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A New Approach for Attaining Admissible and Applicable Output Through A Sustainable and Iterative Design Education Process

Alper Çalgüner[1]
Bülent Ünal[2]
Hatice Merve Demirci[3]
Gizem Bodur[4]

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Abstract

As an interactive project-based problem-solving process, design education entails a sustainable but applicable approach systematically combining a cognitive network's morphological, functional, and conceptual aspects. The framework presented in this study has been designated for ensuring the framework of a specific design education process, demonstrating logic-oriented phases, necessitating an overall scaled association process that consists of a range of alternative ideas sample solutions, and a set of anti-thesis for each case. The operating process portrays a multi-linear flow that should be formulated with a linear structure that could be defined visually by a rounded path to illustrate the comprehensiveness across the timeline along the traditional track through a systematic vision. The framework stated in this study is a compiler guideline aiming to enable provisional circumstances for a specific system structure that effectuate various components due to design education. Besides attaining admissible and applicable student output, it also can pave the way for creative student works in various disciplines basing on studio education.

Keywords: *Design Education, Systematic Thinking, Design Thinking, Design Process, Process Analysis, Creative Decision Making.*

SÜRDÜRÜLEBİLİR VE YİNELEMELİ BİR TASARIM EĞİTİMİ SÜRECİNDE KABUL EDİLEBİLİR VE UYGULANABİLİR ÇIKTILARIN SAĞLANMASINA YÖNELİK YENİ BİR YAKLAŞIM

Öz

Etkileşimli bir tasarı-tabanlı sorun çözme süreci olan tasarım eğitimi, dizgesel olarak bilişsel bir ağyapının morfolojik, işlevsel ve kavramsal yönlerini dizgesel olarak birleştiren sürdürülebilir ve uygulanabilir bir yaklaşımı gerektirir. Bu çalışmada sunulan kavramsal çerçeve, odaklı bir tasarım eğitimi süreci içeriğinin ortaya koyulmasının yanı sıra, bütüncül ölçekli bir birleşim sürecini gerektiren mantık-yöneltimli aşamaların örneklenmesi ve farklı durumlara yönelik olarak uygulanabilecek olan bir dizi antitez önerilmesi amacıyla oluşturulmuştur. İşletim süreci, geleneksel işleyişin dizgesel yaklaşım doğrultusunda görsel ortamda döngüsel olarak betimlenmiş olan zamansal kapsayıcılığını gösteren çok boyutlu doğrusal bir yapı ile tanımlanmıştır. Bu çalışmada sunulan çerçeve önerisi, tasarım eğitiminin çeşitli bileşenlerini etkinleştiren özelleşmiş bir dizge yapısının koşula bağlı durumlarını tanımlayan derleyici bir yönerge ortaya koyma amacını gütmektedir. Bu yönergenin kabul edilebilir ve uygulanabilir öğrenci çıktıları sunabilmesinin yanı sıra, tasarım eğitimini temel alan çeşitli disiplinlerde elde edilebilecek yenilikçi öğrenci çalışmalarının yolunu açacağı öngörülmüştür.

Anahtar Kelimeler: *Tasarım Eğitimi, Dizgesel Düşünme, Tasarım Düşüncesi, Tasarım Süreci, Süreç Çözümlemesi, Yaratıcı Karar Verme.*

[1]*Prof. Dr. Alper Çalgüner, Gazi Üniversitesi, Mimarlık Fakültesi, Endüstriyel Tasarım Bölümü E-posta: acalguner@gazi.edu.tr, ORCID: 0000-0001-7816-9752*
[2]*Doç. Dr. Bülent Ünal, Atılım Üniversitesi, Güzel Sanatlar, Tasarım ve Mimarlık Fakültesi, Endüstriyel Tasarım Bölümü, E-posta: bulent.unal@atilim.edu.tr, ORCID: 0000-0003-1721-7903*
[3]*Arş. Gör. Hatice Merve Demirci, Atılım Üniversitesi, Güzel Sanatlar, Tasarım ve Mimarlık Fakültesi, Endüstriyel Tasarım Bölümü, E-posta: merve.demirci@atilim.edu.tr, ORCID: 0000-0002-0315-5898*
[4]*Gizem Bodur, E-posta: gizemmbodur@gmail.com, ORCID: 0000-0003-2081-4901*

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Introduction

Design education has tracked a pretty consistent path from the beginning of the 20th century. Via various media and design tools, educators try to carry out sustainable design process structures to train design students portrayed as future designers. They also lean to enhance students through a broader scale of designer skills during this process. Along with design courses, the acquisition of intuitive deductions entailing justifiable prescience and an interactive data network, especially ideation and visualization processes, are typically conducted by ostensible analytical methods, somewhat aloof from systematic thinking. This causes quite complicated association and signification modalities. Consequently, this circumstance uproots the guideline by estranging it from its corroboratory modernist essence in a wide variety of design disciplines like industrial, graphic, architectural, or interaction design. With that purpose in mind, design schools need to purify and update the uniquely valuable studio teaching components separately and interact with each other.

