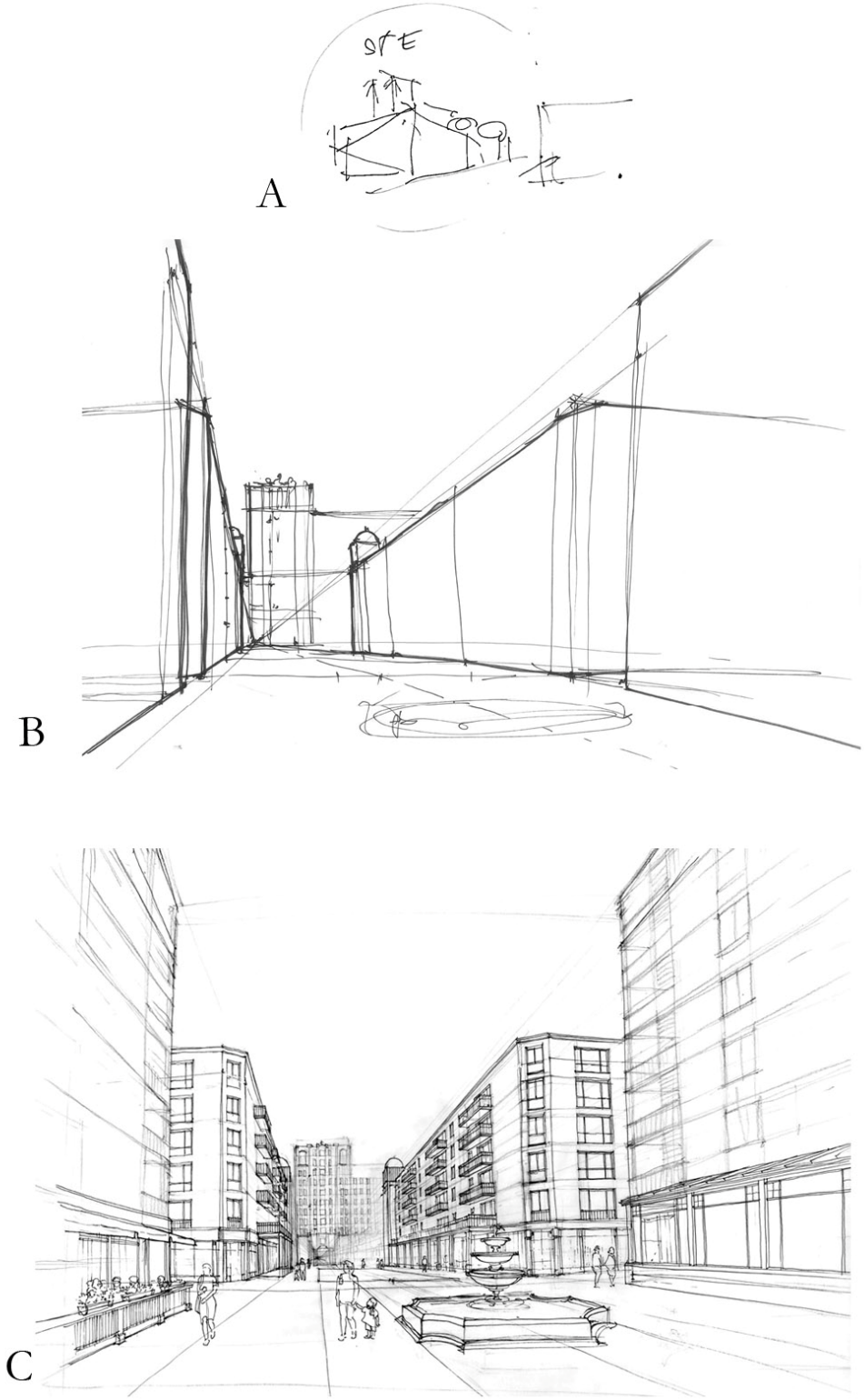


Fig. 121 A – Elizabeth Plater-Zyberk, B, C – Joanna Pętkowska-Hankel,
stages of perspective formation, from the communicating sketch PM (A) to the preliminary version (C)

D

E

Fig. 122 Joanna Pętkowska-Hankel, successive stages of perspective development,
one can see the change in the architecture of the corner tenement houses (D) and searching for the loggia form (E).

VI. 4. 7 **Seventh Day** (8 October 2015)

The seventh day was filled with verification meetings and preparations for the presentation before the investor, which took place in the evening of that day, as well as to the final presentation the following day. The investor's representative looking at the orthogonal projections stated:

> IR: If there will be any non-planner there I don't think they understand these plans… it's good that the aerials are there.

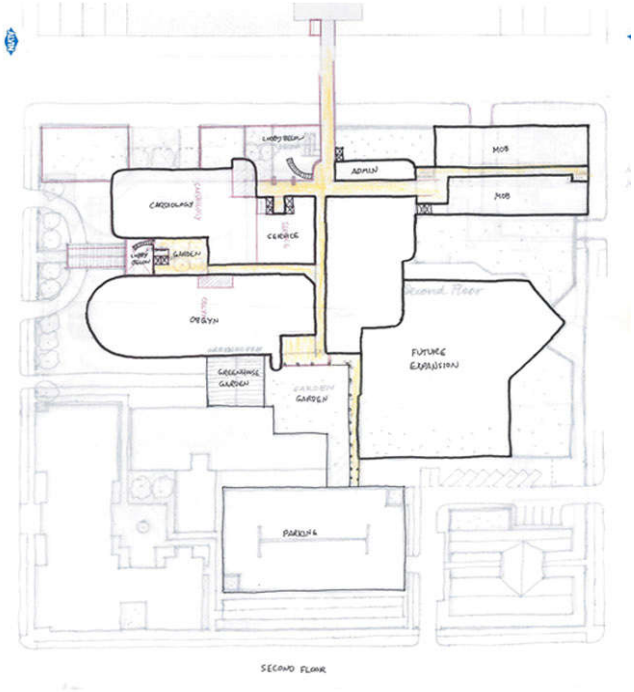
This quote shows the organisers' concern that the project proposals should be comprehensible for people unrelated professionally to architecture, while at the same time presents IR's doubts about the legibility of two-dimensional plans (the validity of IR's skepticism was confirmed by the results of the survey, presented in Tab. 8). That is why the important elements of the workshop are the bird's eye view perspectives and the human eye-level perspectives, corresponding to the natural perception. It is worth quoting here the subsequent commentary by Elizabeth Plater-Zyberk from the evening presentation, which was evoked by the sight of many people crowding at the pin-up boards with perspectives:

> PM: We put so much effort into making what is drawn here possible in the form of plans with numbers, dimensions and so on… but people always prefer perspectives.

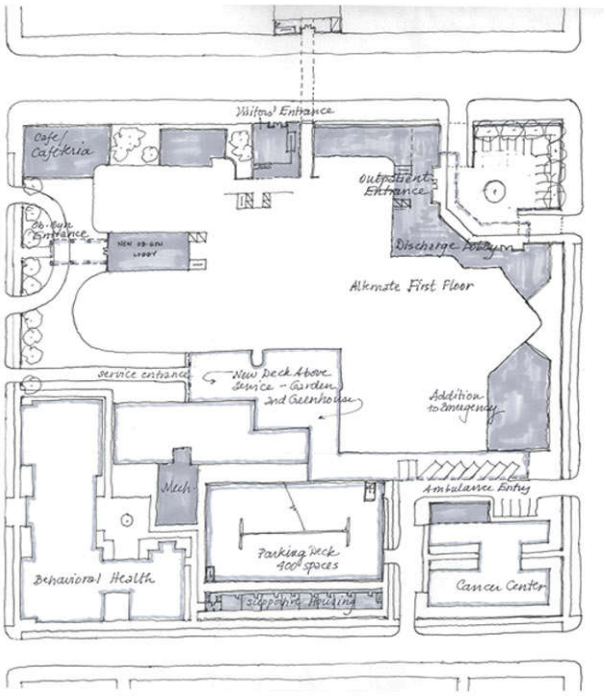
Fig. 124 shows the most recent sketches specifying the location of the Saint Mary Hospital function. Fig. 125 presents the method of producing drawings, displayed this day both on the boards in paper form and in the final presentation – the linear sketch was made manually, while the colours were added on the computer or with the use of felt-tip pens. That is how plans from Fig. 126 were developed which present two design options: with buildings around the school playground and the school, as well as without them. The second version was made on a separate sheet of paper and stuck to the first plan.

Fig. 123 Discussion on freehand perspectives during the presentation for the investor

In Fig. 127–131 sketches of perspectives were shown, which due to the limited time during the charrette workshops were only slightly coloured, so as to extract the most important spatial features – mostly those which had with similar colours on the plan – buildings, greenery, pavements, streets. This reduced the attractiveness of the message in comparison to the fully coloured drawings, which was important at the presentation stage, while their substantive content remained the same. The time an illustrator would spend on painting with watercolours was saved in order to create more drawings about the project. Again, the relative speed of traditional techniques can be noticed.



