Interdisciplinary Collaboration and Teamwork in Design Issues: Assessment of Team Performance Conditioned by Professional Backgrounds

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Abstract
Design is an interdisciplinary, multi-actor process that requires the collaboration of professionals from a range of disciplines. This study aims to ascertain the potential benefits and drawbacks of integrating professionals from diverse disciplines, including design, engineering, and social science, in teams tasked with addressing design challenges. In order to achieve this, a qualitative research study was conducted, whereby professionals were observed as they worked on a specific problem concerning design issues. The professionals were grouped into three teams comprising five professionals in each. The teams were assigned an identical task. A single expert was responsible for observing and evaluating the processes of design activity. The process in question pertains to the initial five of the six principal distinct categories of design activity, namely; 'roles and relationships,' 'planning and acting,' 'information gathering and sharing,' 'problem analyzing and understanding,' 'conflict avoiding and resolving,' 'concept generating and adopting' as proposed by Cross and Cross (1995). The study reviewed the outputs provided by each team under the 'concept generating and adopting' category. The research findings indicated that professionals from engineering and social science disciplines could successfully work out ill-defined design problems and add value to the discussion, particularly in the 'generating and adopting concepts' phase.
Keywords: Design Collaboration, Design Activity, Team Performance Assesment, Disabled

1.   INTRODUCTION
Currently, many design schools propose a design background as a requirement to admit students for their graduate education (URL 1, URL 2, URL 3, URL 4). This condition causes people to think that design and design-related procedures are highly technical issues that can be acquired through a strictly determined process of learning. Accordingly, design education is an unbreakable chain of knowledge accumulation, which can only be carried out by attendants of design-related disciplines. The validity of this statement is important because the reverse case could potentially change the prevailing dynamics of design education. Also, it has the strength to affect professional treatment in coping with design problems. If it were found that professionals of other disciplines could comfortably place themselves in teams attempting to solve design-related problems, a new perspective and objection would be negotiable.

Designerly ways of knowing incorporated into design thinking and culture of organizations with its tools and methods. In practice, design thinking has evolved into a cultural and organizational structure that enables the interpretation of new phenomena and the reinterpretation of existing concepts across disciplinary boundaries(Elsbach, 2018).

Do these advancements transformed design to become a discipline that does not necessarily require a specific education? This research does not aim to find whether this overcapitalized proposition holds. Rather, it investigates the likely presence of professionals of other disciplines in teams that gather to cope with design problems. So, more than concentrating on whether professionals of other disciplines can alone understand/cope with

design problems, this study focuses on the dynamics and efficacy of teamwork performed by a diverse group of professionals. Namely, homogenous teams consist of professionals from design-related disciplines, and heterogenous teams that unite/merge professionals of engineering and social science disciplines with professionals of design-related disciplines.

2. LITERATURE SURVEY

This research moves from curiosity to finding the role of prior knowledge and experience on performance to finding suitable solutions to design-related problems, which evolved and questioned the issue regarding participants and borders of design activity. In this concern, Verma (1997) researched graduate or undergraduate-level university students in the design departments. Her focus mounted on two issues; the first is related to the nature of prior preparation, and the second is the timing of that prior preparation. Verma'work concentrated on a particular issue at the individual level.

However, design is an interdisciplinary, multi-actor process (Girard & Robin, 2006) that necessitates teamwork of diverse professionals from a range of disciplines (Bunt and Brown, 2023). As any kind of individual response is highly correlated with skills and the mastery of technical specifications and procedures in a specific field, a study that investigates the likely compatibilies of professionals of other disciplines in design should not look for individual performances. Non-design professionals are not expected to be acquainted with the procedures, even to a certain extent, with the issues of design. Still, they are expected to add perspective and depth to comprehend the problem and propose solutions based on their visions and way of thinking outside the box. Recent research might be given as an example of how the 'collective expertise' of interdisciplinary collaboration might surpass the decisive role of individual 'architectural expertise' and take the lead in the design process (Kasalı and Nersessian, 2015). Thinking that design necessitates teamwork, the role and contribution of professional expertise should be inspected in the plural.