Studio-based activities extensively conduct design studio courses to support students' work and enhance interaction through a formulated educative structure based on informal learning that focuses on intuitive comprehension. Students need to represent knowledge externalized by carrying out the right project execution strategy to improve their product development processes. In design education, studio courses are considered the core courses. Studio education is defined as a reflection of Schön's (1984) act, in which design students pursue a design project under the design studio's educators. In other words, the design studio is seen as the focus of design education, and design criticism is considered the primary medium where design students present their progress to discuss and get feedback from educators. Considering the design studio and criticism, the educator-student relationship and the communication between them are essential for educators to convey their design knowledge throughout the studio project critics.

The existing design models used in studio courses are assessed very similarly to design practice. Students, who play a significant role in design education, personalize the project plan presented to them in the design process according to their knowledge and skills and provide an output at the end of the process. The process's personalization is shaped according to the goals and learning motivations that the student is expected to achieve at the end of the process. Still, a student did not have bad experience and process management competence as practitioners have, so there may be problems in the process and output. Furthermore, existing design process-related models in the literature appear to guide students through the process to design the right thing.

However, as design educators, we now see a need for a sequential design model to guide design students to design the thing right. As a result, there is a gap in the design education literature regarding the educational guidelines not being system-based, educator supervised, iterative, sustainable, and interpretable. These criteria involve a flexible structure, receptive to up-to-date terms, trends, or social tendencies. Portrayed occasion refers to the continual theme and context of design thinking. With this aim in mind, in this paper, we aim to cover the common grounds of design education and studio courses in design education. Afterward, we would examine examples of the existing design models applied in studio courses and why it is vital to claim a design model used in design education should be educator-supervised, iterative, sustainable, and interpretable.

Methodical Approach

Most of the researchers define design thinking as a critical activity. However, it is not always clear how design researchers think about design. The role and quality specifications of design thinking have been interrogated through previous research without a framework of a formulation guiding how design thinking could be processed and applied to various briefs. This deficiency has traditionally been overcome by a predominantly holistic approach based on intuitive or sequential thinking. This viewpoint acknowledges well-defined borders of standard design stages and disciplines in interaction with design studio courses.

However, most educational researches do not tend to be functional decomposition and morphology oriented, for this type of orientation necessitates a systematic approach to inclusively handle a directional process that is regar(Wong & Siu, 2012). By a converse approach, some researchers like Brooks Jr (2010), Parnas and Clements (1986) emphasize various disabilities of rational approaches to the design process. These discussions reflect design education as critical drawbacks of using intuitive grasping in unison with systems thinking. However, to keep in mind, system structure avails to entail ease of comprehension and use in every sense. Through this directional process, the educators typically stress an integrationist manner on common qualities concerning industrial outputs or creative monuments during studio courses.

The goal of conducting this review was to provide a summary and synthesis of the previous research on design models and frameworks in design education and implementation attempts that integrated models to facilitate designing. This review included pieces of literature (research studies, case-based studies, conference proceedings, and book chapters) to examine the possible design models that support designing the thing right in design studio course education settings. The reviewed literature was included if they met the following selection criteria:

- The reviewed literature has generally discussed student-centered design models that support sustainable and iterative results in design education.

- This review focused on implementing design models in design education, and literature that investigated/discussed design models in other design research areas were excluded.

- The results presented in a study or a literature work do not overlap with

- The reviewed literature included papers published before 2020 and written in English.

Literature that did not meet the selection criteria was excluded. The book chapters that discuss the roots of design models and frameworks were included even though the publication date was not within the review period.

