Design thinking in architectural and urban design - space prototyping

Elżbieta Grodzka

Wrocław University of Science and Technology
Wrocław, Poland

ABSTRACT: The main aim of this article is to outline the implementation and impact of the *design thinking* (DT) methodology to the History of Conservation and Restoration of Greenery course conducted in the Faculty of Architecture at Wrocław University of Science and Technology (FA-WUST), Wrocław, Poland. A short theoretical introduction aims at presenting the main assumptions of this iterative methodology developed at Stanford University, and its individual phases. The next part presents the interpretation of individual stages and their influence on the didactic practice at the FA-WUST. This part demonstrates that design thinking is a very adaptable didactic tool. Its implementation has resulted in higher performance of architecture students, who not only acquire theoretical and practical knowledge, but also develop soft skills like group work, empathy and communication.

INTRODUCTION

Design thinking (DT) can be described as a methodology of design, which integrates many disciplines of science. The focus on humans and their needs is its main characteristic feature. Initially, it was used in engineering and design; however, gradually it has evolved into a more comprehensive structure, and has been used in solving complex issues of the modern world, one example of which may be its application in designing a new system of education in the United States.

DT has originated from the Silicon Valley academic environment, from where it has found its application in business, and has recently been gaining more and more popularity all over the world. One can talk about it in the context of methodology, culture and even philosophy, but the fact that it is an approach to creative problem solving that is widely recognised as a valuable route to human-centred innovation, remains unchanged [1].

DESIGN THINKING

The seed of the anthropocentric design idea in engineering appeared in 1958 at Stanford University, thanks to John Arnold, professor at MIT and later at Stanford University. He looked for a broader context for the theory of the engineering design process and a tool that would enable the creation of not only new products and technologies, but also the modelling of processes and integration of various scientific disciplines [2][3]. In the 1950s, during the Cold War and arms race, ideas of this kind were considered very avant-garde. The intellectual oeuvre of Arnold was continued in the 1960s by Robert McKim, professor in mechanical engineering at Stanford University, and Matt Kahn, professor in art and art history there who created the first interdisciplinary Joint Program in Design (JPD) at that university merging design, engineering and arts [4].

In the following decades, the idea of human-centric design was developed, and due to IDEO, a design and innovation company founded in 1991 by David Kelley and other educators and designers, it has gradually begun to be applied by businesses. At the beginning of the 21st Century, the design thinking methodology became more widely known, following the establishment of the Hasso Plattner Institute of Design (now known as the Stanford d.school) and its branch in Potsdam.

PHASES OF THE PROCESS

The Stanford model is one of the most popular models of DT. It consists of five phases, i.e. *empathise*, *(re-) define*, *ideate*, *prototype* and *test*. It is not a linear model as demonstrated in Figure 1. Moving from one phase to another depends on the dynamics of the process and the results achieved at each stage. The starting point can be the *empathise*

or *ideate* phase. The verification phase is always the *test* phase - its results determine, which phase should be repeated and how to remodel the process so as to obtain satisfactory results. Figure 1 below presents the main assumptions for each stage according to the Stanford model [2-4].

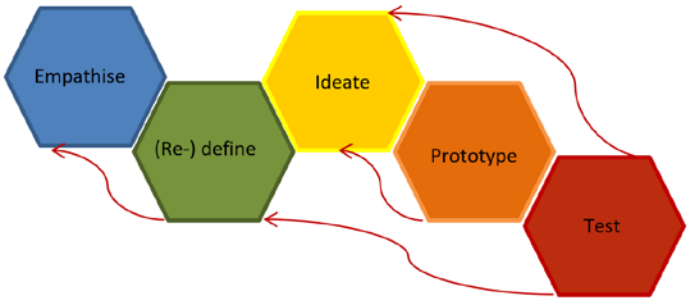

Figure 1: Stanford model of design thinking (DT) - phases of the process.

The author's own experiences, incorporated into the model, are based on the course: *Innovation by Design* by Mark F. Schara at Stanford University, attended by the author in the framework of the programme: Top 500 Innovators, Science, Management, Commercialization (sponsored by the Ministry of Science and Higher Education in Poland), and also the author's internship in one of the companies in Silicon Valley: Speck Design, Applying Design Thinking.