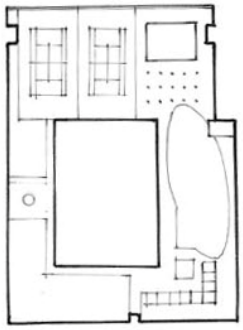
A

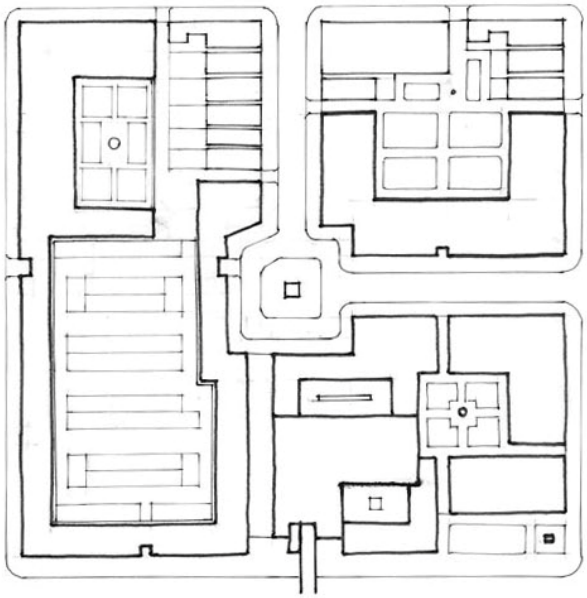


B

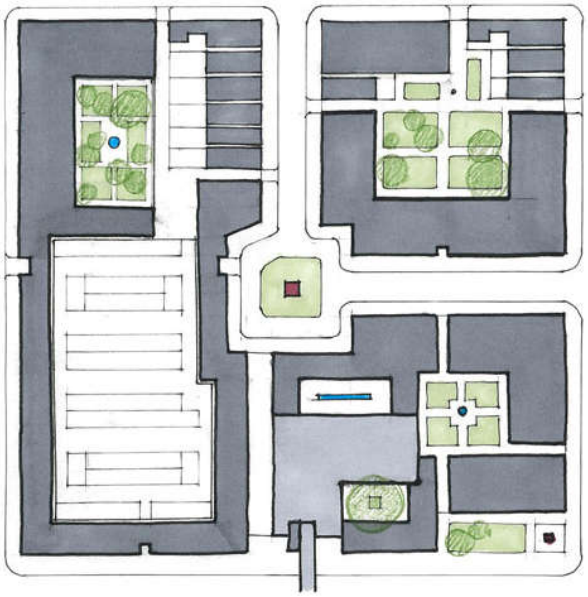
Fig. 124 A – Matt Lambert, B – Elizabeth Plater-Zyberk

The final perspectives were drawn by the I1 with the use of a ruler, which according to the definition adopted in Subchapter II. 5 does not exclude them from the group of freehand drawings. What is worth noticing, is that reaching their form, i.e. the creative stage (initial sketches, e.g. Fig. 103) took place without a ruler, which was supposed to increase only the precision of the performance, similarly to the use of computer programs in the post-workshop phase.





Alternate North
with Residential Tower



Alternate North of Division

Fig. 125 Senen Antonio

Fig. 126 Senen Antonio

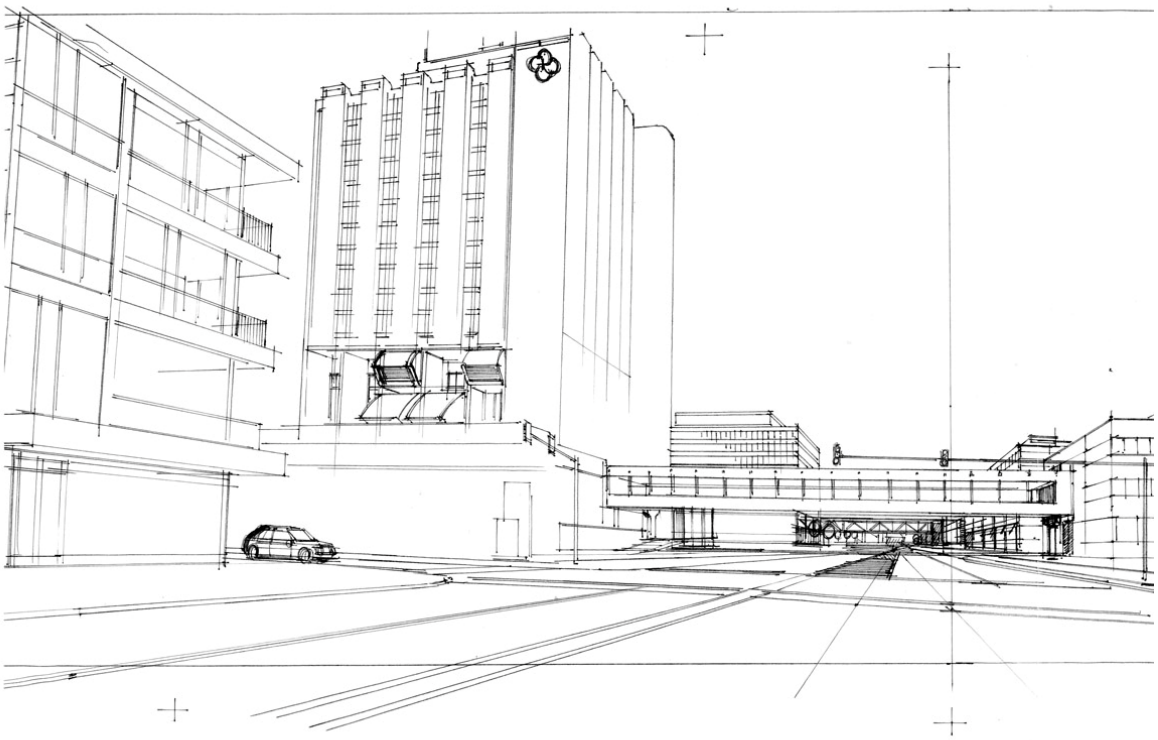


Fig. 127 David Carrico

Fig. 128 David Carrico

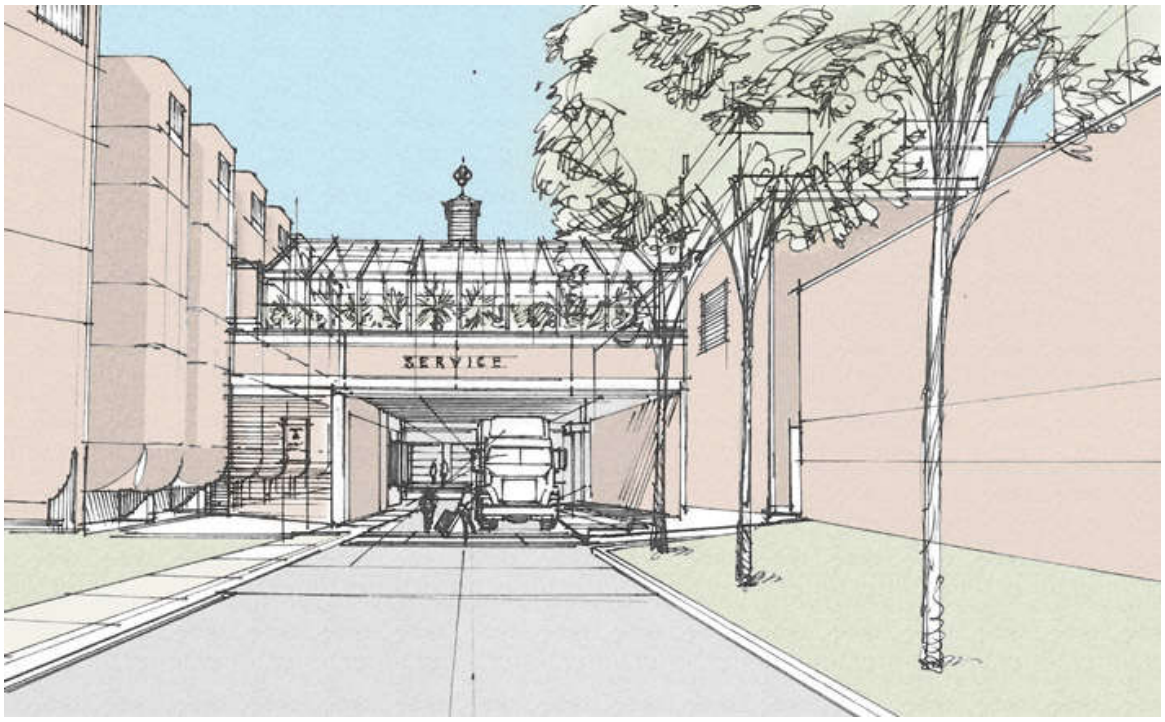


Fig. 129 David Carrico

Fig. 130 David Carrico

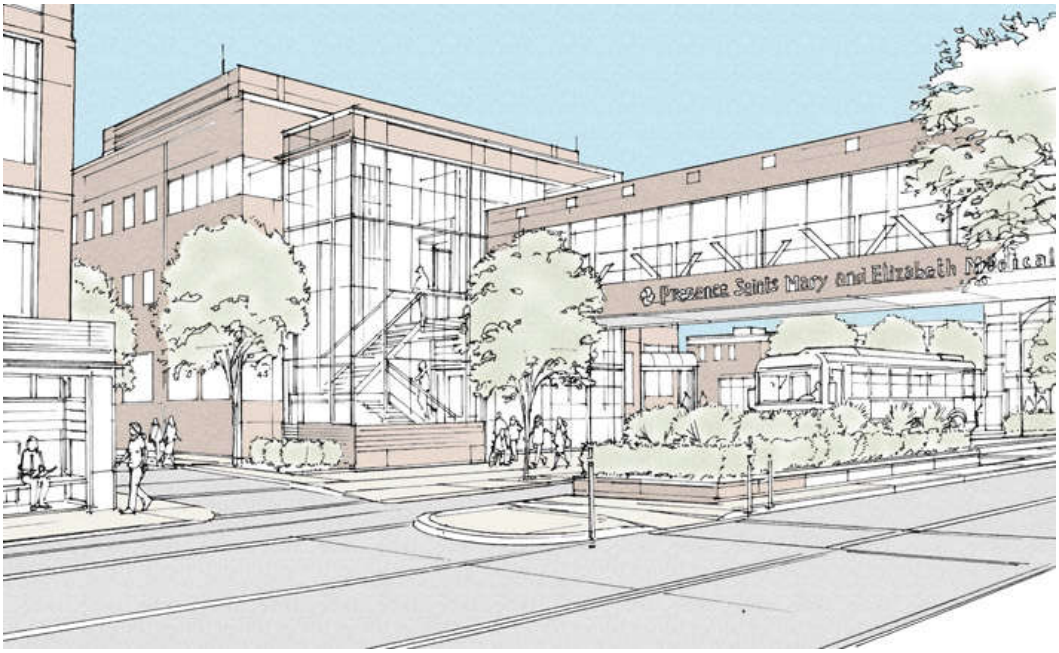


Fig. 131 David Carrico

VI. 4. 8 **Eighth Day** (9 October 2015)

PHASE IV – Presentation

The last day of the charrette workshop was devoted to the final presentation and its preparation. Some perspectives have been coloured entirely for the charrette (Fig. 144 and 145), and when it comes to the rest – the final colour scheme was given after the workshops by I1 (in Subchapter VI. 5 their final versions were presented).

