

The Effect of Remote Collaborative Work on Design Processes During the Pandemic

Pelin Ozturk ^a | Cem Avci ^a * | Cigdem Kaya ^a

^a Istanbul Technical University, Industrial Design: Istanbul, Turkey.

* Corresponding author: avci@itu.edu.tr

ABSTRACT

At the beginning of 2020, COVID-19 spread rapidly all over the world. Social distancing has been one of the measures taken to prevent the disease from spreading, meaning employees and students have been forced to work remotely using communication tools. Within the design field, professionals and students working remotely were limited to using communication tools developed during the design process, finding ways to use these facilities in accordance with their practice routines in the physical environment. In this article, the tools used to conduct collaborative design processes remotely during the pandemic were examined through a questionnaire study. Even though designers have had to work digitally to maintain workflow during this period, positive experiences were observed when using the special tools. However, the transfer of tacit knowledge was restricted in design projects due to limited spatial communication. While many designers discovered they could already use the available tailored tools, many improvements were suggested through needs that were previously unknown becoming explicit.

Keywords: Collaboration, Design Process, Virtual Design, Remote Collaboration, Pandemic.

INTRODUCTION

During the design process, stakeholders with different levels and areas of expertise contribute to defining design problems within projects. Moreover, it is possible to design new solutions within the limits defined by these different competencies. However, physical contact is sometimes not possible during these design stages. For example, the recent COVID-19 pandemic a newly discovered virus caused an infectious disease, COVID-19 which outbreaked in Wuhan, China in 2019. It is declared as a pandemic affecting many countries globally by WHO in March 2020. The declaration of infectious disease as a pandemic caused fear and panic in individuals, has enforced many changes to both life and work. Within the design profession, the collaborative design process has suffered in particular because it requires bringing different people together. Once the disease spread and became a pandemic, the World Health Organization (2020) published an interim guide explaining how to take precautions in the workplace with a recommendation that a physical distance of at least 1 m should be maintained between people. Consequently, the number of physical meetings had to be minimised and employers were forced to implement teleconferencing or teleworking systems. While many studies have been conducted in the field of design by remote collaboration, the use of new tools has remained an option for individuals and

companies. However, the current pandemic has forced many designers to work remotely, meaning the use of such tools has become a compulsory part of their practice.

Prior to the pandemic outbreak, when a group of designers needed to meet and discuss a topic in collaborative practice (such as analysing design problems or synthesising decisions), they needed different solutions to achieve this aim. Stakeholders would gather in virtual mediums with the benefits of online solutions to share knowledge. Given the increased use of online collaboration tools because of the pandemic, it may now be worth re-examining whether and how any online solutions provide a suitable environment for analysing and synthesising design problems.

Designers tend to share their ideas through various channels, such as notes, drawings, and models. Moreover, it is essential to portray ideas on paper for the design process. Accordingly, with social distancing it is essential to develop different ways of continuing this type of visually supported communication for the continuity of the design project.

Designers and their teams had to use some collaboration tools in a virtual environment to remotely manage this situation. Although almost every co-worker uses online communication tools, the need for visual knowledge sharing requires advanced collaborative remote whiteboard platforms. These platforms allow distant teams and individuals to communicate and collaborate without the restrictions of physical locations and whiteboards. Such platforms facilitate the joint exploration of solutions and the development of each participant's existing ideas. Therefore, participants can continue to gather, share, and discuss design decisions on paper under the new circumstances.

From this perspective, online platforms are a practical and efficient medium for professionals and students who have to work remotely. While the basic screen sharing feature of ordinary online communication tools can be considered satisfactory, most designers had to experience new and previously untried tools during the pandemic. As more designers have been forced to adopt these new measures, remote working may change the process of collaborative design in the next decades.

The purpose of this study is to gain a clear understanding of the changing experiences in collaborative design practice during the pandemic, the reasons for designers needing other individuals in design processes. Furthermore, the changing habits in design practice during the pandemic and the suitability of remote communication or collaboration tools are analysed. This attends to collaborative practice in the literature regardless of a pandemic outbreak.

1. DESIGN PROBLEM, DESIGN PROCESS, AND COLLABORATION BEFORE COVID-19

During the COVID-19 outbreak, increased use of online collaboration tools created the need to revisit the definition of the design problem and its possible solutions in the literature. An unexpected pandemic challenged previous literature written under pre-pandemic (or 'normal') conditions. In this new normal, the ways designers think and address design problems had to adopt under crises where physical contact in office space was severely limited.

