다학제 협업을 위한 디자이너와 엔지니어의 특성 연구

디자인 씽킹 워크숍 결과 분석을 중심으로

Investigating the Characteristics of Designers and Engineers for Multidisciplinary Collaboration

Focused on the Analysis of Design Thinking Workshop

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Abstract

The essence of multidisciplinary collaboration is in the reconciliation between two different disciplines. How team members of different disciplines communicate and efficiently work together is crucial to achieve an ideal outcome. Design, as a discipline, has been considered to have integrative properties regarding both artistic capabilities and others that are related to engineering aspects. To prepare for the unprecedented changes and complex problems of our ever-changing society, designers should be aware of the multi-dimensional challenges that cannot be solved with a single perspective. As such, it is necessary to encourage a successful teamwork involving professionals from diverse disciplines. As a beginning of a long-term study, this paper solely focuses on the collaboration between designers and engineers, who are considered as intuitive and analytical thinkers. Through the analysis of the past multidisciplinary collaboration workshop, the purpose of this research is on emphasizing the importance of multidisciplinary approach in relation to designing innovative products and services. Prospective empirical research should focus on analyzing multidisciplinary teams in order to clearly discover the moment of conflict and synergy points.

Keyword

Multidisciplinary Collaboration Workshop, Convergence, Design Thinking

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요약

다학제 협업의 핵심은 다른 두 분야 간의 화합이다. 서로 다른 분야의 팀원들이 의사소통을 하고 협력하는 방법은 그 효율성에 따라 이상적인 결과를 달성하는데 중요한 역할을 한다. 학문 분야로서의 디자인은 예술적 능력과 공학적 요소를 종합적으로 갖춘 통합적인 속성을 지닌 것이라 간주되어 왔다. 끊임없이 변화하는 사회의 전례 없는 변화와 복잡한 문제점에 대응하기 위하여 디자이너들은 단일 관점으로는 해결할 수 없는 다차원적인 이슈에 대비하고 있어야 한다. 따라서 다양한 분야의 전문가들이 참여하여 성공적인 팀워크를 이끌어내기 위한 연구가 필요하다. 본 논문은 장기적인 연구의 출발점으로, 직관적인 사고를 하는 디자이너와 분석적인 사고를 하는 엔지니어 간의 협력에만 초점을 두었다. 연구의 목적은 과거의 다학제 협업 워크숍에 대한 분석을 통하여 혁신적인 신제품 및 서비스 개발에 있어서 다학제 협업의 중요성을 강조하기 위함이다. 향후 연구에서는 다학제 팀에 대한 실증 조사를 통하여 그들의 갈등 요소와 시너지 효과를 불러일으키는 요인을 분석할 계획이다.

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1. Introduction

1-1. Background and Purpose

As the world faces unprecedented changes through technological development, demand for consumer needs have increased and expanded in various ways. In the traditional context, people were accustomed by considering arts and sciences as the original liberal arts that were institutionalized. However, as entering the twentieth-century, the encyclopedic education of history, natural sciences and mathematics, philosophy, and social sciences have been divided into specific subject matters by using its own methods.[1] Design, as an integrative discipline, has also been developed throughout the century in relation to activities that draws upon artistic abilities and others that are closely related to engineering aspects.[2] In the academic discourse, the role of design is considered to cover many different disciplines as the meaning can be perceived broadly in various contexts.

The objective of this research is to emphasize the importance of multidisciplinary collaboration between designers and engineers in order to solve multi-dimensional problems of our society. By studying the concept of design thinking and multidisciplinary approach, this paper accentuates the expanded roles and abilities of designers and why designers should not work alone but to think together with the professionals from other disciplines. Especially when designing or developing new or improved products or services; it is essential that designers should collaborate with engineers to balance intuitive and analytical thinking throughout the problem-solving process. Recently, corporations are pursuing to create products and services that are both functionally superior and emotionally positive; thus, aiming for a design-inspired innovation to achieve brand royalty and high reputation from the customers.[3]

1-2. Scope and Method

This study reviews the different types of disciplinarity in able to clarify each terminology. By comparing the definitions brought from dictionaries and published articles, this paper addresses the definition and concept of multidisciplinary. By focusing on how and why multidisciplinary collaboration is necessary to achieve innovation, the research reflects the different mindset of a designer and an engineer within the context of creating new products or services together. This paper also introduces design thinking process that highlights abductive reasoning, a way of thinking and imagining what possibilities lies in able to solve a complex problem.