Fig. 132 shows the work on last perspective, whose sketch based on the photo made by PM was combined with the final view. Again, the accurate message of a quick drawing, enabling communication between the PM and the I1, is striking. All the most important elements from the general communicating sketch were taken into account in the final perspective. For PM, it was particularly important to stress the Presence Health logo (a four-leaf clover) in a cubic form of the entrance, intended to be a common element for the complex of hospitals and Presence Health, which is clearly visible in the sketch.

The visual attractiveness of the drawing in opposition to its substantive content was a very interesting issue. In communication, aesthetic features were not important; its legibility came to the fore. In the presentation, on the other hand, the visual qualities were on a par with the content message, as it was the moment of ‘selling’ the idea.

A

B

C

Fig. 132 B – Elizabeth Plater-Zyberk, C – David Carrico,
PM communicating sketch (B) based on a Google Street View (A) photo explaining what to include in perspective. As can be seen in the final drawing C, the information message of the sketch was sufficient.

What counted then was the recognizability of the project. It is worth to return to the children's drawing created during the Youth Session workshop (Fig. 96). The child's dream about an Apple store in the neighbourhood and a sketched cube corresponding to Apple's simple design inspired the project team when they were searching for the form of entrance to the Saint Mary Hospital. In the case of a building in Fig. 132C, the investor decided to repeat the same cubic shape of the entrance and create a recognizable architectural element.

Fig. 133 Introduction to the final presentation by the investor's representative

Fig. 134 Presentation of workshop results displayed on pin-up boards

The multimedia final presentation open to all interested parties was held in the auditorium of the Saint Mary Hospital. After a brief introduction of the investor's representative, PM presented the results of the workshop. Then, guests moved to the room where all the materials were displayed on the pin-up boards, from initial sketches to the final design concept. The project team was standing nearby, ready to answer questions and dispel any doubts. During the presentation, questionnaires were distributed to the guests, summarised in Tab. 8.

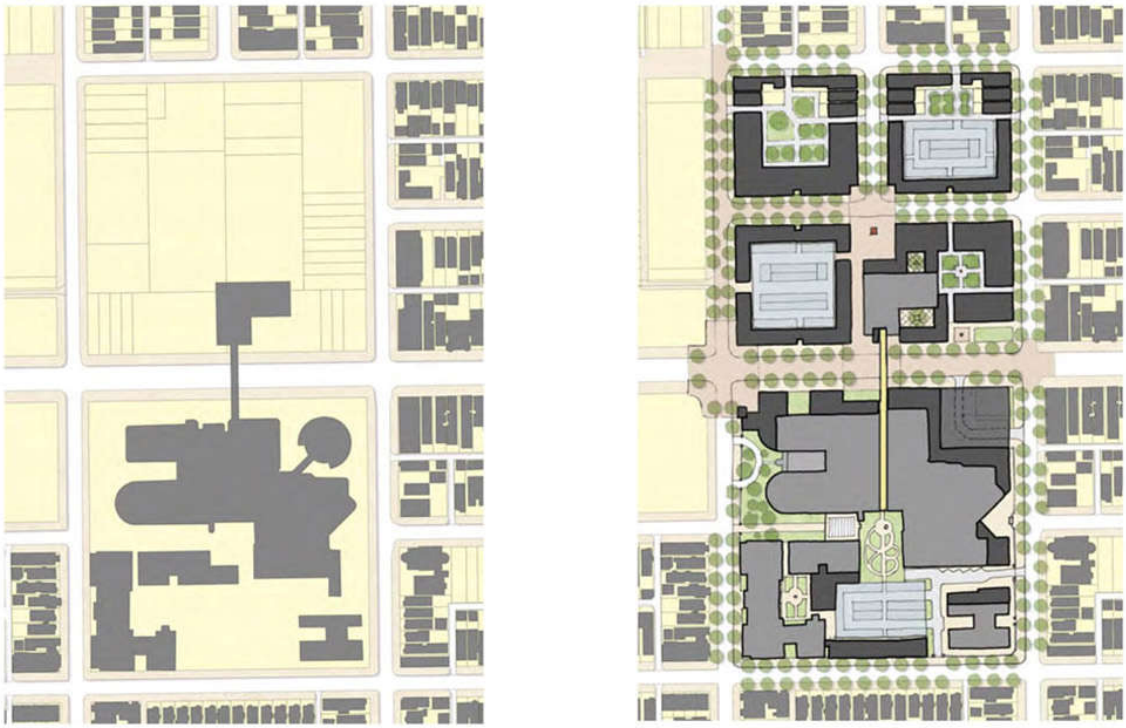
Below, in Subchapter VI. 5, materials from the presentation were collected to complement the design concept with regard to freehand drawing.

VI. 5 Presentation of final conceptual drawings

A. B.

C.

Fig. 135 Saint Elizabeth Hospital – existing state (A) and two design concepts (B, C)



A. B.

C. D.

Fig. 136 Saint Mary Hospital – existing state (A) and 3 design concepts (B, C, D)

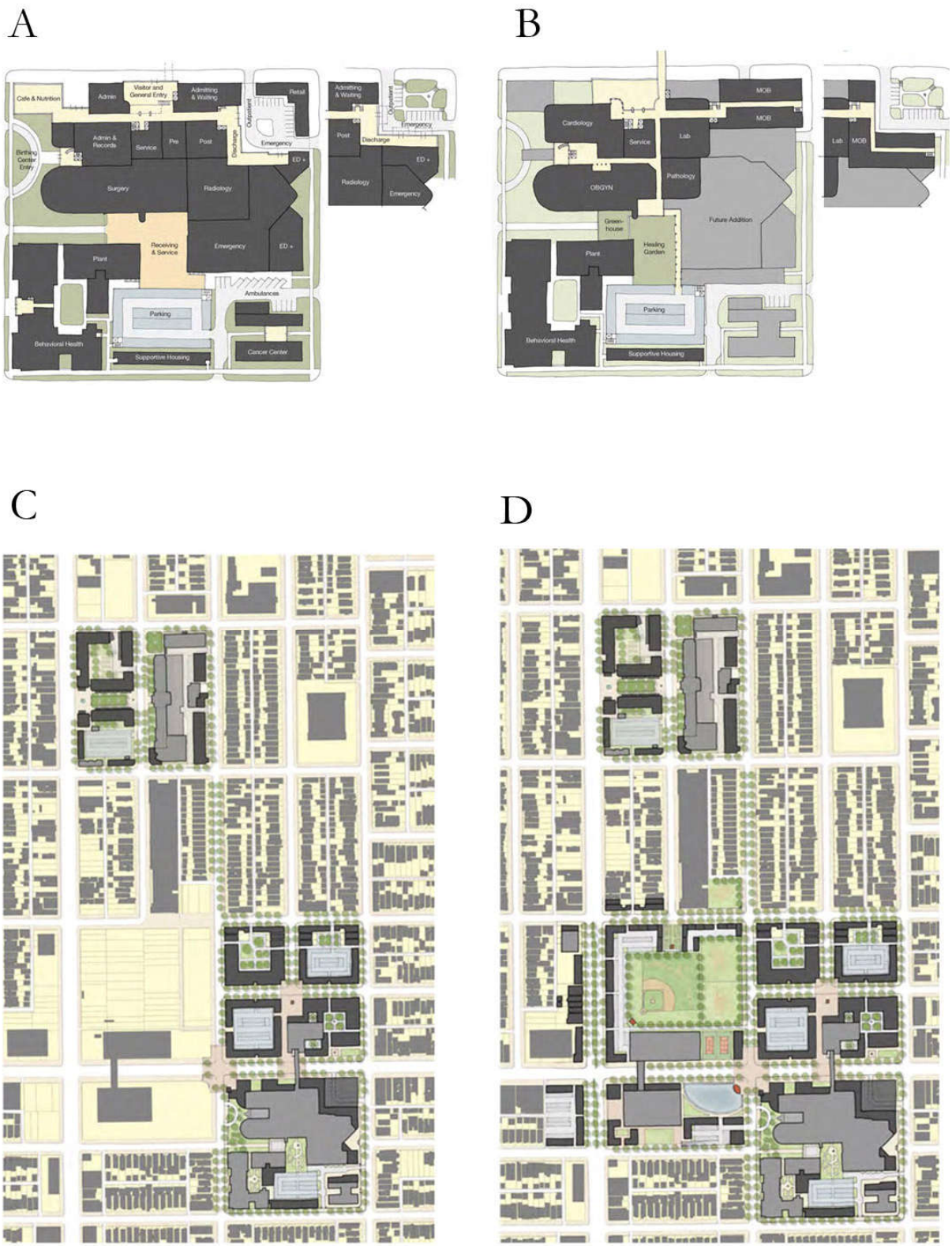


Fig. 137 Saint Mary Hospital – first floor (A) and second floor (B) and other possible design solutions for both hospitals (C, D)

Fig. 138 David Carrico,
Saint Mary Hospital – an existing pedestrian walkway between the buildings over the Division street 'touching' the new cubic glass entrance form