The *empathise* phase consists in defining the recipient/user/client of a given project/solution/service and to study their current problem or need. It is the stage of collecting information about the potential recipient by the design thinker fully focused on the task at hand. The purpose is to get to know the needs of the recipient and their environment. Typical research tools to collect information include conversation, survey, observation, interaction, empathy map, interview and site visits. The focus should be on conveying information from the outside by eliminating one's own judgment and by avoiding hasty conclusions. The only moment when some subjectivity is acceptable is using intuition to identify the so-called understatements and to discover the reason for contradictions between the recipient/responder's statements and; for example, actions in a given situation.

In the *(re-) define* phase are formulated the main assumptions for the project on the basis of the data collected in the *empathise* phase. The name of this stage, however, is somewhat controversial, as it suggests that the design thinker should made an attempt to go beyond the scheme (i.e. play with the frame) and look at the problem from a different angle or consider whether the need sometimes lies elsewhere than the initial assumptions would suggest. To illustrate this process, the metaphor of a frame and a picture can be used, where the frame (assumptions/schemas/beliefs) defines the picture (situation), which due to the frame is perceived as a complete whole, while actually the frame is adjustable and can be easily moved, which changes the whole picture.

The *ideate* phase can be described as generating the concept of solving a problem. In this phase, all tools in the inventory of innovation and creative thinking stimulation can be used, such as popular brainstorming, mind maps, etc. Very often it is also a phase of team work, during which special techniques are applied, including the ability to provide feedback. The final result should be the choice of a solution or solutions for further development in the *prototype* phase.

Building a prototype of the solution enables testing and feedback gathering. In the *prototype* phase, the essence is not to create a perfect prototype, but a prototype which captures the essence of the solution. The materials used to build the model do not have to be the target materials. Kelley describes this phase *as thinking by means of hands* [5]. In the Stanford d.school, it is popular to use everyday or recycled materials, possibly paper, cardboard, sometimes also digital prints from 3D printers.

The finished prototype should be handed over to the recipient in the *test* phase. At this stage, the design assumptions and design solutions are verified. The design thinker presents only the general principle of the prototype's operation without trying to promote the suggested solution. The key moment of this phase involves collecting feedback from the recipient, which enables an improvement of the solution. As in the *empathise* phase, the design thinker's attention is focused on the recipient, i.e. what they say, what they do and what comments and suggestions for improvement they have for subsequent prototypes. The *test* phase is the key of the DT method as it verifies ideas in practice, which can be extremely effective during projects' implementation.

IMPLEMENTATION

The methodological diagram presented in Figure 1 can be interpreted in an infinite number of ways, adapting to the conditions and main assumptions of the project classes. The procedure presented in this article is only an example, the author's own suggestion, of how the main assumptions of this methodology can be translated into didactic practice.

The classes presented in this article were held in the Faculty of Architecture at Wrocław University of Science and Technology (FA-WUST), Wrocław, Poland, during the History of Conservation and Restoration of Greenery course,

conducted by the author. Twenty-five first-year second-degree students of MSc studies took part in it. The design task consisted of changing the character of Kazimierza Wielkiego Street in Wrocław, Poland from the main transport route in the Old Town to a *woonerf* - a living street.

The schedule presented below is an original proposition by the author to integrate the design thinking methodology into the design practice at the FA-WUST. The students had 12 lesson hours, which were divided into six modules of two hours each, to complete the task. They were divided into five five-person smart teams. Kazimierza Wielkiego Street was divided into five sections - one for each team. Most of the work was done in the classroom as workshops. The schedule of classes is presented in Table 1.

Table 1: Course design exercise schedule for History of Conservation and Restoration of Greenery.