The mechanisms of teamwork in design related issues are complicated learning processes that develops in successive zones, which gave chance to interchange of ideas in the last developed '*social zone*' (Tessier, 2023), which is core to the focus area in this research. This complexity is considered and its implications on the group's performance is well-awared of before arriving at conclusions.

Another important issue related to teamwork is related to leadership. Participants employ a '*linear ordering schema*' to determine the leader in spontaneously established informal teams lacking a formally attended leader. They check the consistency of the leadership characteristics that emerge around them with the '*linear ordering schema*' they have established in their minds (Carnabuci, 2018). The emergence and effective establishment of leadership in teams that do not have a clear definition of authority directly impact the efficiency and effectiveness of teamwork. In this respect, the research would provide insights into observing the contested leadership among professionals of different disciplines within the groups. Some studies follow a strategy to blend novice and expert designers in assembling the team composition and leadership roles that would inspire interdisciplinary design studies (Kiernan, 2020).

Design takes place at macro and micro levels (Stumpf and Donnell, 2002) and becomes more and more complicated regarding scale and content. Most of the time, this complexity '*spans both the design process and relevant aspects of the design context*' (Valkenburg and Dorst, 1998). In this context, collaboration is necessitated to '*share expertise, ideas, resources or responsibilities*' (Chiu, 2002). This study attempts to understand the possible opportunities and drawbacks of the likely presence of professionals from other disciplines in teams that strive to resolve design problems.

Typically, one confrontation between designers and engineers exists in the construction industry with the necessity to jointly bring the designed projects to life. The motivation in such projects was considered in a research that found '*design process efficacy*' as a factor influencing the motivation of architects and engineers in a collaborative design activity (Oyedele, 2010). In another research, Yin (2011) also measured collaborative design performance by a multi-criteria '*design performance measurement (DPM)*' matrix adressing five basic indicators '*efficiency, effectiveness, collaboration, management skill, and innovation*'.

Cross and Cross considered '*teamwork and social processes*' in the design of a bicycle accessory (1995). The design was carried out by a team of three members whose design backgrounds and professional roles were not mentioned. Viewed from the perspective of design in general, their study addresses important processes that might be common for all design-related disciplines. They proposed six principal categories that correspond to distinct processes of design activity; '*roles and relationships,*' '*planning and acting,*' '*information gathering and sharing,*' '*problem analyzing and understanding,*' '*conflict avoiding and resolving,*' and '*concept generating and adopting.*' Their research is of value for sketching a general framework in this study to observe teamwork in design activity.

3.   STUDY DESIGN AND PROCEDURE

In this research, professionals shall be competent to use and synthesize knowledge in group work. Graduate students are believed to perform better on this occasion. The sample population in the research are professionals selected among graduate students from several universities in Ankara, Turkey.

3.1   Study Design

A qualitative research study was conducted with professionals from various disciplines who convened and collaborated in groups to address a design-related problem. The objective of the study was to evaluate team performance in identifying solutions to design-related problems conditioned by professionals' diverse backgrounds. Specifically, the study examined the impact of contributions from professionals with non-design backgrounds on the team's performance. These contributions encompassed their prior knowledge, occupational experience, and other relevant factors that contributed to identifying suitable solutions to design-related problems.

The research was conducted by observing three groups working on a specific design problem. The groups were assembled based on the professional backgrounds of the participants. The first group (Group A) was the homogeneous group, comprising professionals with a professional design background; the second group (Group B) was the first heterogeneous group, comprising professionals from design and engineering disciplines; and the third group (Group C) was the second heterogeneous group, comprising design and social science professionals.