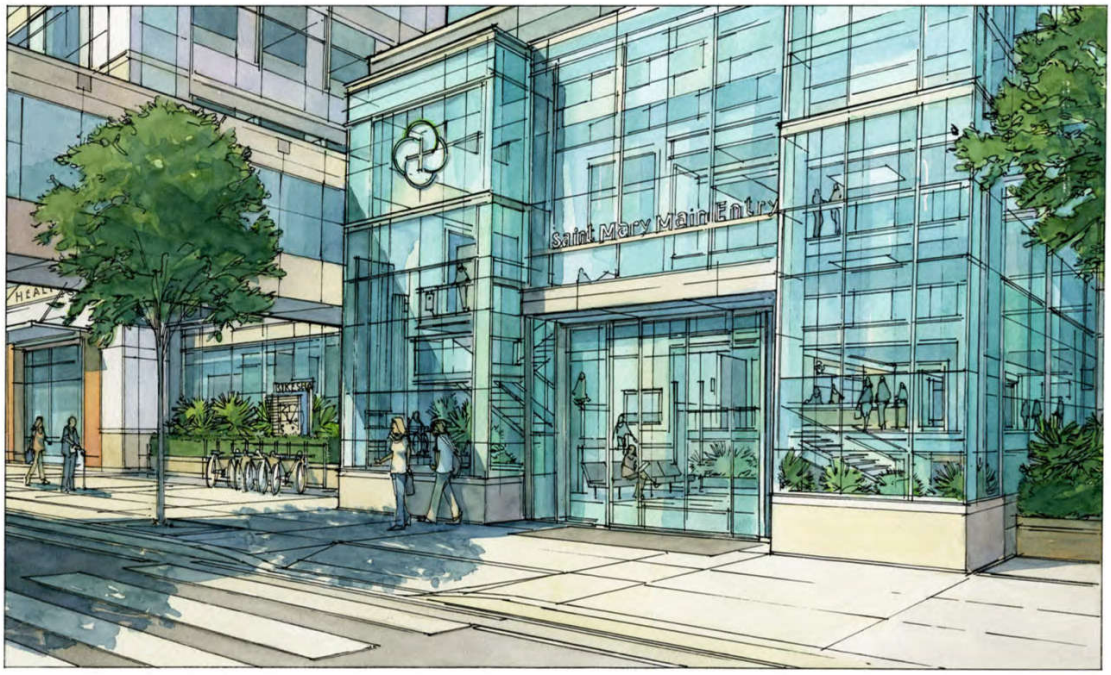


Fig. 139 David Carrico,
Saint Mary Hospital – view of the new form of visitors' entrance; on the left a link above the Division street

Fig. 140 David Carrico,
Saint Mary Hospital – view of the new buildings on the corner of the Division and Lewitt streets. In the background there is a hospital tower and a pedestrian walkway between the buildings over the Division street.

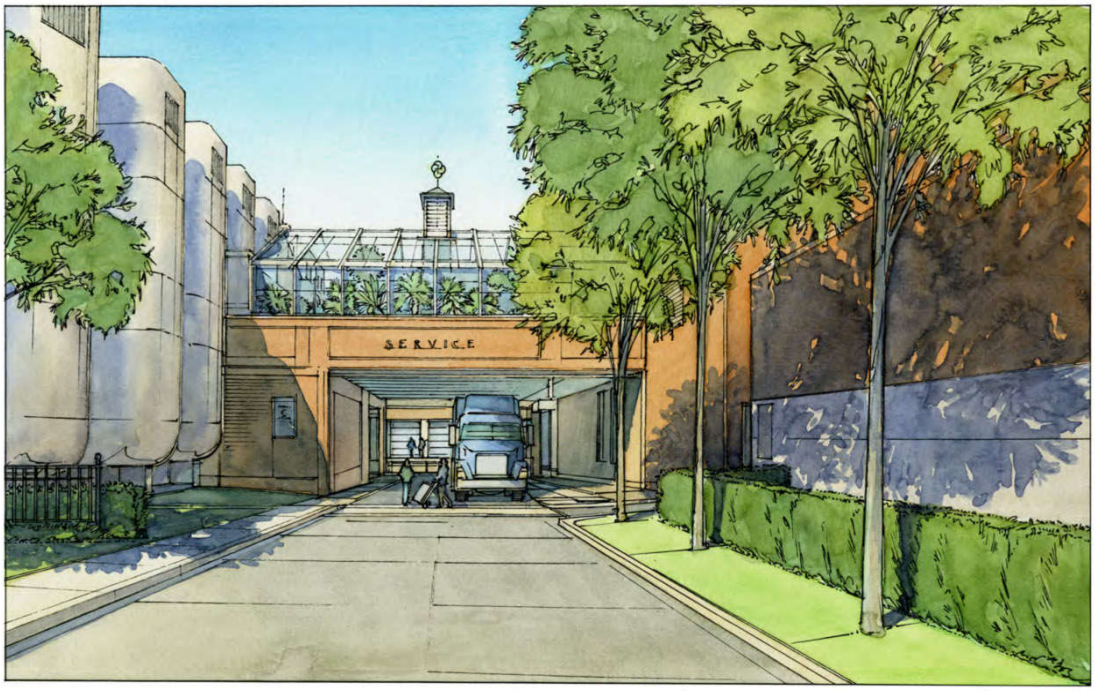


Fig. 141 David Carrico,
Saint Mary Hospital – design of a winter garden over a technical passage

Fig. 142 David Carrico,
Saint Mary Hospital – bird's eye view of the northern part of the project – four quarters with an extensive hospital complex, complemented with residential and hospital service buildings and a car park in the middle of the quarter

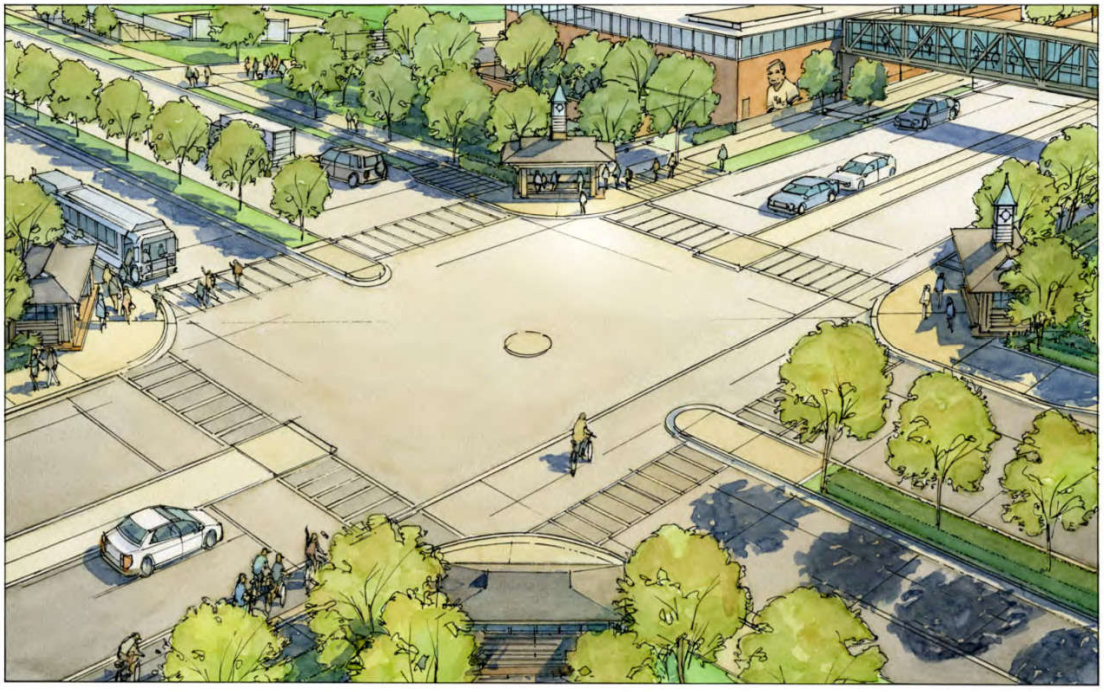


Fig. 143 David Carrico,
The project of the Western and Division street crossing with corner pavilions and seating places, a shop etc. connected to bus stops which are located in the immediate vicinity

Fig. 144 Joanna Pętkowska-Hankel,
Saint Elizabeth Hospital – view of the development project at the intersection of Western and Le Moyne streets, in the background there is a historical tower of Saint Elizabeth Hospital, on the axis of the designed oblong square, perpendicular to Western street.

Fig. 145 Joanna Pętkowska-Hankel,
Saint Elizabeth Hospital – on the longitudinal axis of the square, a historical tower is visible.

VI. 6 Conclusions from the charrette workshop in Chicago

The most important conclusion from the Chicago case study is the confirmation of most of the previous observations collected during the numerous workshops mentioned in Subchapter I. 1. The documentation, which consisted of recordings, drawings and notes taken from the participant observation, the questionnaires for designers (Tab. 7) and the participants taking part in the charrette workshop (Tab. 8), as well as the interview with Elizabeth Plater-Zyberk, created a scientific research basis which could help authenticate the previously observed phenomena (1), as well as single out the new ones (2).

1) Conclusions confirming the previous observations

Drawing during the workshop documented the line of thought and was an active process involving the eye, brain and hand; unspoken observations had a chance to find an outlet in the drawing (Tab. 7, PM–B[68]; PD–B). It also facilitated remembering in the form of sketchnotes (Fig. 87 and 102).

Freehand drawing was 'self-inspiration' for its authors – the sketch brought further connotations, thus catalysing the thought process (Fig. 100 and description on p. 177; Tab. 7, PM–B).

A handwritten record of design ideas made it possible to manifest the designers' individuality and personality (Fig. 101).

The precision of digital tools, constituting their considerable advantage in the final phase of the project (Fig. 135–137), was a disadvantage at its initial stage, thus the initial sketches were hand-drawn (Fig. 97, 98, 100, 101, 103–106, 111 and 112E).

The concept creation phase, characterised by frequent changes of ideas, required a fast, intuitive and easy to use tool – freehand drawing met these criteria, but depended on the proficiency in using it. The slowdown in work also resulted in a limited possibility of introducing changes in freehand sketches (Tab. 7, PD–B; SD2–B; D1–B; D2–B; I1–B).

Communication between designers using freehand drawing was quick and clear, faster than verbal communication, because the team was used to the transfer of graphic information during the charrette workshop (Fig. 114–116, 121A and 132).

[68] The designation of persons (PM, PD, D1 etc.) can be found in Tab. 7 in the first column from the left; letters A, B, C, D and E indicate the questions asked to them in the questionnaire, located in the top row of the table. The explanations of acronyms (e.g. PM – Project Manager) can be found on p. 160.