This review was conducted using a systematic search of the online libraries and databases such as Elsevier, Web of Science database, Taylor & Francis Group, Google Scholar, Science Direct, and Wily Online Library. We used the various search terms and keywords such as ("design models" and "design education"), ("focus of improvement), ("design models" and "professional / practitioner"), ("design models" and "orientation focus"), ("design models" and "tools used"), ("design models" and "systems content"), ("output specifications on design students") ("steps of defining product ideas") and ("design thinking phases"). We used the selection above criteria for the articles and published works referenced in this review since the trends and direction of the design models and framework research is focused mainly on providing "designing pathways feature" to support students' learning engagements. Each article was examined and included if it demonstrated a sufficient description, theory, or empirical evidence of the effectiveness of each design model that supports sustainable and iterative implementation in design education.

Data Processing and Signification

In these instances, the interactive data network is extensively composed of enclosed operators that also act as components of a system. However, this structure cannot be defined as a system originated by fissionable units comprising sub-components. The structure needs clustering and positioning/classification of the components. The multi-dimensional flow of this structure's components interaction serves the opportunity for attaining admissible and applicable outputs through a sustainable and iterative design process. It could be transformed into perceivable, producible, accessible, or useable products by conducting crosswise interrogations through the student's cognitive network. This would possibly ensure a wide intellectual scale for generating solution alternatives and a range of anti-theses that are expected to pave the way for self-control, which appears to be necessary for the proposed guideline.

Keeping the fundamental focus of attaining the stated output, this guideline would trigger a higher rate of creative output by providing opportunities for generating alternative stimuli. In this sense, decomposing each network unit analytically would serve the opportunity to recompose the specific design criteria in a broader scale of idea production for a higher possibility of creative output as a side effect.

In this reflective mode, systematic design thinking offers ways to examine the productivity of developing theories and practices through a systemic formulation by intuitive thinking, which plays a critical role in attaining predictable creativity. Therefore, systematic design thinking would also provide options to distinguish between specific design methods and principles as they involve varying focuses (human-centered or technology-oriented, product-centric, or product-oriented) that can be positioned on a chart to determine the components and modes of association to be analysed. The qualified data situated in Table 1 are processed to be components of a future guideline constructed upon systematic analytical thinking.

The guideline requires specific literary terms that are given with the stated contexts below:

Analysis: A process basing upon decomposition of components for processing them individually or interactively towards an aim of recomposing an integrated design in the light of a justified future foresight. Positioning and accommodating the valid components in an interactive network can be conducted by defining taxonomic models of approach or generic titles that would qualitatively fertilize the examination.

Component: Every stylistic/structural, functional, or conceptual factor decomposed, positioned, and correlated in an interactive network to be processed, either individually or as classified.

Design thinking: Specialized skill of a designer based on a versatile pattern, aiming to define a human need-oriented problem and transform it into a functional design solution, in the light of a justified future foresight attained by systematic and intuitive comprehension.

Intuitive thinking: A holistic thinking approach for comprehending the instantaneous reality without abiding by any systematic treatment. This activity's output generally embodies novelty but not any reasoning or supportive evidence.

Justifiable prescience: A future foresight generated with measurable, verifiable, and defended scientific data.

Multi-dimensional cognitive network: The holistic base of an analytic process has connections with other networks and harbors qualified components and their defined interactive coordination mode.

Predictable creative output: Novel and valuable output that is significantly independent of a random ideational production process also can increase the possibility of continuous innovativeness.

Prototyping: A prudential process where the whole scenario fiction is discussed in the light of justifiable future prescience. Prototyping entails an interrogative poof checking involving potential slips or setbacks that could threaten the application field's operational process.

Sequential thinking: A linear thinking process having its defined order having a chained structure, not exposing a prerequisite correlation between the chains. A chain's response triggers the next chain by maintaining a progressive process.

System: A set of correlated components constituting a whole body, identifying and adapting its boundaries, order, and modes of interaction with its environment. A system exposes a chained formulation towards a defined objective, where each prerequisite ring of the chain is derived from the previous by involving and surpassing it at the same time.

Systematic thinking: Thinking through a systemic formulation with analytical proposals that have not complemented themselves and analytical concepts that have not exposed themselves. Causality proves the process, and concepts prove themselves and each other in systematic thinking.

Systematic design thinking: A conceptual way of systematic thinking using scientific data ensures a derivation or a reduction process through the production or productization of a vision.

Studio Courses: Design studio courses are considered the center of design education to support design students' product development process. These courses are supported by studio-based activities such as desk benchmarks to support students' work and enhance the design studio environment. The table critics structured in the design studio, where design students present their progress and discuss with instructors for feedback, are crucial to improving product development and learning processes.