Based on the literature review, previously conducted multidisciplinary collaboration workshop will be analyzed to understand the different traits of designers and engineers. Through the analysis, this paper will indicate the need for multidisciplinary collaboration and how

1) R. Buchanan, Wicked Problems in Design Thinking, Design Issues, Vol.8, No.2, 1992, p.5.

2) J. M. Utterback, Design-inspired Innovation, World Scientific Publishing Co. Pte. Ltd., 2007, p.63.

3) Ibid., p.154.

the prospective study should be conducted.

2. Convergence and Design Thinking

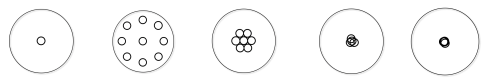
2-1. Types of Disciplinarity

The term "discipline" is defined in hard-copy dictionaries as a branch of knowledge (10 dictionaries), instruction (5), learning (3), teaching (3) or education (2); or a field of study (3) or activity (1).[4]

[Table 1] Definitions on different types of disciplinarity[5]

Types	Definitions
Intradisciplinary	Working within a single discipline
Multidisciplinary	People from different disciplines working together, each drawing on their disciplinary knowledge
Cross-disciplinary	Viewing one discipline from the perspective of another
Interdisciplinary	Integrating knowledge and methods from different disciplines, using a real synthesis of approaches
Transdisciplinary	Creating a unity of intellectual frameworks beyond the disciplinary perspectives

In general, disciplinarity can be categorized in five different types; intradisciplinary, multidisciplinary, cross-disciplinary, interdisciplinary, and transdisciplinary.



[Fig. 1] Visualization on the types of disciplinarity[6]

Intradisciplinary, also known as monodisciplinary is defined as working within a single discipline. Multidisciplinary means people from different disciplines working together, each drawing on their disciplinary knowledge.[7] Cross-disciplinary is a term to express viewing one discipline from the perspective of another.[8] Interdisciplinary is to integrate knowledge and methods from different disciplines, using a real synthesis of approaches. On the other hand, the term transdisciplinary was not clearly found in any of the dictionaries, meaning that it is a relatively new term.[9] Definition of 'trans' is stated as on or to the other side of; across; beyond.[10]

2-2. Difference between Multidisciplinary and Interdisciplinary Approach

Many argue that the difference between 'inter' and 'multi' is largely numerical. 'Multi' means many; more than one. 'Inter' means among; between; mutual, mutually.[11] The term interdisciplinary was found in all three dictionaries of the 1970s.[12] Multidisciplinary team-working does not require all members to perform the same roles, but the role clarification between the members is essential.[13] These two terms are frequently used in healthcare departments or in hospitals where several different medical teams work together to accomplish the same goal. In many preliminary

4) B. C. K. Choi, A. W. P. Pak, Multidisciplinarity, interdisciplinarity and transdisciplinarity in health research, services, education and policy: 1. Definitions, objectives, and evidence of effectiveness, Clin Invest Med, Vol.29, No.6, 2006, p.352.
5) Alexander Refsum Jensenius, Disciplinarities: intra, cross, multi, inter, trans, http://www.arj.no/2012/03/12/disciplinarities-2/, 2012.
6) E. F. Zeigler, Professional Preparation and Discipline Specialization in Canadian PE and Kinesiology. Journal of Physical Education, Recreation & Dance 61, 1990, pp.40-44.
7) Alexander Refsum Jensenius, Op. cit.
8) H. N. Su, I. M. Moaniba, Investigating the dynamics of interdisciplinary evolution in technology developments, Technological Forecasting & Social Change 122, 2017, p.12.
9) B. C. K. Choi, A. W. P. Pak, Op. cit., p.352.
10) Marriam-Webster Online Dictionary, https://www.merriam-webster.com/dictionary/trans.
11) V. Wilson, A. Pirrie, Multidisciplinary Teamworking Indicators of Good Practice, The Scottish Council for Research in Education, 2000, pp.1-2.
12) B. C. K. Choi, A. W. P. Pak, Op. cit., p.352.
13) Ibid.