Role	Age	A. Could you design without freehand drawing?	B. Please explain your answer.	C. Have you ever learned freehand drawing?	D. If yes, for how long and at what point of your educational and/or professional career?	E. Please evaluate your free-hand draw-ing skills (0 – poor, 10 – excellent)
PM	50+	No	The iterative process of design – drawing, auto-critiquing, re-drawing, over and over – requires quick, intuitive reactions, that are best recorded and changed by hand drawing. Sketching involves eye, hand, brain coordination that allows quick evolution of ideas. Freehand drawing incorporates the assumption that drawing is a process of learning and improving.	Yes	I have drawn from childhood with little training, but extensive practice as an architect and urban designer.	6
PD	50+	No	I have some computer drafting experience (where making changes is greatly facilitated) but actual design for me is always accomplished with freehand drawing. It is essential part of the thought process for me.	Yes	As a part of my university (School of Architecture) education I took several classes in freehand drawing and mechanical drafting (parallel ruler + triangle, etc.).	8
SD1	35–50	Yes	Yes, with limitations. I am not proficient in CAD, but for certain aspects of design (e.g. graphic design, certain visualizations) I know enough of image editing software (e.g. Photoshop) to design on the computer. However, my preference is still freehand drawing.	Yes	I first formally studied freehand drawing with an art teacher at the age of 8. Throughout my primary & secondary education, freehand drawing was part of the art program within my school's academic curriculum. In college, the architecture program included freehand drawing classes in freshman & sophomore years.	10
SD2	25–35	No	Computer-first design begins with a series of constraints due to the medium (software) and utensils (input devices). Drawing by hand is essentially free from constraint. After many years of freehand drawing, I can feel with my pen and produce work of thought in progress. The computer requires pre-visualization otherwise recorded by pen strokes on paper.	Yes	Along with architectural education. Various techniques in different courses. The most specific being a drawing techniques class, continued through practice with design studio sketching and hand drafting.	Plans – 10, Perspectives – 6
D1	25–35	No	Although I love computer design programs like SketchUp I always start my designs by hand. It is the easiest and most flexible way to get my ideas on paper.	Yes	My first year at University of Miami and during my semester studying in Rome.	5
D2	25–35	Yes	Yes, but it takes longer. I prefer to sketch out ideas and concepts freehand before moving to digital media.	Yes	All five years of college/ university. Sometimes professionally (5 years).	8
I1	35–50	Yes	It's useful, but not absolutely necessary.	No	Selftaught.	9 – always room for more practice!

Tab. 7 Answers provided in the questionnaire for project team members (original spelling)

Communication between the designers and the stakeholders who were unrelated to architecture or urban planning with the use of freehand perspectives was easier, because two-dimensional projections and cross-sections were often hard to read for lay people; that has been confirmed by the statements made by the investor's representative and project manager (see p. 202) and by the answers given to the questionnaire addressed to the participants of the final presentation (Tab. 8). It results from the final presentation that the three-dimensional message was the preferred option (Tab. 8, columns A and C), though it is difficult to conclude that it should be at the same time freehand drawing, as the presentation did not include 3D drawings other than freehand drawings.

The non-literalness of freehand representations and its unfinished nature encouraged discussion, stimulating the imagination and creative associations (Tab. 8, P1–B[69]). It was one of the manners to achieve cooperation with the local community, important in the assumptions of the Community Visioning project. Freehand drawing facilitated the presentation of the study general matters in the conceptual phase. Perspectives helped to avoid unnecessary remarks, superfluous at this stage, as to architectural details, which were not usually presented in a precise manner because in the urban scale they were not the subject of the study – what mattered was the spatial and functional composition and the general nature of space (Tab. 8, P3–B; P4–B).

Freehand drawing enabled an easy adjustment of the form of transmission of the project content so as to cause a specific effect, e.g. by emphasising the most important features characterising the project (Fig. 121 and description on pp. 194, 199) or covering up others, which sometimes contributed to the distortion of reality.

The specific aesthetics of freehand presentation was perceived by the majority of receivers as attractive and has a positive impact on the perception of the project.

Freehand drawing provided the project manager with control over the flow of information, because it was the project manager who decided how to show graphically the implemented project and what drawings to show. The vast majority of communicating and corrective sketches were made by PM (Fig. 114I, 115A, 121A 132B), which showed the hierarchy of the team.

[69] The designation of individual participants (P1, P2, P3 etc.) can be found in Tab. 8 in the first column from the left; letters A, B, C and D indicate the questions asked to them in the questionnaire, located in the top row of the table.

Partic-ipant	Occupation	Age	A. Which methods of the presentation best explained the project?	B. Why?	C. Which methods were not clear to you?	D. Why?
P1	Health Care	25–35	3D drawings	[They] helped me imagine what was going in and what it would look like.	2D drawings	It was hard to understand from an aerial view what might be going in.
P2	Physician	25–35	digital visualizations + freehand drawings	It is easy to follow with 3D.	2D plans	Hard to visualize future.
P3	Consultant	35–50	freehand drawings	[They] captured the look and feel of new places.	plans	Harder to decipher the more detailed drawings.
P4	Registered Nurse	25–35	3D drawings	[They] bring the plans to life.	–	–
P5	Registered Nurse	50+	combination of digital visualizations + explanation	–	mostly clear	–
P6	MBA/MPH student	25–35	3D drawings	2D drawings were extremely hard to see	2D drawings	Could not see most of the 2D drawings.
P7	Retired CPS Teacher	50+	The plans, visualizations and verbal descriptions were best for me, combined with the verbal.	Slides and verbal description allowed me to understand [in a way] with which I am very familiar.	pointer on the screen	At times, had some difficulty following the pointer used on the screen.
P8	Physician	50+	plans, verbal description, digital visualizations	All were need together.	very clear	–
P9	Analyst	25–35	plans, verbal description, digital visualizations	Easy to follow along an image if someone walks thru it.	–	–
P10	Government and Community Relations Consultant	35–50	digital visualizations and verbal description	The pictorial descriptions supported by verbal explanations of the rationale helped advance understanding of concepts.	the more technical drawings	[They] were harder for a lay audience to understand.

Tab. 8 Answers provided in the questionnaire for the workshop's participants who arrived at the final presentation (original spelling)

2) New conclusions

The participation of children in designing during the Youth Session workshops (see IV. 4. 2) was a new experience. The results may lead to the conclusion that drawing allowed children to become full-fledged participants in the design process. It triggered their willingness to share observations and ideas, sometimes difficult to communicate verbally.

Due to Chicago's non-homogeneous social structure, the workshops made it clear how important it is to find a suitable way of communication of such diverse participants (my previous experience was primarily related to the Polish population which is homogeneous linguistically and culturally). The drawing was a universal 'language' of the message, independent of nationality, cultural background, level of education, social status or age.

The charrette workshop aspect that I have not noticed before is the great importance of verbal communication, which is confirmed by the participants' statements (Tab. 8, P7–A, B, P8–A, P9–A, P10–A, B), as well as the importance of combining verbal communication with the visual one (Tab. 8, P7–A, P8–B, P9–B, P10–B).

From the questionnaire for the team it results that all designers learned to draw at various stages of their education (Tab. 7, column D), apart from – interestingly – the I1, i.e. the person whose work at the charrette was based on this skill. So it clear that such skills can be learnt without specialised courses. The answers to the question about the evaluation of one's own drawing skills are also worth commenting (Tab. 7, column E). The answer of the designers assessing their drawing skills the highest (SD1, D2, I1) to the question whether they could design without using freehand drawing was in the affirmative, and that in spite of their high qualifications and skills (Tab. 7, SD1–A; D2–A; I1–A), and those who rated their skills lower could not imagine design without freehand drawing (Tab. 7, PM–A, PD–A, SD2–A, D1–A). The use of freehand drawing in this group of designers, therefore, does not seem to depend much on the proficiency in using it.

Although to the question: 'Could you design without freehand drawing?' (Tab. 7, column A) three designers answered in the affirmative, when they elaborate on that, two of them suggest that this is their preferred technique (Tab. 7; SD1–B, D2–B). Interestingly, the answer to this question does not depend on the age of the respondents, which often goes hand in hand with the degree of habit of using digital techniques. Two out of the three youngest designers (SD2, D1) could not work without freehand drawing, while the third one (D2) could, but still preferred sketching in the early design stage.

VII. CONCLUSIONS

VII. 1 Verifying the hypotheses and answering the research question

General hypothesis:

H. Freehand drawing has attributes that render it useful in the design process and it is therefore used in the process.

Those attributes were presented in the detailed hypotheses below and verified by the studies conducted in both the theoretical (Chapter V) and practical (Chapter VI) part of this dissertation. The hypotheses were assigned categories of drawings adopted in the Chicago case study. The attributes described as well as the resultant functions answer the research question about the present role of freehand drawing in the architectural and urban design process.

H1. Freehand drawing enables the designer to record and understand space and therefore constitutes an element of the phase that precedes the design process.

- **Refining visual perception and the resultant learning, understanding and remembering of space**

By its nature, drawing is a notation of processes that organise visual perception. Consequently, the development of drawing skills is based on its refinement, while visual perception involves the understanding of what is seen and distinguishing between the view of an object: external impressions that are synthesised by the brain, and the object itself: the knowledge of the object complemented in the process of identification and recognition (see Fig. 22 (3) and p. 59). The study of drawing consists in realising the distinctiveness of these two components, which, when combined, result in a full understanding of the object and the surrounding space.

Both visual perception and drawing are processes of actively processing information from the environment, with the result being that they are remembered. In the case of drawing, this stems from the dependency on the context and involves episodic memory (see pp. 64 and 88–89), which enables the recollection of information in connection with an activity, e.g. drawing. A direct, tactile contact with objects in space, intensified by drawing, activates recollection through the recognition of a previously perceived stimulus

and comparison with the current observation (see p. 63). This results in precedents (see pp. 66 and 89) to which architects and urban planners refer in their designs more or less consciously but which may also inhibit the search for new solutions (a phenomenon known as functional fixedness, see pp. 66–67).

- **Learning the context, in particular its non-material aspect**

  Designs are created in visual (existential) space, although the design process itself occurs mostly in mathematical space (see pp. 80–81). A subjective, first-hand drawing notation made on the site helps realise how many factors must be taken into consideration in the design process other than numerical data. Drawing on location helps learn the non-material context of a place (its identity, aesthetic and compositional value, changing colours, customs of its residents, etc.).

- **Learning the brevity of notation and developing creative individuality**

  By its nature, a drawing is made quickly, especially on location, which makes learning to draw in shorthand possible. It consists in selecting the level of detail depending on the needs and type of drawing, which refers to the design stages in the future work. The conciseness of a sketch gives it semantic depth that requires an abstract representation of spatial concepts from the creator and interpretation skills from the addressee. A drawing is always individual and subjective in its nature; the free choice of the tool, viewpoint and how the subject is approached develops the creative individuality of an individual and makes the freedom of expression possible (especially in the form of autonomic architectural drawings, see V. 4).