In the early 1960s, members of the Design Methods Movement believed that design should be based on systematic and scientific design methods based on research, which could be

taught and learned. There was no difference between the design process and the design method—the method was the process. According to this simplified model, the design process is conceptualised as a three-step process that requires systematic analysis, synthesis, and evaluation (Goldschmidt, 2014). According to Asimow (1962), the design problem contains analysis, synthesis, evaluation, and decisions, which is extended through optimisation, revision, and implementation.

Conversely, the wicked problems approach formulated by Horst Rittel sought an alternative to the linear, sequential model of the design process explored by many designers and design theorists (Buchanan, 1992). Here, the design process is divided into two distinct phases: problem definition and problem solution. Problem definition is an analytic sequence where the designer determines all of the elements of the problem and specifies all the requirements for a successful design solution. Problem solution is a synthetic sequence that provides a final plan for moving into production, where various requirements are combined and balanced against each other (Buchanan, 1992).

After these developments, researchers started to consider ‘descriptive design models’ that contrasted with normative models and methods. Here, the description of actual design behaviour was essential to make progress in understanding thinking as it occurs in real-life design practice (Goldschmidt, 2014). However, there was a serious challenge in this new paradigm—little was known about how designers think and especially how they generate and develop ideas (Goldschmidt, 2014).

Buchanan (1992) mentioned that discussions between designers and scientists create a constant problem of not allowing reflection opportunities between the characteristics of design and its connection with the arts and sciences, industry, marketing, and the people who use the final outcomes of design thinking. He stated

...Instead of yielding productive integrations, the result is often confusion and a breakdown of communication, with a lack of intelligent practice to carry innovative ideas into objective, concrete implementation. In turn, this undermines efforts to reach a clearer understanding of design itself, sometimes driving designers back into a defense of their work in the context of traditional arts and crafts. Without appropriate reflection to help clarify the basis of communication among all the participants, there is little hope of understanding the foundations and value of design thinking in an increasingly complex technological culture (p. 8).

2. REMOTE COLLABORATION

Design is a complex activity inherently based on the input of many other disciplines, stakeholders, and users. In recent years, product designers, customers, suppliers, and clients have become even closer and connected. Moreover, working together has become crucial in the design process (Maciver & Malins, 2016). However, as stated by Rittel, most of the design problems are wicked. Wicked design problems are ill-formulated, where the information is confusing, there are many clients and decision makers with conflicting values, and the ramifications are thoroughly confusing (Buchanan, 1992). These features have made it problematic to model a framework that adequately defines and generalises the process, because each design case is unique. In addition, the teams in the design work are unique and random and because the design itself is unpredictable, collaborative work needs structuring (Maciver et al., 2016).

According to Maciver et al. (2016), one trend of collaboration in the design process is global connectivity through instant communication, which has created a diverse network of designers, customers, users, clients, engineers, researchers, manufacturers, suppliers, retailers, and others, both inside and outside the design process. With the increasing globalisation and specialisation in design, collaboration between partners in distant locations has become crucial (Kolarevic, Schmitt, Hirschberg, Kurmann, & Johnson, 2000).

Online platforms have been developed that enable sophisticated modes of creative communication. Online solutions allow users to log in to a blank page designed to replicate a virtual whiteboard and digitally draw simultaneously by several people. Audio and video web conferencing is available free of charge and overcomes language barriers through shared display environments and visual communication. Further, instant messaging services allow informal communication within the team during the working day (Maciver et al., 2016).

Team members could work together simultaneously on a design anywhere (synchronously) or separately (asynchronously). However, this emerging type of cooperation often requires new design and communication methods to ensure success (Kolarevic et al., 2000).

Even if communication among people is the indispensable part of working together and collectively producing, this does not have to be in the same location. Although remote working (also known as teleworking and distal working) enables people to share, it is known to affect the work experience and outcomes of individuals (Fay, 2017) and can reduce the process of tacit knowledge transfer among those communicating (Arthur & Rousseau, 1996).

Computer-supported cooperative work (CSCW) has been studied for approximately 40 years (Carstensen & Schmidt, 1998). Furthermore, the studies for developing software of "cooperative work" made CSCW subject of design disciplines by collaborative design practices that involve software users, developers, and designers to apply their knowledge and experiences (Kyng, 1991). It is apparent that computer support facilitates decision-making in the design process, enabling many individuals to create an impact on each other and communicate with these facilities (Grudin, 1988).