Context and Principles

In design projects, the process is performed by benefiting the knowledge from different backgrounds. These backgrounds should be in a sequential order to expose a consistent flow. In order to accomplish this, in Table 1, references are given under the step-by-step formulated sequential design processes. In the table, the information is coded in two steps. First, the coded data is compared statistically with the proposed output. Then, in the second step, the associated data is interpreted in light of the stated framework principles. Thus, the associated data is filtered by the following generic titles: Focus of Improvement, Focus of Orientation, Tools Used, Systems Content, Output Specifications on Design Students, Steps of Defining Product Ideas, and Design Thinking Phases (Table 1). These generic titles were discussed through the comparative interpretation of Table 2 contexts. (The authors defined the generic titles used for filtering.)

The six generic titles, except Design Thinking phases, and their familiar contexts are also the determining components that are consciously included in or excluded from the framework network. The underlying reason for this configuration is comparatively testing the determination criteria of the framework principles composed using the interactive association between those components.

Evaluating the focuses of improvement, each selected reference has its qualitative focus of improvement concerning the design studio course process's specific aspects. Contrary to traditional design processes, the framework proposes focusing on a holistic and progressive comprehension of the system network instead of improving each component or aspect.

The founding principle of the framework necessitates removing any hierarchical sequences of aspects. Therefore, it would be unfeasible to define the educator, student, researcher, or practitioner aspects in strict order of decisiveness. However, the framework approach stipulates the educator's flexible guidance in compliance with the stakeholders' (educator, student, researcher, and practitioner) competencies through the whole process. Different stakeholders involved in the design process may also benefit from the framework, unlike our references in Table 2. Educators and students can benefit from the framework during their design studio courses. If an educator concurrently acts as a researcher, s/he may also benefit from the framework as a sustainable and iterative process in her/his research.

The principles defined through the framework context arise utterly independent from any tools that directly or indirectly concerning design activity. However, the guideline enables adaptation of the operating process to any design tool usage. By associating the functions of various tools in design practice with the interactive components of the network of the framework, it would be possible to specialize the guideline through a flexible exposition, considering each case's peculiar circumstances or opportunities.

The framework is structured on a network modeled as a systematic representation of an interactive design education procedure. While this approach necessitated a purposive chained structure, considering the stated theoretical background and some of the problems associated with the systematic design model and showed that most of them stem from the sequential nature of the process that Kroll, Condoor, and Jansson (2001) have emphasized, the formulated framework context principally excludes sequential or cyclic processes. However, its operational process can be visually defined by a linear progression to expose the arrangement of the specified phases or by a rounded scheme to indicate its comprehensiveness. Intuitive processes are entirely covered as system components that would act as keys to open the planned exits for various shortcuts or probable creative outputs.

Focused Literature Review

It is formulated on a self-evaluative operating model. The framework necessitates an overall scaled association process that consists of a range of alternative ideas, sample solutions, and a set of anti-theses for each case. The interactive data flow on the network emphasizes the guideline's analytic interrogative character.

The framework is also generated and effectuated independent from the extensively approved phases of the design thinking process. However, its practical execution is predicted to be also analysed through the guidance of those phases in the future. For indicating the significance of design thinking data, which would be imported components of the network of the framework during practice, design thinking phases are accommodated for facilitating a probable comparative discussion in Table 1.

Focus of Improvement **[1]**	*Orientation Focus* **[2]**	*Tools Used* **[3]**	*Systems Content* **[4]**	*Output Specifications on Design Students* **[5]**	*Steps of Defining Product Ideas* **[6]**	*Design Thinking Phases* **[7]**
Design Process & Management **[1.1]** *Product Quality* **[1.2]** *Designer Skills* **[1.3]** *Data Management* **[1.4]** *Process Management* **[1.5]**	*Educator* **[2.1]** *Student* **[2.2]** *Researcher* **[2.3]** *Professional/ Practioner* **[2.4]** *Human-centered or technology-oriented* **[2.5]** *Product-centric / product-oriented* **[2.6]**	*Hardware Tools (HwT)* **[3.1]** *Software Tools (SwT)* **[3.2]** *Theoretical Tools (TT)* **[3.3]** *User Journey Mapping* **[3.3.1]** *Socratic Dialogue* **[3.3.2]** *Service Safari* **[3.3.3]** *Heuristic Tool* **[3.4]**	*Systematic Process (SP)* **[4.1]** *Sequential Process (SqP)* **[4.2]** *Intuitive Process (IP)* **[4.3]** *Cyclic Process (CP)* **[4.4]**	*Predictable Outcomes* **[5.1]** *Creative Outcomes* **[5.2]** *Iterative Outcomes* **[5.3]** *Invariable Outcomes* **[5.4]** *Inspirational Outcomes (for non-designers)* **[5.5]** *Intuitive Outcomes* **[5.6]**	*Counterargument / Antithesis generation* **[6.1]** *Associating the idea with components of an intellectual network* **[6.2]** *Crosschecking the output with the feedback data after designing* **[6.3]**	*Empathize* **[7.1]** *Define* **[7.2]** *Ideate* **[7.3]** *Prototype* **[7.4]** *Test* **[7.5]**