  On the other hand, the brevity of a drawing combined with ineptitude entails the risk of notational errors and an undesirable interpretation of its content.

- **The study of composition and formal decisions**

  Formal experiments involved in drawing, such as isolating the contour, focal point, leading lines and planes, walls and the floor (in the urban planning sense) as well as composing the focus taking into account the curve of sensations (see p. 95 and Fig. 34) are similar or identical to issues in the field of architecture and urban planning. Sketching

on location is therefore a tool to analyse and synthesise the views, and thereby to learn composition.

- **The ability to notice cardinal principles, disregard details and order information**

  Drawing may activate the perception of the logic and structure of the environment, which helps find the answer to the design problem at a later stage. The essential element of proper drawing notation is to isolate the structural skeleton (see pp. 99–102). This is helpful in the design work at the stage of locating centrelines, laying out rooms and window and door openings or deciding on the urban planning concept where the tendency is to structuralise and lay down clear rules for town plans.

  However, there are cognitive aptitudes that make it possible to conjure up a whole image without recognising the simplest structural skeleton, which suggests that drawing experience is not always necessary to notice and implement the rules present in the environment.

- Category of drawing: **sketchnote** (see p. 163)

  The sketchnotes (e.g. Fig. 102) created during the Chicago workshop were made in shorthand, as their purpose was to note down information as quickly as possible. Not only did they make it easier for the participants to remember information but also the accompanying active thought process served as an introduction to the design process.

SUMMARY:

Freehand drawing enables the designer to record and understand space, most importantly due to the development of perception skills that lie at the bottom of the active reception of spatial attributes, and the study of composing and ordering information. At the same time, the freedom of expression involved in drawing develops creative individuality. Drawing enriches the analysis of a place undergoing design transformations with subjective impressions of the designer, enabling them to record the non-material aspects of the context. However, drawing proficiency is essential here, as its lack may result in notational and interpretive errors. While drawing is not the only way to record and understand space, the familiarity with this medium expands the range of research tools available to the designer.

The above-mentioned properties corresponding to the categories of drawings from the Chicago case study confirm the hypothesis adopted and show the rationale for using drawing at the pre-design stage as well as in architectural and urban planning education.

H2. Freehand drawing enables the designer to translate thought into form and therefore constitutes an element of the conceptual phase of the design process.

- **Tactility – drawing as a craft – learning to use the potential and limitations of materiality**

A drawing reveals a clear connection between the cause (thought transformed into gesture) and effect (trace on the drawing surface). The tactile connection between the tool and the hand as well as, indirectly, between the eyes and the brain, results in a deep processing of data, which has a positive impact on their understanding and remembering.

The drafter learns the limitations of materiality; drawing is a metaphor of building and indirectly teaches architects how to work with building materials.

In the drawing craft there is a valuable relationship between the creator and the creation. There is a direct link between the craftsman's activity and the resulting form. The craft teaches the attributes of real space, where the limits of what is possible are clear and tangible. In CAD programs, by contrast, the understanding of processes that occurred between entering a command and creating a line is not significant; consequently, the creator-creation relationship and the study of cause-and-effect relationships do not occur. The attractiveness of simulation representations on screen may lead to the loss of judgement of object materiality and domination of visual criteria.

Drawing teaches that decisions should be approached with humility, as redrawing one solution after another takes time, which can be used to contemplate the design solution. Apart from its unquestionable advantages, the ease with which changes can be introduced in computer software can sometimes result in a superficial approach to the subject.

A high level of drawing craftsmanship is an element of gaining the respect of the project owner in the design process based on drawing as well as preserving the creator status by the architect.

On the other hand, the lack of sufficient drawing skills may constitute an inhibitory restraint. The boundary of precision and complexity of forms resulting from the use of traditional tools is shifted due to their digital equivalents and the combination of techniques. A phenomenon known as ‘notational bottleneck’ (see p. 126) is thus eliminated.

- **A holistic approach to the design problem and selecting the level of detail depending on the design stage**

Drawing makes it possible to operate on different levels of abstraction at the same time, from detail to the whole building. A drawing tool may be easily adapted to the level of detail adopted and to highlight the aspects that are important for the specific design phase. A drawing is most often created to a specific scale that gives an opportunity to take in the entire design. This is different with CAD software, where the constant zooming in and out distorts the sense of the actual size of buildings and their relation to other elements.

An architectural drawing always represents one ‘frozen’ view, which constitutes a major imperfection compared to digital models that offer a free view of a building from any angle and show desired longitudinal sections or cross-sections.

A holistic approach to a design is facilitated by computational design focused on the relationships between components of a building as well as the BIM technology used to manage data and coordinate industries.

- **Ambiguity – in search of the design solution**

Cognitive processes and creative thinking depend on the tool used. In this context, the most important attribute of a drawing is its ambiguity and semantic saturation, which triggers lateral transformations (see pp. 67, 71 and Fig. 23, 24), i.e. creative associations stimulating new ideas. They are a result of reflection-in-action (see pp. 113–114), i.e. the phenomenon of reacting to a drawing visualisation in real time, followed by the creation of new representations. A visualisation is created due to interactive imagery (see p. 115), which in turn creates both the notion and the image conjured up by that notion. Accordingly, sketching is not only a process of representing mental images but also, through creating visual representations, a release of images of the designed unit in the interchanging modes of ‘seeing that’ and ‘seeing as’ (see pp. 114–115).

Ambiguity constitutes one of the most important differences between design thinking using drawing and CAD software, which requires precision already at the early stage of design. The need for accuracy may lead to a premature specification of an idea and block alternative solutions of the design problem.

Drawing gains significance as an instrument of uninhibited creative searches (especially in the form of autonomic architectural drawings, see V. 4).

However, creative thinking in design may also be induced without the presence of drawing, for instance by verbalisation or a combination of techniques, including digital and traditional ones, which may expand the spectrum of associations evoked.

Ambiguity and the lack of precision are only desirable at the early stage of design and their role gradually declines, as the solution is specified.

- **The convention of architectural drawing – semantic depth and design criteria other than profitability**

The convention of architectural drawing requires skill in terms of both notation and reading. Moreover, the aforementioned ambiguity necessitates the interpretation of coded content. A drawing has therefore a deeper message than one arising from functional or structural searches and has the chance of expressing the idea of the design, the key element of architecture and urban planning that determines their presence in the public discourse. A simulation (see pp. 123–124), on which digital tools are based, does not require skill in reading and interpreting; its universality may oversimplify both the architectural notation and message, no longer requiring an audience aware of its symbolism and metaphors.

Consequently, a drawing draws the attention to non-measurable attributes of architecture, whereas a possible negative aspect of the BIM technology is the automatic preference for easily quantifiable criteria, e.g. economic profitability.

On the other hand, the convention of architectural drawing may lead to a fragmentary perception of space and favouring views, and thereby aspects of the design, resulting in a phenomenon known as the ‘image trap’ (see pp. 127–128), where what is refined is the drawing rather than design solution. Convention entails the risk that content may be

recorded and communicated incorrectly, thus resulting in financial losses as well as misinterpreted architecture that ‘speaks’ in a different way than intended in the drawings.

- Categories of drawings: **initial sketch, conceptual sketch** and **final conceptual drawing** (see p. 163)

  Initial sketches (e.g. Fig. 97 and 103) created during the Chicago charrette were ‘self-correcting’ and ‘self-inspirational’; the authors noticed their own mistakes as they worked on them, which served as an impulse for change, including by creative associations. Thus, the design solution evolved and the initial sketch transformed into a conceptual sketch. Individual layers of tracing paper helped preserve subsequent stages of the thinking process in a material form, making it possible to compare them and reverse to earlier options, if necessary. Although redrawing required time, it also encouraged reflection on the strokes. The initial sketches made to one scale offered an opportunity for a quick visual comparison of individual team members’ ideas, taking into consideration the proportions and relationships between the objects. Sheets of tracing paper were often full of drawings from various angles, with a varied degree of detail and completion, which indicated that the thought process occurred on many planes simultaneously. Comparing those sketches required skill and entailed the risk of possible misreading as a result of the need to build the entire image based on projections, sections, perspectives and diagrams. The initial sketches were the most abstract and lacked precision, as their aim was to show an idea in broad outline. Their originality stemmed from the fact that, in most cases, they had not been affected by consultations with other designers at that stage. The initial sketches made by parents and children served as an inspiration for the designers.

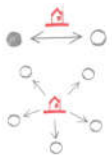
  Conceptual sketches (e.g. Fig. 108 and 117) were an intermediate stage between initial sketches and the final conceptual drawing, gradually gaining details and decreasingly showing the individuality of the author.

  The final conceptual drawings (e.g. Fig. 135 and 138) constituted a product of collective thought at the lowest level of abstraction and therefore the highest level of detail among the categories of drawings distinguished in Chicago. Precision required at this stage had an impact on weakening the individual character of the drawings, which also resulted from the use of a computer (adding colours to the plans).

SUMMARY:

Freehand drawing enables the designer to translate thought into form due to a tactile connection between the hand, tool and drawing surface, the possibility of operating on different levels of abstraction at the same time and a holistic approach to the design to a specific scale that makes it possible to examine spatial relations. The most important attribute of a drawing that evokes creative associations producing new solutions of the design problem is its ambiguity. A drawing has the potential to code a message with semantic depth and preserve the idea of the design and other criteria than, for instance, economic profitability. On the other hand, a drawing always entails the risk of the 'image trap' and notational and reading errors as a result of the aforementioned convention. However, the conscious use of this tool may eliminate those phenomena.

The attributes corresponding to the categories of drawings in the Chicago case study confirm the hypothesis.



H3. The role of freehand drawing is to communicate within and outside the design team, which is why it is an element of all phases of the design process that require communication.

INSIDE THE DESIGN TEAM

- **A fast method of communication between design team members, in particular in workshop-based projects**

Workshops provide for the presence of people involved and real-time designing, which requires a material form of the proposals under discussion such as drawings on paper or physical models. A similarly graphical form is assumed by comments. A second reason why drawing is used in communication during workshops is the constantly evolving concept devoid of precision and full of understatements, which is why the communication method must suit this type of notation. The time frame increases the need for creating a quick message, and freehand drawing serves this purpose. Although its speed is relative, depending on the skill of its authors and the knowledge of its addressees, drawing remains the basic tool of communication during workshops.