Remote communication for conducting design studies is examined in practice and education related studies. Both of these require communication of the participants to act and decide together, even if they are not in the same physical space. As remote collaboration requires digital tools, it is necessary to move physical actions to the digital domain in collaborative design studies (Wenzel, Gericke, Thiele, & Meinel, 2016).

In the virtual 3D world, where different designers can present their work from different places while being virtually located, it has been observed that communication is not compromised significantly and design collaboration can be conducted adequately (Gül, 2011). Since the importance of working remotely has now been realised, businesses and educational institutions have assigned large budgets to set up digital tools to support similar collaborative work. However, effective use of these tools and their derived benefits depend directly on the willingness of users (Cheng & Kvan, 2009).

The reflection-in-action concept in design practice, as defined by Schön (1985), also allows design education to be shaped with the learning-by-doing principle. Therefore, an important form of design education is provided by design studios through face-to-face meetings where students are guided by a tutor to learn the process (1985). Conducting design education

digitally in an online environment is named as virtual design studio(Wojtowicz, 1995). In design education, focusing on the process is an indispensable part of learning. Therefore, such new forms of meetings (such as digital medium integrations) have a counterproductive effect on learning, because they reduce attention (Kvan, 2001). However, it has been shown that virtual design studio practice can improve student experiences and outcomes with the use of appropriate learning design in which students observe other students' work, even if they attend passively (Jones, 2020).

The use of suitable tools is very important in terms of ensuring work is conducted efficiently and reaches its purpose. Moreover, digital tools should be acceptable and usable for individuals beyond being only functional equipment. In this way, it is possible for all individuals to contribute who need to work together (Wenzel et al. 2016).

Maher, Bilda, and Gül (2006) examined three different media where designers are able to (1) sketch face-to-face, (2) sketch remotely with appropriate software, and (3) model objects in a 3D virtual world. While designers usually produce sketches in the physical environment, they focused on problem synthesis and created various alternatives for a solution. It was observed that while designers collaborate remotely and use some software for sketching or modelling, they completed the synthesis in a shorter time and focused on iteration in solutions in the digital environment.

Gül (2011) gained some insights into the collaborative design process from an educational purposed workshop. Although the quality of the output was high with advanced content, the students experienced difficulties in using new tools, technical connection problems, and process management. Problems such as disruption of participation and communication barriers emerged as important problems for the collaborative design process.

As stated previously, the literature review on the collaboration during the design process was conducted under normal conditions. During the pandemic, the confinement and lack of physical contact provided an unexpected opportunity to obtain new knowledge on how designers think and work. With the aim of understanding the effect of remote collaborative work on the design process, a questionnaire with structured and open-ended questions was designed.

3. METHODS

To gain initial knowledge on the tools and features of online design collaboration, a questionnaire was published online. A total of 103 participants provided feedback that evaluated the process of collaboration involving designers, design students, engineers, marketers, and customers. Three participants were excluded because they were not involved in the remote design process.

The questions were grouped into the following categories:

- Demographic information, such as age, educational background, employment status, and role in the design process,
- Identifying questions, such as degree of usage of whiteboard tools, communication methods, adequacy of applications, and stages involved in the design process within the scope of remote collaborative work,

- Likert-scale questions to evaluate the design process in collaborative work away from the physical environment,
- Likert-scale questions to evaluate interpersonal communication in collaborative work away from the physical environment,

Questions to evaluate collaborative remote work and changing work habits post-pandemic. In the quantitative part of the questionnaire, the participants responded on a seven-point Likert scale with labels from 'strongly disagreed' to 'strongly agreed', from 'worsened significantly' to 'improved significantly', and from 'insufficient' to 'sufficient'. Moreover, two open-ended questions were asked to elicit in-depth qualitative responses. The first asked about how the platforms used by participants for whiteboard purposes could be improved. The second provided an opportunity for participants to share their experiences that would affect their design processes post-pandemic.

The reliability of the questionnaire was verified by calculating Cronbach's alpha values higher than 0.7 (0.713). In addition to descriptive statistics, categorical variables were primarily compared using the Pearson chi-square test and Fisher's exact test for present data. After relevancies among categorical variables were studied, interactions between the variables were examined using a logistic regression test. Normal distribution of all quantitative values were indicated by skewness and kurtosis. The differences between groups were calculated by an independent sample T-test. All statistical analyses were conducted using SPSS v20.0, and a p value of <0.05 was considered statistically significant.