Each group consists of five professionals. The homogeneous Group A brings professionals from design disciplines together and comprises two architects, two interior architects, and a city planner. The first heterogeneous Group B brings professionals from design and engineering disciplines together and comprises an architect, a city planner, an interior architect, a civil engineer, and an environment engineer. The second heterogeneous Group C brings professionals from design and social science disciplines together and comprises an architect, a city planner, an interior architect, a sociologist, and a political scientist.

3.2   Procedure

The research procedure involved the examination of teamwork among groups with a range of professional backgrounds tasked with developing solutions to a specific design problem. These groups were assigned an identical task and observed by a single expert, who focused on the processes of design activity as defined by Cross and Cross (1995).

3.3   Situation and Setting

The research was conducted in a studio setting to facilitate a supportive work environment. The task was initiated by handing out the problem sheet and presenting the problem in a pre-determined vocabulary and format. All teams were assigned with identical durations, and the groups were not given any critique or assistance.

PROBLEM DEFINITION

CHALLENGING the PROBLEMS of DISABLED PEOPLE

Ensuring the full participation of individuals with disabilities in social life represents a significant and enduring challenge, manifesting in spatial and political dimensions. It is anticipated that this challenge will evolve with the dynamics and requirements of the present era. The issue is addressed at different scales and contexts, especially in cities, where the spatial dimension is manifested with changes in social interaction patterns within space and society.

In addressing this ongoing problem, the group is expected to work as a team and conduct a discussion, making suggestions with spatial and political implications regarding the measures to ensure the full participation of individuals with disabilities in society.

After the allotted time for the collaborative work, the team would reflect on the content of the work with the tools provided. This reflection's format and presentation are at the group's discretion. The reflection should comprise keywords highlighted that emerge during the group discussion.

TOOLS

The group will be handed a computer with internet access, blank papers in A4 and A3 formats, colored pencils, cardboard and scissors to reflect their work.

DURATION

The discussion will be conducted in two one-hour sessions, with a 15-minute intermission between the two.

Figure 1: *Handed problem sheet*

3.4   Evaluation Criteria

The performance of each group is observed and evaluated in terms of the process they have undergone. The process in question pertains to the initial five of the six principal distinct categories of design activity, namely; 'roles and relationships,' 'planning and acting,' 'information gathering and sharing,' 'problem analyzing and understanding,' 'conflict avoiding and resolving,' 'concept generating and adopting' as proposed by Cross and Cross (1995).

Also, the final output submitted by each group was evaluated. The groups were asked to distill keywords representing their discussions. With this respect, '*concept generating and adopting'* that was defined as a category of processes of design activity by Cross (1995) was discussed as an indicator of performance.

Several studies have been conducted that focus on teamwork. One of these studies aims to measure in-team performance and the contributions of team members by a range of variables using disciplined protocols (Guaman-Quintanilla, 2022). However, concerning the

duration and available resources allocated to this research and to keep a simple experiment design, this study concentrates on the outputs provided by the teams as collective and shared proposals. The observations made in the research also verified a participatory acting on the problem by team members.

4   DISCUSSION

Teamwork performances of the groups were discussed basically on two premises: teamwork as process and teamwork as output.

4.1   Teamwork as process

The performance of each group is observed and evaluated in terms of the process they have undergone. The process refers to five of the six main categories that correspond to different processes of design activity, namely; '*roles and relationships,*' '*planning and acting,*' '*information gathering and sharing,*' '*problem analyzing and understanding,*' '*conflict avoiding and resolving.*' as proposed by Cross and Cross (1995).

4.1.1   Roles and Relationships

All the groups were assigned the same task with a sheet of paper specifying the problem and explaining the purpose of the research. The observation concentrated on the process of teamwork performed by each group. The discussions were realized in an equal and respectful manner. Neither of the gatherings showed a despotic reaction between members of the groups. This corresponds to a horizontal distribution of roles and democratic organization of relationships in the gatherings. In other words, no hierarchical relationship pattern was apparent among the members of each group.