A disadvantage of a drawing message in the entire design process, including at workshops, is the notational and reading errors that result from the convention of architectural drawing that requires skills as well as a lack of drawing skills, which, in combination with the misinterpretation of information gaps, lead to misinformation and financial losses. This problem can be eliminated by a BIM system, providing access to data and data flow to the widest group of people involved in the design possible.

Sometimes a description, both written and verbal, stimulates the formation of creative images better than a drawing. A premature graphical specification of a solution may eliminate alternative lines of reasoning.

Freehand sketches created by a designer on a construction site explain the intricacies of a detail or form of the building, whereas the use of the BIM technology increasingly reduces the need to make them, e.g. with applications such as BIMx.

A drawing reinforces the social aspect of design, which loses its significance in the digital environment (e.g. in a BIM system) in the sense that physical contact between designers is not a prerequisite for effective communication.

- **Placing the architect in the central position of the author, creator as well as information manager**

In the traditional drawing-based design process, the organisation of work is hierarchical (vertical). A drawing, as a tool of communication, gives the architect control over the flow of information, placing him/her in the middle of the action, so that he/she is the only person to gain a full picture of the situation and the status of the building's author. Furthermore, this tool helps create client relations by increasing the prestige of the architect as the 'director' of the whole enterprise. This was apparent during the Chicago workshop, where it was the project manager who decided how to show the developed design graphically and which drawings to show.

The BIM technology integrates specialists at one level, in a common model by many authors, enabling access to and the flow of information to the widest group of people involved in the design possible. Also evolving is the range of skills required from the design team. The architect may thus lose his/her previous position. The organisation of work is becoming more horizontal.

- **An attractive and clear message**

The convention of architectural drawing may prove difficult to read by laymen. These problems are apparent during workshops attended by residents and other stakeholders. Orthogonal projections are representations that are far from natural and do not appeal to perception. Bird's-eye and man's-eye views are created to imitate perception to a greater degree. Their aim is not to produce a realistic representation but rather convey as clear a message as possible, which is why certain elements of a sketch may be underlined or omitted. What has to be expressed precisely in a computer model the sketch can easily note in a non-literal manner because precision, which is required by computers, is not only unnecessary but may also be detrimental at this stage of design. Visually attractive freehand perspectives that show the atmosphere of a space are also intended to promote the design and 'sell' it to a wide audience.

Nevertheless, one has to bear in mind that freehand views may misrepresent the actual attributes of the designed space, showing only a fragment of it. Meanwhile, the presentation of buildings based on simulation does not create barriers resulting from the need to have the skill to read the message and therefore has potential as a tool of social participation.

During the discussion of a concept with stakeholders, a drawing explicitly specifies the proposals. Sometimes a verbal description is more beneficial, as it may elicit new ideas from the participants without suggesting them a literal solution.

- **The effect of the non-literalness of freehand representations – the impression of the ongoing room for debate on the design**

The sketchy character of freehand visualisations makes thus represented designs appear to be proposals with some room for change, which works well during workshops based on social participation. Such 'open' proposals stimulate dialogue. The opposite is true for computer visualisations that suggest the solution is final and any debate closed.

Inaccuracy loses its advantages as the design solution becomes more specific, and showing this type of non-specific message at too advanced a stage of the design may create distrust in the design solution.

- Categories of drawings: **communicating sketch, corrective sketch** and **final conceptual drawing** (see p. 163)

  Communicating (e.g. Fig. 132B) and corrective sketches (e.g. Fig. 116A) created during the charrette in Chicago were quick and synthetical. The number of details was substantially limited to make the message more focused and the concern for their visual appeal was abandoned, since information was brought to the forefront. The communicating sketches made by parents and children invited to the workshop were a form of eliciting information from the community, facilitated by the fact that drawing is in itself a natural and attractive activity, especially for children. A diverse community in terms of ethnicity, culture, language and age from a variety of educational backgrounds had an opportunity to communicate information in the universal 'language' of drawing.

  The final conceptual drawings (e.g. Fig. 135 and 138) were created in order to present the design to participants at the end of the workshop. Their role was primarily to communicate information, which proved least effective in the form of orthogonal projections and significantly more accessible in the case of perspectives. Their visual appeal was conducive to a positive reception of the design proposal and marketing activities.

SUMMARY:

Freehand drawing is used to communicate within the design team, in particular in workshop projects, as it enables a quick, material notation of the ever-changing concept based on a drawing convention shared by the designers. Effective communication depends on the degree to which both the author and the addressee is familiar with the convention, which repeatedly leads to misunderstandings and financial losses. Those negative phenomena may be eliminated by a BIM information management system. A drawing remains the basic medium of information in the workshop design process based on social participation. In a traditional design process, freehand drawing placed the architect in a central role of an information manager, as was evident during the Chicago workshop; with the advancement of technology, this role may change. Freehand drawing

serves as a means of communication with laymen (non-planners) due to a clear message (that appeals to perception as well as repeating patterns and symbols) that records, in an attractive way, the most significant attributes of the designed space. The sketchiness with which the concept is presented creates the impression that it is open to debate and encourages participation. On the other hand, the freehand perspectives preferred by the participants reinforce the fragmentary perception of the design, with the result being that some of its aspects may be favoured while others omitted.

The attributes corresponding to the categories of drawings in the Chicago case study confirm the hypothesis.

The general hypothesis is confirmed by detailed hypotheses.

The hypotheses, functions as well as categories and characteristics of drawings were presented in the diagram below (Fig. 146).

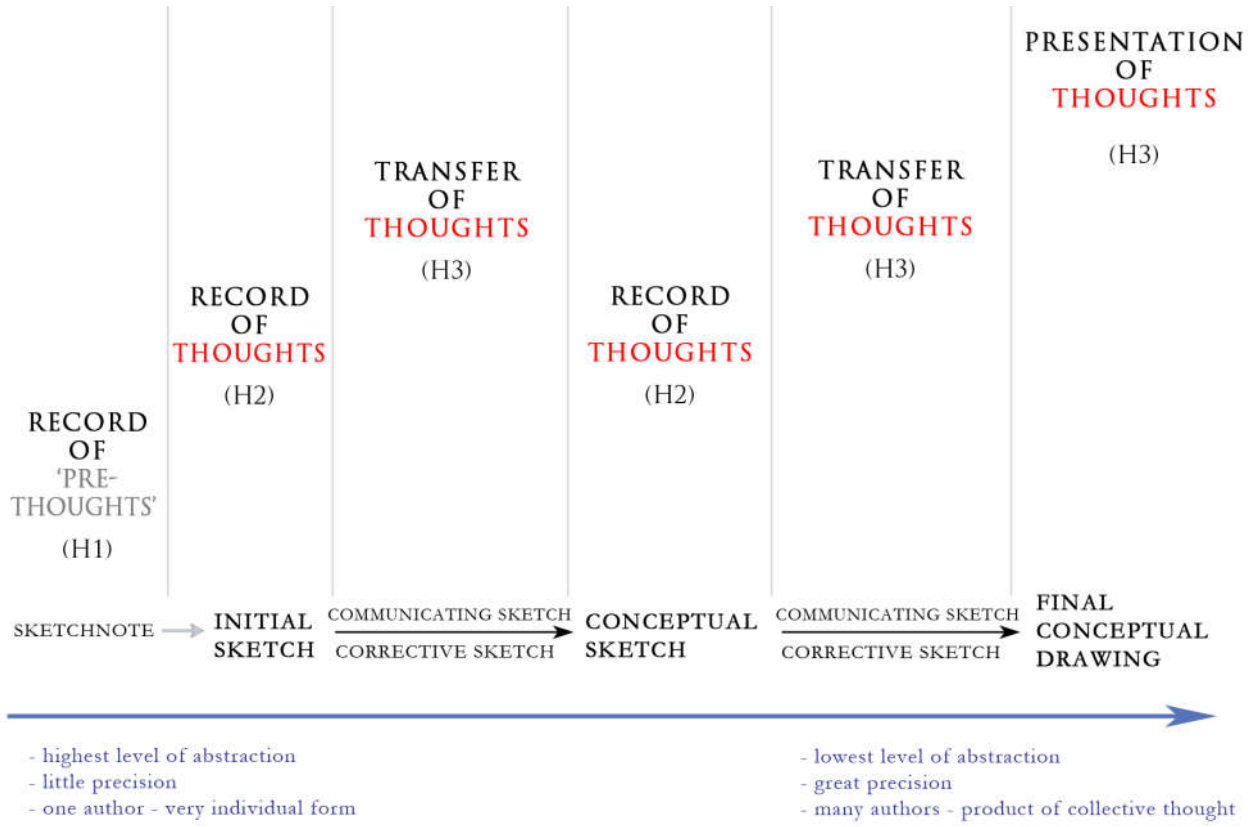


Fig. 146 The categories of drawings created at charrette workshops and functions they perform as the design project progresses

VII. 2 Outlook

The attributes and resultant functions of freehand drawing that confirm the hypotheses lead to the conclusion that drawing – despite technological changes – will remain among tools used by architects and urban planners in the design process. With respect to the schema presented in the introduction to this thesis (Fig. 1), this sentence may be reformulated to conclude that the blue area will not disappear in the further stages of transformations (Fig. 147).