4. RESULTS

Within the 103 respondents, 100 (97.1%) worked remotely during the pandemic. Of these, 42 (42%) were postgraduates, 58 (58%) were graduates, 83 (83%) were professionals, and 17 (17%) were students. Further, 56 (56%) were product designers, 38 (38%) were researchers, and 23 (23%) were interface designers. In addition, there were other collaborative working roles represented such as UX designer, graphic designer, design manager, and architectural designer.

Only 67 (67%) of the participants needed to use the whiteboard, of which 41 (61.2%) produced whiteboard solutions through existing communication tools and 26 (38.8%) used specific whiteboard applications.

When comparing professionals and students, there was no statistically significant difference in the rate of whiteboard usage ($p = 0.144$). When participants were compared according to educational status, those with a postgraduate education had a greater tendency to use the whiteboard, although this difference was statistically insignificant ($p = 0.054$).

It was revealed from the Likert-scale questions that compared to students, professionals thought staying away from the working environment significantly improved the design process ($p = 0.028$). The reasons students perceived remote working as having a detrimental effects on the design process were an inability to share opinions over sketches or drawings and assessing the design process on prototypes ($p = 0.040$ and $p = 0.025$, respectively). Regardless of employment status, graduates found that not working mutually with stakeholders in a common physical environment caused tension ($p = 0.014$).

In the remote collaboration, it is statistically significantly revealed that the participants using whiteboard who include both using any applications and producing a solution via other communication tools without any need to an application consider that the interpersonal communication is getting easy ($p = 0.002$). Moreover, participants using whiteboards stated they could express themselves more efficiently and were more creative and productive within this period compared to participants not using whiteboards ($p = 0.001$ and $p = 0.039$, respectively). Within this period, participants using whiteboards also stated they had to form renewed habits to maintain efficient communications ($p = 0.002$).

Based on these results, participants were asked whether it would be possible to work remotely permanently in the future. While employment status had little effect on answers to this question ($p = 0.954$), participants with a postgraduate education considered working habits would change at a higher rate ($p = 0.004$). Similarly, participants who used whiteboards thought working habits could alter in the future ($p = 0.003$). Among all participants using whiteboards, no difference was revealed in the thoughts of those who used applications ($p = 0.641$). Having a postgraduate education and experience of working with whiteboards pre-and post-pandemic were found to be effective factors when determining whether to continue working remotely post-pandemic ($p = 0.007$, $p = 0.040$, and $p = 0.017$, respectively). This was determined from the multivariate analysis, which included educational background, employment status, whiteboard usage, application usage, and experience of working with a whiteboard pre-pandemic.

5. DISCUSSION

Professionals observed that their processes improved when they were away from the physical work environment. However, students found that working remotely and being away from the classroom/studio environment adversely affected their design processes. This was because they were unable to share ideas through sketches or drawings and lacked evaluations of the design process over prototypes. This caused tension in the students, making it difficult to work remotely during the concept development and detail design stages of the design process.

While it is known that collaborative working in the design process is possible with the transfer of tacit knowledge among the participants, being unable to evaluate designs through sketches and prototypes may have restricted knowledge sharing. Nevertheless, the main reason why professionals were less affected by the situation can be explained by them finding it easier to express their knowledge due to their high levels of experience. Further, the responses from professionals indicated that they perceived independence from distance an advantage to expressing themselves more effectively, which was due to digital communication allowing more frequent responses. This is portrayed in the following response: 'We were able to get feedback faster, and we had the chance to test ideas with more people using digital prototypes and collaboration tools'.

Professionals who trained using traditional methods and learned design through practice were able to transfer tacit knowledge in the digital environment. However, new designers trained in pandemic conditions need to develop new methods of acquiring tacit knowledge from digital media in the future, otherwise this could result in a generation of designers who are not prone to collaboration with other stakeholders. For example, although one student participant thought that working away from the physical environment would benefit their

life on becoming a professional, they felt the effect of decreased communication and practice on the design process would be negative:

Frankly, I can even say that working remotely in matters other than the design process is 100% efficient, but when it comes to design, I think that besides the advantages, less contact with people or reduced contact with production has negative effects on creativity. At this point, although the advantages of working remotely outweigh, I have started to think about how to compensate for the effect of reduced practice.

Participants who found a whiteboard solution (such as screen sharing) and those who used specifically designed whiteboard tools were considered whiteboard users in the context of communication between collaborators during remote work. Both groups found interpersonal communication easier when conducted remotely rather than physically. Although the absence of any significant difference between these two groups would imply screen sharing from available communication tools meets the explicit needs of designers, most users in this group had not experienced any whiteboard applications previously. In further studies, both forms of application should be evaluated separately to enable a deeper interpretation of the benefits of these platforms. In addition, from the answers to the question on development proposals, it is clear that some users do not know all the features of the tools they use or the purpose of the platforms. For example, 'If the parties could draw simultaneously on the same screen', 'It can be better if it has voice speech feature and ability to speak on separate platforms', and 'There may be options such as surveys that other users can actively participate'.