In cumulative and from the perspective of various roles and relationships attained, there was no apparent and decisive formation of hierarchical relationship patterns in the groups. Obviously, considering the limited duration of the task and the fact that the members of the groups had never met before, an elaborate distribution of roles showing a hierarchical organization in the groups was not expected. Still, some members of the groups were more effective in the discussions and informal initiatives were taken in leading the discussions. For groups A and C, there was evident leadership of city planners. For group B, leadership was contested between the city planner and the civil engineer. The leadership seemingly could be attributed to being more acquainted with appropriate knowledge on the subject and nature of the problem. But, it might also relate to the success of planners in adapting their knowledge to the situation.

4.1.2   Planning and Acting

If planning is understood as a pre-step of effective and synchronized acting on the designated problem, all groups could be criticized for having significantly poor performance. Neither of the groups prepared a time schedule or a customized plan for their prospective work initially. Also, neither of them had appointed one of their members for the key tasks such as moderation and note-taking. In the course of their work, as the ideas emerge and concretize, neither of them defined duties and shared responsibilities. In the research, groups started the task by carrying out a discussion. All the groups continued the discussion alone for some time without worrying about the submission of an output, which is required as the ultimate source signifying the completion of the task. The groups started preparing a final output when they realized they were running out of time. So, the time constraint seemed to be the decisive factor that motivated the groups to move on to acting. Also, in this respect, the groups performed poorly in planning before acting.

4.1.3   Information Gathering and Sharing

Searching the Internet and relying on individual experiences and knowledge of the members was the general tendency in *gathering and sharing information*. Borrowing from the experiences of the attendants abroad was an interesting common source of inspiration in the groups. This might happen because the groups were convinced of the idea that

disabled people in Turkey are faced with serious problems compared to the problems abroad. Also, standards concerning disabled people in developed countries, especially those in Europe, could be taken as a model and an example that would uplift the standards and the lives of disabled people in Turkey.

4.1.4 Problem Analyzing and Understanding
Observations revealed variations in how the various groups approached and conceptualized the problem. Notably, the homogeneous team comprising design professionals exhibited a direct approach centered on solution formulation rather than problem analysis. In contrast, the heterogeneous team assembled with professionals from design and engineering disciplines allocated significant time for problem definition, encompassing an analysis of the relevant actors and processes, before formulating their solution proposals. Similarly, the team comprised of professionals from the design and social sciences disciplines, engaged in an in-depth discussion to establish a comprehensive framework that was followed by their proposals for the solution. The observed differences in the allocation of time for problem analysis could be attributed to the familiarity of the problem with the respective group members. The consensus on the problem definition might also have influenced the time allocated for problem analysis.

4.1.5 Conflict Avoiding and Resolving
The discussions were held in a respectful environment, but there were conflicts, contradictory issues, objections, and defended ideas among the members of all groups. The conflicts were more apparent in the teamwork performed by designers and engineers. Even some conflicts were left unresolved, and an attendant with a design background refused to sign the output of her group. The general tendency to resolve conflicts was to try to reach a consensus. The consensus did not always reflect a totally shared idea or proposition. Rather, it worked as a mechanism to suspend rivalry, keep working, and make way toward submitting a final output. In group B, designers focused more on convincing engineers and getting them to their side. However, persuading the opposition was not a frequent attempt or an apparent strategy among the members of the groups.

4.2   Teamwork as output
The final output submitted by each group was evaluated. The groups were asked to distill keywords representing their discussions. With this respect, 'concept generating and adopting' that was defined as a category of processes of design activity by Cross (1995) was discussed as an output and indicator of performance.

Highlighted keywords were another apparent output representing emergent ideas in the discussion of the groups. With this respect, the keywords distilled in each group were elaborated to explore the content and depth of the discussions.