research, "multidisciplinary team approach" consists of several professionals or individuals who utilize their own skills from their perspectives; while "interdisciplinary team approach" integrates the traits of different disciplines to create a single unified approach.[14] The common factor is that they both include multiple disciplines to achieve a common goal.

2-3. The Importance of Multidisciplinary Collaboration

Based on the previous literature research about the definitions of each terminology, the concept of multidisciplinary is clarified and distinguished from the similar term interdisciplinary. According to the other precedent studies, the advantages and disadvantages of multidisciplinary collaboration are indicated in the table below.[15]

[Table 2] Advantages and Disadvantages of Multidisciplinary Collaboration

Advantage	Disadvantage
Improve communication ability	Frequent conflicts based on miscommunication
Get acquainted with the collaborative process and product development	Confusion and misunderstanding of each other's discipline
Foster collaboration skills	
Positively beneficial for future career development	Time pressure
Different professions complement each other	Different approach regarding the same topic may lead to poor outcome

Multidisciplinary collaboration can improve communication ability with the people from other disciplines. Tang and Hsiao stated this as the most significant advantage of Multidisciplinary Collaboration during their workshop. It automatically forced the team members to communicate clearly as they needed to explain their ideas to people with different backgrounds.

On the other hand, according to the multidisciplinary collaboration workshop results, there were conflicts due to miscommunication and different opinions between designers and engineers.[16]

2-4. Abductive Reasoning and Design Thinking

The concept of multidisciplinary approach is related to abductive reasoning, which an American philosopher Charles Sanders Peirce have originated.[17] Conventional types of reasoning, inductive and deductive, focuses on generalizing or narrowing down existing ideas and choices. However, abductive reasoning is different as it allows people to imagine what could be possible and go for the best inference by testing the hypothesis.[18] It is said that many business schools emphasize inductive thinking and deductive thinking that deals with logic and analysis based on observable facts. On the other hand, design schools encourage abductive thinking that allows the creation of new ideas and challenge the restrictions.

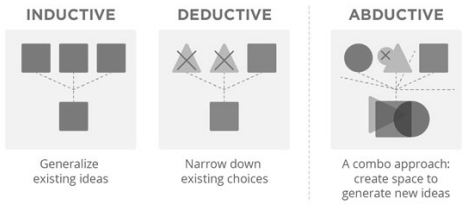
14) R.L. Jessup, Interdisciplinary versus multidisciplinary care teams: do we understand the difference?, Australian Health Review, Vol.31, No.3, 2007, p.330.

15) H.H. Tang, E. Hsiao, The advantages and disadvantages of multidisciplinary collaboration in design education, IASDR: 5th Intl Congress of the Intl Association of Societies of Design Research, 2013, pp.5-9.

16) S. Kim, Multidisciplinary Collaboration and Design Thinking: Understanding the Difference between Designers and Engineers, Master's Thesis, Hongik University, 2016, pp.40-43.

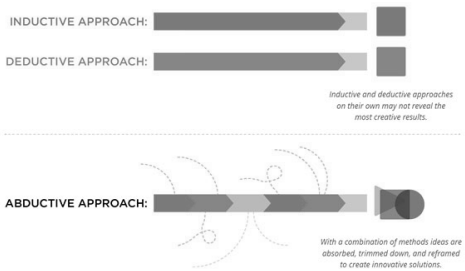
17) R. Curedale, Design Thinking Pocket Guide, Design Community College Inc., 2013, p.11.