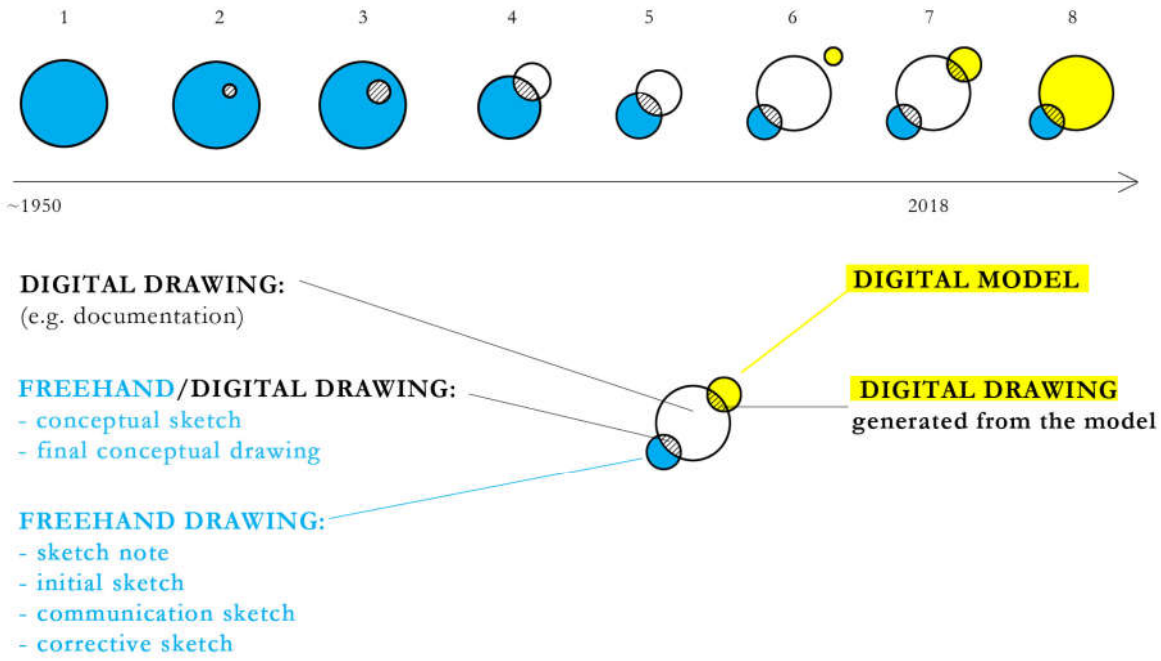


Fig. 147 A group of freehand drawings was divided into categories adopted in the Chicago case study. Although they refer to specific materials collected during the charrette, they may be universal nonetheless; similar categories may be found in every design process involving drawing.

The yellow field (digital modeling), which is not the direct subject of this dissertation, will likely expand. One may predict that the white area, i.e. two-dimensional CAD drawings that have no reference to the model, will entirely disappear from the diagram over time. 2D drawings (primarily construction documents) will presumably be generated using only the model (yellow hatched area).

The dissertation demonstrated that while the use of drawing is being limited in certain aspects of design, it is being increased in others. The study helped establish the most important attribute of freehand drawing that determines the extent of its present use,

namely its **ambiguity**, which stems from nothing other than the freehand nature of this tool.

The use of drawing is gradually limited in those aspects of design where precision beyond the capability of the human hand is of importance. Consequently, in the phase of noting down thoughts (Hypothesis 2), freehand drawing does not occur at the stage of developing a predetermined design concept, i.e. at the stage of drafting construction documents, where the accuracy of notation is key. Furthermore, the need for precision in conveying thoughts (Hypothesis 3) exists in numerous aspects of design and therefore the use of freehand drawing is also being significantly limited in this area. Most importantly, this refers to the coordination of data from specialists involved in the design: communication mistakes as well as time and, consequently, financial losses resulting from ineffective information management in a traditional design process based on drawing are minimised by the BIM technology. It also enables, through available applications, conveying information on a building site more precisely compared to a freehand sketch.

However, the use of drawing is also being expanded in those aspects of the design process where ambiguity is an advantage. This primarily applies to the act of creation, i.e. the moment of searching for and noting down the design thought (Hypothesis 2). Due to the function of interactive imagery of the designer, the phenomenon of reflection-in-action and the process of ‘seeing as’, an ambiguous sketch stimulates lateral transformations that lead to new ideas for a solution to a design problem. Ambiguous autonomic architectural drawings give architects and urban planners, who are usually bound by the requirements of the design brief, the freedom of creation, or the freedom to ‘be themselves’. The significance of such independent visions will grow with the progress of automation, when creativity and the ability to evoke free associations come to the fore among skills that differentiate people from machines.

A drawing will still have an application in conveying thoughts (Hypothesis 3), precisely because of the positive role of ambiguity, which consists in stimulating dialogue and therefore the search of the design solution in a team. This is particularly noticeable during design workshops such as charrette workshops, which require that the proposal be presented so that the participants have a sense of an ongoing debate and openness to change, which is facilitated by the sketchiness of drawings. Furthermore, the ambiguity of a sketch allows designers to leave certain aspects of the design unspecified, as they are insignificant at the given stage of its development.

The ‘open’ nature of freehand drawing gains in significance in the increasingly complex and time-consuming spatial planning. It is a challenge in the planning process to adopt an approach that would not impose the means to achieve particular goals but instead provide for presenting possibilities and engaging parties without offering ready answers (Krämer et al. 2016). An urban planning design should not be perceived as a product but rather as a process or, more specifically, an effect of bottom-up processes. This relationship was described by Otl Aicher:

> development is the spirit of below. the modern world likes to be seen as the world below. education is education from below, from the point of view of the children. the state is the state from below, from the point of view of the citizens (…) and mind is mind from below, from the point of view of making.[70] (Aicher 1991, 147)

The dialogue-stimulating ambiguity of freehand drawing and the simplicity and naturalness of the very action of drawing and perceiving what has been drawn aligns well with this approach, which is particularly noticeable during the charrette workshops. Drawing allows to co-design, and thus allows the charrette participants not to be a passive audience that only accepts or rejects the project, but rather to feel responsible for it.

Just as it is possible to read without understanding, it is also possible to look without seeing[71]; the significance of freehand drawing also extends to those areas that consist in an active reception of the environment (Hypothesis 1). An ambiguous drawing makes it possible to express the degree of diversity of individuals that make up a community. It offers to look at space from an individual perspective, observe everyday reality, overcome stereotypes and notice possible areas for intervention and improvement. This is consistent with the aforementioned approach to planning as a bottom-up process. Stephan Willinger observes, ‘Spatial planning is not a calculable engineering task! It is a (possibly fair) policy of interests… and those interests are always subjective!’[72] (van Haaren and Schmidt-Kallert 2015, 110) A set of observations is then transformed into a design proposal, which may acquire, thanks to personal drawing notes, an original form adapted to the context. An urban planning process that takes into account the feelings of individual residents who participate in its creation allows a narrative that is not imposed but

[70] ‘entwicklug ist der geist von unten. die heutige welt will sich verstehen als welt von unten. erziehung ist erziehung von unten, von den kindern her. der staat ist der staat von unten, von den bürgern her. (…) und geist ist geist von unten, vom machen her.’ (original spelling, translation into English: Joanna Pętkowska-Hankel)

[71] The issue of looking and seeing is elaborated in a book entitled *Zobaczyć* [To See] by Bohdan Paczowski, a collection of essays compiled mostly from a column entitled ‘Więcej wiedzieć, żeby więcej widzieć’ [To Know More to See More] in the *Res Publica Nowa* quarterly (Paczowski 2005).

[72] Raumplanung ist keine berechenbare Ingenieuraufgabe! Sie ist (möglichst gerechte) Interessenpolitik… und diese Interessen sind immer subjektiv!’ (translation into English: Joanna Pętkowska-Hankel)

developed ‘spontaneously’, whereas architecture created based on a metaphorical and ambiguous recording method has a chance of expressing semantic depth and being subject to interpretation.

‘It is quite possible to find two people who call themselves architects and yet hardly share any of their daily tasks.’ (Lawson 2004, 1); this is precisely why one of the most important conclusions of this thesis is to emphasise the significance of the diversity of design tools and methods available to an architect or urban planner. This is particularly important nowadays, in times marked by technological changes that, while bringing about enormous improvements, should not overshadow the still relevant virtues of traditional techniques. Design tools do not compete against each other; they are simply different and therefore result in thoughts being recorded and conveyed differently. They should limit free creative activity and suggest the solution as little as possible, especially at the first stage of design.

The understanding of the graphical needs of designers resulting from the changeability of recorded and conveyed information as they evolve with the successive phases of the design is the key element in selecting suitable design tools. The selection should be as wide as possible in order to reflect the diversity and individuality of the creators in the modern world, which is becoming increasingly unified.

The results assumed at the beginning of the work on the PhD thesis have been achieved to a large extent. This is particularly true of the summary of knowledge and the observations made during my work at numerous charrette workshops and during the 10 years of teaching practice, including both freehand architectural drawing at the Warsaw University of Technology and drawing courses for young people and parents with children. On the other hand, the case study in Chicago gave me a very clear idea and conviction that the description of the use of freehand drawing during this project can refer fully solely to the workshop methods; it can be used, however, to a much lesser extent as a universal characteristic of the use of drawing in 'non-workshop' design. This lack of a broader application of the results of the empirical part of the work (Chapter VI) is – in my opinion – the greatest research restriction of this PhD thesis; the conclusions from the research included in Chapter V refer to design in a universal approach.

The suggestion that the choice of the precision of the tool should depend strictly on the level of the project advancement (in case of both traditional and digital techniques), and that designers should not limit themselves to one tool, but rather try new means of expression, may constitute valuable advice on the use of drawing in design.

When it comes to drawing education, it would be advisable to limit long hours spent on realistic drawing studies for the benefit of the so-called 'urban sketching' (quick sketching of architectural objects and wider urban space from nature). In addition, it would be prudent to teach direct observation from nature (i.e. to transfer the proportions, inclination of lines, shapes and colours onto paper), before introducing the principles of convergent perspective. It would be also sensible to leave a complete freedom in the choice of a drawing or painting technique that emphasises the personality and ingenuity of the draftsman.

Further research work could focus more closely on the use of the conclusions from the PhD thesis, briefly outlined above, as a basis for the proposal of a drawing educational programme and suggestion for the use of drawing in design. In addition, it would be valuable to take a closer look at the latest input tools that allow the most accurate record of the draftsman's gesture. Converting it to the digital environment would result in a faster creation and reception of the message and, if necessary, its efficient modification, which in turn could build the potential of a tool facilitating social participation.

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- Slawomir Gzell, 23 September 2015, interview, Warsaw
- Elizabeth Plater-Zyberk, 3 March 2015, interview, Chicago
- Harald Kegler, 5 December 2016, phone interview, Warsaw-Kassel
- Krzysztof Koszewski, 2 February 2017, interview, Warsaw

The sound recording of the interviews is included on the CD-ROM.

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