Module number	Phase in design thinking and its duration	Activity during classes	Homework
1.	Introduction *Empathise* (2 x 45 minutes)	• Presentation of the design topic • Presentation of the main assumptions of design thinking • Introductory exercise to *empathy* • Division into smart teams • Overview of homework	• Making a mock-up of the prepared fragment of Kazimierza Wielkiego Street, scale 1:200, duration: two weeks (for classes in module 3) • Local vision - creating a map of *empathy*, time: one week (for classes in module 2)
2.	*(Re-) define* *Ideate* (2 x 45 minutes)	• Introductory exercise to (re-) definition • Introductory exercise to ideation • Work in smart teams	
3.	*Prototype/Test/Ideate* (2 x 45 minutes)	• Introductory exercise to giving feedback • Work in smart teams	
4.	*Prototype/Test/Ideate* (2 x 45 minutes)	• Work in smart teams	
5.	Final version (2 x 45 minutes)	• Work in smart teams, scope of the study: scale model 1:200, 10-minute presentation in Power Point, which was to include three views from the human perspective	
6.	*Test*/Presentation (2 x 45 minutes)	• Final presentations of the work results	

For the above-mentioned course, two additional steps were introduced: a theoretical introduction; and time to prepare the final version of the project. Figure 2 illustrates the adjusted DT process for the course.

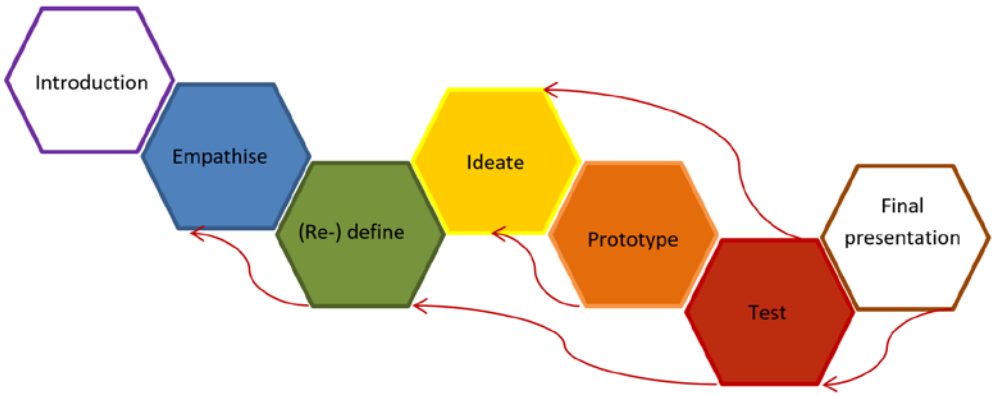

Figure 2: Design thinking model adjusted for History of Conservation and Restoration of Greenery.

The didactic objectives of the course were primarily focused on designing modern public spaces in cultural and social contexts. The student learning outcomes were defined as the knowledge and understanding of the natural environment's importance in architectural and urban design, the ability to make a critical analysis of existing conditions and formulate

design conclusions in an interdisciplinary context. The design thinking methodology enabled the inclusion of architectural and urban design's determinants resulting from the psychophysical characteristics of man, and also helped with shaping teamwork skills, formulating feedback and developing the ability to present one's own project to a potential client. An important element of the process was strong customer orientation, active listening training and the ability to deal with criticism.

DETAILED DESCRIPTION OF THE CLASSES

The individual stages of the project were carried out according to the schedule. The first module was to familiarise students with the general assumptions of the design thinking methodology and give practical tips on which elements should be paid attention to during each stage of the project. The students were also familiarised with one of the techniques of creative thinking called the visual language. Then, the students were divided into smart teams and each team was assigned a different part of Kazimierza Wielkiego Street in Wrocław, Poland. Each team was given a homework assignment to prepare an overall 1:200 scale working mock-up of the project topic to form the basis for the *prototype* phase. The next step was to move to the *empathise* phase by means of an introductory exercise which the students performed in teams of two. The main purpose of the exercise was to train the interview skills aimed at learning the respondent's needs. Then, the principles of constructing the so-called empathy map were discussed. Subsequently, each smart team was assigned a task to make an empathy map for the designed area.