4.2.1 Generating and Adopting Concepts
The discussion was not an appropriate forum for planning and considering future moves of the group members. Instead, it was a time for *generating and adopting concepts*. The homogeneous Group A consisted of design professionals—two architects, two interior architects, and a city planner- considered the problem to be mounted on social and spatial domains. They cautioned about the solutions to problems of disabled people that proposed only spatial means to remain inadequate and generate inefficiency. The group highlighted that the challenges faced by individuals with disabilities cannot be addressed through solely spatial interventions. Instead, they emphasized the importance of considering social processes alongside spatial instruments to effectively combat the issues faced by this population. The group also saw the problem of disabled people as a matter of barrier-free access and participation in city life. They highlighted their equal presence as an unnegotiable human right and a necessity in a democratic society. To sum up, their stance was to provide the adaptation of disabled people in social life by removing physical barriers

and flattening social injustices that would help them be more productive and morally stronger.

The group's justification for their attention and approach to the problems of disabled people is based on democracy and human rights. They thought considering spatial and social issues to support each other would maintain an inner balance and help disabled people to be healthy and more productive, also adaptive to social life and community.

Group B examined the problem's physical, psychological and sociological implications on the individuals and the community. They thought that the difficulties faced concerning disability in society are sourced with respect to the capabilities of disabled people. Specifically, on the one hand, they saw disabled people as capable of overriding some of the problems that become insurmountable as they hesitate to take action or lose their faith and courage in attempting to integrate into social life and the community. On the other hand, they thought that the removal of some of the problems concerning disability in society takes place beyond the capabilities of disabled people.

In practical terms, they related the problems of disabled individuals in society occurring at individual and supra-individual scales. Likely, they thought that solutions to those problems could be found at the individual level by encouraging and motivating disabled people to take action and remove barriers in front of them. In this respect, they also accentuated the role of education in creating awareness about the problems of disability and developing ways of respectful and ethical conduct with disabled individuals.

They highlighted the qualities of the physical environment that do not conform with the universal standards to support the ergonomic and comfortable use of the disabled people at the supra-individual scale. Also, they put an accent in bringing the qualities of the physical environment to universal standards and betterment of the conditions that would ease the use and participation of the disabled people by the local and central governments. They also wished a more responsive media to bring the problems of disabled people to the forefront and take active role in pulling the barriers in front of disabled people down.

Group C claimed that disabled people should act more demanding and actively to ensure a well-functioning physical environment and responsive society. They also highlighted education and regulation to maintain a system that integrates disabled individuals into society. They thought that the existing system functions more to segregate than to integrate disabled people into social life. They proposed creating one spatial setting that is inclusive and open to disabled people unless a physical environment with a specific configuration is a necessity. They exemplified their strategy with one school for all the students that offers opportunities for interaction in its commonly shared spaces while having specific spatial settings, rooms, and spaces designed and devoted to the convenience and use of students with disabilities. They saw design professionals in a key role in facilitating well-functioning, accessible physical environments responsive to the needs of disabled people. Finally, their stance considers an accessible spatial setting to be a surmountable problem unless there exists an awareness for removing the barriers in front of disabled individuals in society.

4.2.2 Highlighted Keywords
One of the specific requirements given to the groups was to mention and highlight keywords that would distill their discussion. The highlighted keywords in each group represented the attention and accent along with the terminology that reflect the composition of each group in terms of professional backgrounds of team members. Also, highlighted keywords as distilled, debated and concretized outputs of the discussions became the core outputs of the experiment manifesting the reconciled issues among the members of the groups.

Group A that consisted of professionals with design background highlighted and submitted the below keywords.

Table 1: *Highlighted keywords by group of professionals from design-related disciplines*

Traffic	Democracy	**Segregation**	**Integration**	Human Rights
Subway	Pedestrian	Illness	**Employment**	Population
Unemployment	Sports	Power	Communication	City Center
Education	**State**	Local Government	**City**	Barriers
Media	Network	Equity	**District**	Shopping Mall

Group B that consisted of professionals with design and engineering backgrounds highlighted and submitted the below keywords.