18) A.G. Lafley, R. Charan, The Game-Changer: How You Can Drive Revenue and Profit Growth with Innovation, Crown Business, 2008.



[Fig. 2] Defining the inductive, deductive, abductive methods of reasoning[19)]

Abductive reasoning can be the essence of design thinking, which is a creative process based on constructing and synthesizing new possible ideas.[20)] Design thinking process consists of five main phases: empathize, define, ideate, prototype, and test.[21)] The essence of design thinking process lies in the initial stage of empathy by understanding the user and in the prototype stage where experimental iteration takes place. Since it is known that design thinking's core attributes include ambiguity, collaborative, non-judgmental, and open mindset[22)], ideas are not rejected at the initial stage of brainstorming or ideation. This encourages people to think without any constraints and fear that may evoke creative thoughts. More than just a methodology design thinking acts as a cultural way of thinking, which means to evolve a certain company's culture or structure.[23)]



[Fig. 3] Abductive approach can produce innovative solutions[24)]

Through design thinking, many companies have experienced innovation by integrating proven practices not only from design industry but also engineering, arts, social sciences and business sectors. It makes possible to comprehensively solve a complex problem.[25)] With the human-centered design method, design thinking emphasizes the significance of observation and interaction with users to gain feedback regarding a new idea, a product or a service. Design thinking approach requires fast response in prototyping and testing stages to seek for the most effective way of iteration towards new ideas.

3. Multidisciplinary Collaboration Workshop for Innovation

3-1. Workshop Analysis

In 2016, a multidisciplinary collaboration workshop was conducted to understand the different traits of students who are involved in design and engineering field of study. Twenty-four participants were divided into five different teams consisted of four to five members. The teams were grouped according to their academical backgrounds: designer team, engineer team, interdisciplinary team,

19) I. Jokhoi, I. Chalmers, Using Your Logical Powers: Abductive Reasoning for Business Success, User Experience Magazine, Vol.15, No.4, 2015. http://uxpamagazine.org/using-your-logical-powers/ (Credit: Pivot Design Group)
20) C. Aminoff, et al., The Changed Role of Design, Provoke Design Oy/Ltd, 2010, pp.5~6.
21) Hasso Plattner Institute of Design at Stanford, An Introduction to Design Thinking Process Guide, https://dschool.stanford.edu/resources/a-virtual-crash-course-in-design-thinking
22) A. Baeck, P. Gremett, UX Best Practices: How to Achieve More Impact with User Experience, 2011.
23) C. Aminoff, et al., Op. cit., p.6.
24) I. Jokhoi, I. Chalmers, Op. cit.
25) C. Aminoff, et al., Op. cit., p.6.

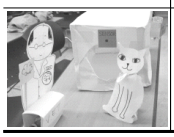
convergence team, and global team. In able to experiment the differences between the two disciplines, design and engineering, all teams were formed in different standards. Also, there was an observer in each team, who did not participate in the project but just objectively observed and recorded the whole process of team-working.

This paper will focus solely on the following three teams for a comparative analysis: designer, engineer, and interdisciplinary team. Interdisciplinary team involved both designers and engineers and it was named hoping that the two disciplines will synthesize the way they work. To clarify, this paper will indicate 'interdisciplinary team' as 'multidisciplinary team'. The workshop was about suggesting a new product or a service associated with a common theme provided at the beginning of the session.

3-2. Characteristics of Designers and Engineers

The workshop revealed critical differences of the teams regarding several aspects during problem-solving process. Following are the main different approaches of the three groups in three large phases during the process.