Table 1 Used Data Filters

Double Diamond and Iceberg Models in Table 2 are widely used by non-designers. These two models guide non-designers via theoretical and heuristic tools to manage the process sequentially, focusing on educators, researchers, and students.

In proposed different design processes in Table 2, externalized knowledge gathered from multidisciplinary research settings is used to guide educators to structure the design project processes and steps. These structured processes are formalized to enhance different designer skills.

	Focus of Improvement [1]	***Orientation Focus [2]***	***Tools Used [3]***	***Systems Content [4]***	***Output Specifications on Design Students [5]***	***Steps of Defining Product Ideas [6]***	***Design Thinking Phases [7]***
DOUBLE DIAMOND MODEL *(Almrott et al. 2020; Torkkeli and Lallimo 2019; Council D. 2011)*	*[1.1]* *[1.5]*	*[2.1]* *[2.2]* *[2.3]*	*[3.3]* *User Journey Mapping [3.3.1]* *Socratic Dialogue [3.3.2]* *Service Safari [3.3.3]* *[3.4]*	*[4.2]*	*[5.1]* *[5.3]*	*[6.3]*	*[7.1]* *[7.2]* *[7.3]* *[7.4]* *[7.5]*
The Design Process *(Aspelund 2014)*	*[1.1]* *[1.5]*	*[2.1]* *[2.3]*		*[4.2]*	*[5.3]*	*[6.2]*	
Systematic Approach by *(Beitz, Pahl and Grote 1996; Council D. 2015; Council D. 2007; Irbite and Strode 2016)*	*[1.1]* *[1.4]* *[1.5]*	*[2.1]* *[2.2]* *[2.4]*	*[3.3]*	*[4.1]* *[4.2]*	*[5.1]* *[5.3]*	*[6.2]*	
ICEBERG MODEL the problem of pattern scoping for international learning environments. *(Lotz et al. 2014)*	*[1.1]* *[1.4]*	*[2.2]*	*[3.3]* *Pattern Development Process Model [3.3.1]*	*[4.1]* *[4.4]*	*[5.5]*	*[6.2]*	*[7.2]* *[7.3]*
Product Development Process Model *(Ulrich and Eppinger 2012; Reinikainen and Björklund 2008)*	*[1.1]* *[1.2]*	*[2.1]* *[2.2]* *[2.6]*	*[3.3]* *PD6 as a non-linear idea generation and evaluation method [3.3.1]*	*[4.2]* *[4.3]* *[4.4]*	*[5.1]* *[5.2]*	*[6.1]* *[6.2]* *[6.3]*	*[7.1]* *[7.2]* *[7.3]* *[7.4]*
Three Dimensions Of Reflective Thinking In Solving Design Problems: A Conceptual Model *(Hong and Choi 2011)*	*[1.3]* *[1.4]*	*[2.1]* *[2.4]* *[2.5]*	*[3.3]*	*[4.1]*	*[5.5]* *[5.6]*	*[6.2]*	*[7.1]* *[7.2]*
The proposed framework	*[1.1]* *[1.2]* *[1.3]* *[1.4]*	*[2.1]* *[2.2]* *[2.3]*		*[4.1]*	*[5.1]* *[5.2]* *[5.3]* *[5.6]*	*[6.1]* *[6.2]* *[6.3]*	*[7.1]* *[7.2]* *[7.3]* *[7.4]* *[7.5]*

Table 2 Questioned Design Models and Processes

Design Council's Double Diamond conveys a design process to designers and non-designers alike. The two diamonds represent a process of exploring an issue more widely or deeply (divergent thinking) and then taking focused action (convergent thinking) (Council D., 2011). In different case studies, this model was used to manage the design process, addressed to educators and researchers. Thus, the researchers stated which information-gathering methods were used in the design phases using this model, and they recommended their outputs be iteratively furthered (Almrott et al., 2020; Torkkeli & Lallimo, 2019).