Participants who used whiteboard tools during the remote collaboration stated that they expressed themselves sufficiently well from afar. However, those who without prior experience of these tools experienced a lower level of expression. In addition, participants using whiteboard tools were willing to acquire new working habits to provide efficient communication during this process. One participant stated that working remotely on the design process with their collaborators during the pandemic elicited new habits that foreshadowed future working habits: 'Every concept that the pandemic process forbids us, such as touching, sharing, and cultural activities, has caused us to apply new habits that we cannot ignore the design-production process'. Another participant commented 'In particular, I think the product design process is an older model compared to the UI / UX design. In the pandemic, industrial design discipline captured the working practices of newer design disciplines'.

Buchanan (1992) stated there is little hope of understanding the basics and value of design thinking in an increasingly complex technological culture without proper reflection to clarify the basics of communication between all participants in the design process. One of these reflections is that disciplines working remotely must arrange their working methods in line with current technological developments. Having to work remotely is a driving force for stakeholders to discover new ways of managing the design process. Accordingly, it is predicted that these new ways will be included in design processes of the future.

We understand from different responses that professional designers who participated also realised the need to develop new communication methods. Comments included 'I realise that I need to adapt my content and methods to online interaction' and 'I think there will be changes in the way people express themselves with communication disorders because I think there will be safe communication face to face'. In a different answer, we can see that both the communication method and the handling of design problems may change: 'I think

we will consider developing solutions for a period of time to add social distance to our design parameters and reduce hygiene and physical interactions between people’.

It was also observed that tension caused by being unable to work face-to-face with collaborators was statistically less significant among participants who preferred the use of whiteboard tools rather than screen sharing. The effect of attention paid by each participant to work in the design process can be correlated with the face-to-face work of collaborative design meetings. Particularly in a working session, participants who focus their attention on the subject will increase their contribution to the results, rendering the output more acceptable to more people. As mentioned in the study of Kvan (2001), this is related to the attention that students give to the process of learning in the design process, which lecturers find difficult to control in the digital domain. This provides an advantage whereby whiteboard tools allow multiple participants to contribute and be tracked. This could be the reason why participants who used whiteboard tools were less effected by the tension of not working face-to-face.

In the previous sections, we pointed out that the participants' some improvement suggestions were already part of the tool, but they were unknown to the participants. This indicates that although the features were present, they could not be accessed and used by the participants. However, all suggestions are not provided by the tools. For example, ‘When changes were made to the collaboration file by the participants in the subject, it would be nice if the previous versions could somehow be hidden in the background’. The collaborative work of designers did not only last for the remote session, with 65.2% of respondents who used whiteboard tools claiming they continued to work in the same online whiteboard after the collaborative sessions. One participant who highlighted this improvement in the questionnaire had to track back and control changes in their co-worker. Another suggestion for sketching features of whiteboards is stated as: ‘Drawing with the mouse is not fast and sufficient, as we are used to drawing on the physical whiteboard. Need to make quick sketches’ A drawing-support algorithm for shapes drawn with the mouse through the application may be a value-increasing feature that would enable more common usage.

In addition to educational status, working status, and usage of whiteboard tools, participant experiences of working with whiteboard tools pre-pandemic were evaluated by a multivariate analysis. Having a graduate degree and experience of using whiteboards pre-pandemic were found to be effective factors that caused participants to think that they would continue to work remotely when the pandemic ended. In previous studies (Maher, 2006; Gul, 2011), it was observed that newly learned tools caused some difficulties in remote design collaboration sessions. Through these outcomes, it can be observed that early users of these platforms have more self-confidence to continue remotely communicating with co-workers.

Although many efforts have been made to enable and improve remote working in the design process, we are going through a period where people do not control their working methods and are having to cooperate remotely. This study shows that designers continuously benefit from collaboration as part of their way of working; hence, they have been searching for tools that would allow them to continue this collaboration during the pandemic. Many previously unknown insights have emerged with the sudden, increased use of these applications. Although the design processes using tools discovered by experienced professionals during this period have improved, the negative impact on less experienced students indicated that the effect of permanent distancing on future designers should be questioned.

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