[Table 3] Problem-solving process and methods of designer, engineer, interdisciplinary teams

Designer team	Engineer team	Multidisciplinary team
1_Initial Phase		
Idea generation by brainstorming and idea sketch _empathy phase	Research for existing technology	Research for existing technology and topic to reframe the problem
		
2_Intermediate Phase		
Research for existing products to validate the idea	Define the idea and seek for technological rationality (I)	Empathy phase for needfinding and ideation (I)
		
3_Final Phase		
Prototype _sketch, physical product	Prototype _physical product	Prototype _sketch, physical product, PowerPoint presentation
		

***(I) represents "Iteration": Several teams went through iteration stage to change idea direction.**

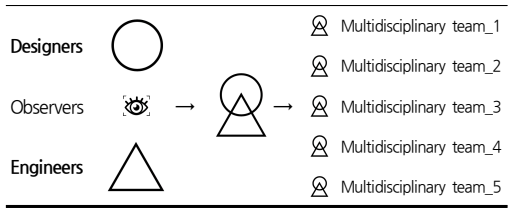
As shown in [Table 3], designer team began with idea generation and brainstorming while the other teams started off by researching existing technology and market. Distinguishable difference of designers and engineers was shown in the intial stage where designers began with imagination and brainstorming ideas as much as possible; while engineers went straight to desk research. In the intermediate phase, Engineer team kept on researching for existing technology; however, changed their idea direction. Although multidisciplinary team also started by researching existing technology and products, they jumped to the next phase of empathizing the users after they have reframed the problem. In the final phase, designers came up with an idea sketch and a series of physical prototypes. Engineer team created just a physical prototype without any idea sketches. Multidisciplinary team showed idea sketches, physical prototype, and also prepared a PowerPoint presentation.

3-3. Reconciliation of the Two Disciplines

A short survey and interview was conducted

after the workshop. Compared to the other teams, multidisciplinary team members had to go through frequent miscommunication and conflicts due to different problem-solving approach, use of common terminologies, and the way they think.[26] According to the observer's report, designers preferred to narrow down their target users and start with idea brainstorming while engineers had doubt on how they can continue to the next step without researching or have knowledge about the technology they will incorporate.

As the workshop was only held for five hours, multidisciplinary team found it difficult to have time for ice-breaking between the members to get together and understand each other first. An effective teamwork is essential in order to successfully achieve a specified common goal. Designers and Engineers who are willing to devote as a multidisciplinary team has to consider that goals are clearly understood by all members and seek for good intra team communication methods. In addition, it is important that all members should have an open-mindset to deal with conflicts due to miscommunication and differences in each other's opinions. Effective distribution of the roles is significant as each member should have different specialties and talents.[27] As such, for a successful multidisciplinary collaboration, it is crucial to share precautions of the characteristics of teamwork throughout the process.



[Fig. 4] Prospective Empirical Research Plan

Based on the findings of the first multidisciplinary collaboration workshop, the next step should be planned to focus on the multidisciplinary teams. The prospective empirical research will be conducted as another one day workshop in order to observe and compare five multidisciplinary teams consisted of the same member ratio of designers and engineers. This experimental workshop will enable us to comparatively analyze the problem-solving process, time spent on each process stage, usage of methods and tools, the moment of conflict and synergy effect, and ideation results.

4. Discussion and Conclusion

The literature study and workshop analysis conducted in this paper are mere initial findings that needs to be further investigated. Prospective study that needs to be followed must provide more case studies about the related topics of multidisciplinary collaboration. Also, the next level of research should review a broader sense of multidisciplinary approach in Korea's Universities that merged design and engineering programs into a design-engineering convergence faculty program. By tracking the change in design institutions and education curriculums, numerous insights regarding the importance of multidisciplinary approach are expected to be found. Along with the society's paradigm shift, convergence between the two disciplines is expected to foster young professionals who will have a wide sense of broader knowledge in both areas of expertise.

26) S. Kim, Op. cit., p.43.
27) D.J. Alberts, A model of multidiscipline teams in knowledge-creating organizations, Team Performance Management, Vol.13, No.5/6, 2007, p.179.

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