The second module of classes began with an introductory exercise to the *(re-) define* phase. Then, on the basis of the empathy map, each team was to create a list of design problems they were going to face. The list was the basis of the *ideation* phase, which was divided into two parts, i.e. individual and team work. Each team member chose one problem from the list, which they tried to solve by using one of the creative thinking methods, i.e. reverse or metamorphosis, presented by the leader. The next stage was to discuss all the suggestions within the smart team and to select solutions for the *prototype* phase.

Both the third and fourth modules were devoted to the *ideate, prototype* and *test* phases. The classes were conducted in a workshop system. The basis was a 1:200 mock-up of the area designed. The first step was to build a prototype of solutions generated in the *ideate* phase. Students had twenty minutes to complete the task (rapid prototyping) using cheap recycled materials; for example, bottle caps or readily available materials, such as paper, and everyday objects, such as toothpicks and sponges. Then, the *test* phase started.

Two smart teams were compared with the other two teams. Each team was asked to briefly present their suggestions to another team to receive their feedback. Then a change, in which presenters became evaluators, took place. After receiving the feedback, the team had 20 minutes to change and improve their prototype solution. The cycle was repeated until one project was discussed by all the teams and the leader. In the case of the History of Conservation and Restoration of Greenery course, there were four rounds, as a result of which four prototype models of public space were created. Each working mock-up was photographed to document the development of the project.

The penultimate module was intended for the preparation of the mock-up final version and a short ten-minute PowerPoint presentation, which was to include three perspective views from the human level made with any technique; for example, freehand sketches or digital collages.

The sixth module, last but not least, can be described as the final test. Each smart team had 10-12 minutes to present their project to an expert team consisting of an educator, city council transport representative, vice-president of the Society for Beautifying the City of Wrocław and experts in experience design. After listening to all presentations and discussions, the expert team chose three best projects. Additionally, each student could vote for the best (in their opinion) project, with the provision that it was not possible to vote for the smart team to which they belonged.

Figure 3: Examples of mock-ups of Kazimierza Wielkiego Street in Wrocław, Poland, presented by smart teams during the final presentation.

CONCLUSIONS

The Stanford DT model is very flexible, which allows the educator to adapt it to different types of classes. Design thinking is becoming more and more popular in the academic environment, which can be evidenced;

for example, by scientific publications describing examples of its use in the education of mechanical engineers [6] and architects [7].

Design thinking has several features in common with traditional architectural design, such as building models and orientation toward the user/client's needs. What distinguishes it, is a strong focus on innovation understood as a useful and purposeful invention, which meets the needs of a future user/client, where the designer's ego takes a *back seat*. It is more experimental and any failure is treated as a natural part of education.

The main work is performed on a model, which is treated as an element of creative work. The mock-up should present the essence of the project, provide room for improvement and modification, instead of being an aesthetically refined object presenting only the designer's vision. In most cases, student models are made very precisely and are monochrome. Here, the mock-up is an element of creative searches and is made of easily available, as well as inexpensive materials. In the context of the design thinker's work, it makes sense because it is better to fail earlier and, thanks to the lessons learned from it, be successful later, according to the principle of Tim Brown from IDEO, one of the precursors of implementing design thinking in business [5].

After completion of the course, students anonymously evaluated it on the student-dedicated Web site of Wrocław University of Science and Technology. Ninety-one percent of students stated that they had been inspired to think independently and acquired new skills, 83% had acquired new knowledge and 91% would recommend classes to their colleagues [8]. A good summary would be to quote a few statements from the survey, which showed the students' attitude to this slightly different form of didactic classes:

- Student 1: *A non-standard approach, i.e. a workshop form which required involvement of the entire team in work during classes and an attempt at persuading students to try to look at the discussed problem from a different perspective was a good idea.*

- Student 2: *The opportunity to discuss our concepts with other teams was also a big plus. A very interesting and desirable form of classes that gave us a lot of fun and knowledge on the topic at the same time. The classes were conducted at a high level and they brought a lot of freshness to the curriculum of the studies.*

- Student 3: *The way the classes were conducted - the teacher had a prepared scenario of classes which she followed changing an apparently* boring *subject into interesting practical classes. She experimented herself and at the same time allowed students to experiment, which should be an inseparable element of ALL classes at the Faculty of Architecture.*

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