Table 2: *Highlighted keywords by group of professionals from engineering and design-related disciplines*

Integration	Cost	**Employment**	Family	Volunteer
Responsibility	**Media**	Cinema	**Education**	Wheelchair
State	**District**	Money	**City**	Automation
Shopping Mall	Bare Minumum	Transportation	Sports	Childhood
Security	**Segregation**	Obesity	Self-Sufficieny	America
Technology	Standardization	Punishment	Blindness	

Group C that consisted of professionals with design and social science backgrounds highlighted and submitted the below keywords.

Table 3: *Highlighted keywords by group of professionals from social science and design-related disciplines*

Planning	Ethic	**Employment**	**Media**	Stairs
Slope	Normality	**Education**	**District**	Rehabilitation
Aesthetic	Blindness	Ramps	**Integration**	Automation
Job	Equity	Participation	Wheelchair	**State**
Hygienic	**City**	Economic	**Segregation**	Family
Manic Depressive	Distance	Private Sector	Modernity	Cigarettes
Sidewalk	Stair	Subway	Westernization	Illness
Rationalism	Positivism	Protectionism	School	Governance

Group A, B and C had 25, 29 and 40 keywords in their list respectively. The keywords were mainly sourced by the discussion notes. So, they give an idea about the sequence of the concepts and topics debated in the discussions.

Group C, consisted of design and social science professionals submitted 40 keywords, which corresponds to almost double of the number of keywords distilled by Group A and B. The number of keywords exceeding other groups in Group C also reflected the depth of the discussions. Important keywords such as **ethics, rehabilitation, hygiene** and **equity** came to the forefront in the discussion.

The analysis of the above tables shows that the three groups share 8 keywords. These are represented by boldface characters in the tabulation. Shared keywords give an idea that

all the groups agree on the problems of disabled people and propose solutions. The shared keywords might be united into a meaningful statement:

The most important dimension concerning disability is the **integration**/**segregation** *of disabled people to/from society and social life, which could be attained most effectively by resolving their* **employment** *status in* **cities. Education** *is the most effective instrument for the purpose, which the* **state** *is expected to take serious roles and increments by encouraging solutions at the* **district** *level.* **Media,** *although questioned seriously in its current acting and mechanisms, is thought to be a potential, powerful and effective device for this purpose.*

5. CONCLUSIONS

The groups were not obliged to submit their work in a prescribed format. However, they were required to distill keywords representing the essence of their discussions. Also, final submissions were expected to be a creative representation of the design activity and process, the experience of each group, and the capacity of the output to present a coherent and comprehensive proposal for the solution of the problem. None of the groups submitted documents other than a keyword list. In this regard, all the groups could be criticized for demonstrating a tendency to adhere to conventional thinking and framework.

The teams were allocated a restricted time to address a particular issue that required specialized attention, expertise, and comprehensive analysis. It was anticipated that the time constraint and the necessity of working in an unfamiliar group for the first time without prior preparation would impede the generation of more creative outputs. It would be beneficial to consider revising and improving the research design to enhance the quality and uniqueness of the outputs. Also, the complex inner structure of teamwork and learning environments in groups should be born in mind before generalizing findings of this research.

The research was conducted with restricted resources and was based on a single expert observation and evaluation. It would be beneficial for future research in this field to be conducted with multiple control groups. Furthermore, a panel of experts should conduct the observation and evaluation.

The primary output of the discussions was highlighted keywords. The distillation of additional keywords reflected the depth of discussions held in groups comprising engineering and social science professionals, thereby indicating an improvement. Furthermore, it offers insights into the involvement of professionals from diverse disciplines in the formation of groups tasked with performing teamwork.

The performance of groups in distilling more keywords might be related to the performance and depth of professionals in the groups. However, this might occur due to the harmonious working environment with reduced resistance to emergent ideas in the groups. The research results demonstrated that professionals and ideas from engineering and social science disciplines might find a place and perform successfully in working out ill-defined design problems and add value to the discussion, particularly in '*generating and adopting concepts*' phase.

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