Systematic design of a new product concept has been dealt with and was contributed to by quite a few researchers. A comprehensive method that is in use for some time has been described in Beitz, Pahl, and Grote (1996). The prescriptive Pahl and Beitz's Systematic Approach is based on four major design stages; "Clarification of the Task, Conceptual Design, Embodiment Design, and Detail Design."

The Iceberg Model is based on the revelation of the ignored information to final impacts throughout the workflow. Beyond the standard stages of the traditional product design development process, the students' inventive and analytical processes qualitatively affect the product outputs. Design students manage the design process during studio courses and systematically collect data as in the Iceberg Model. This model is operated by a systematic and cyclic student-focused process (Lotz et al., 2014). Furthermore, this model aims to bring together the old and new knowledge by building an interactive cognitive network structure.

The traditional product design process embraces a sequential and iterative method. Consequently, every design process stage is expected to connect the gathered knowledge. In the linear design process model, steps are not connected (Ulrich & Eppinger, 2002). In Product Development Process Model, admissible and creative product outputs are exposed by connections formed intuitively between the stages of the product design process (Reinikainen & Björklund, 2008). The relationship between steps of this process enables the control and re-evaluation of feedbacks.

Management and analysis of the information procured by studio education affect the construction of the design process. 'Three Dimensions of Reflective Thinking in Solving Design Problems: A Conceptual Model' proposes a systematic design process that the educators and design students could use as a problem-solving method (Hong & Choi, 2011). The product outcomes are expected to be Inspirational (for non-product designers) and Intuitive by a reflective educational approach based on design thinking.

Surveying the literature review through Table 2, the field of study was divided into research areas and filtered with six main titles and subtitles. The authors examined the efficiency levels of the filters. Depending on the contents and iteration levels of the filters, their appearance in the framework process is shown in six matrixes (Table 3).

Matrix 1	Focus of Improvement				
	Design Process & Management	Product Quality	Designer Skills	Data Management	Process Management
ITERATION LEVEL IN THE REVIEWED LITERATURE					
	▒				
	▒			▒	▒
	▒			▒	▒
	▒	▒	▒	▒	▒
APPEARANCE IN SIDEG	✓	✓	✓	✓	✓

Matrix 2	Orientation Focus					
	Educator	Student	Researcher	Professional/ Practioner	Human-centered or technology-oriented	Product-centric / product-oriented
ITERATION LEVEL IN THE REVIEWED LITERATURE						
APPEARANCE IN SIDEG	✓	✓	✓	✗	✗	✗

Matrix 3	Tools Used			
	Hardware Tools	Software Tools	Theoretical Tools	Heuristic Tool
ITERATION LEVEL IN THE REVIEWED LITERATURE				
APPEARANCE IN SIDEG	✗	✗	✗	✗

Matrix 4	Systems Content			
	Systematic Process	Sequential Process	Intuitive Process	Cyclic Process
ITERATION LEVEL IN THE REVIEWED LITERATURE				
APPEARANCE IN SIDEG	✓	✗	✗	✗

Matrix 5	Output Specifications on Design Students					
	Predictable Outcomes	Creative Outcomes	Iterative Outcomes	Invariable Outcomes	Inspirational Outcomes	Intuitive Outcomes
ITERATION LEVEL IN THE REVIEWED LITERATURE						
APPEARANCE IN SIDEG	✓	✓	✓	✗	✗	✓

Matrix 6	Steps of Defining Product Ideas		
	Counterargument / Antithesis generation	Associating the idea with components of an intellectual network	Crosschecking the output with the feedback data after designing
ITERATION LEVEL IN THE REVIEWED LITERATURE			
APPEARANCE IN SIDEG	✓	✓	✓

Table 3 Crosstabs for Literature Findings and the framework

"Methods are an integral element of the design process, enabling designers to structure the development process of a product. The most successful concept generation methods are deliberate thinking processes designed to help designers find the inspiration to build upon their research and produce new ideas and fresh insights." (Rodgers & Milton, 2011, pp.95). Moreover, "prior experiences can serve as sources of inspiration" (Eckert & Stacey, 1998, pp.11). From our viewpoint, this priority can be attributed to a hierarchical settlement, a compositive component of primary design education. Designers, in general, exhibit complicated comprehension, identification, and expression qualities throughout the design process. Keeping together these qualifications, we aim to compose basic principles of a guideline for a method that would guide design educators and researchers in operating a productive educational process that ensures predictable and estimable creative outputs.

Through the scope of the research, we have based on systematic thinking structure and procedure to set up the basis of the guideline. Salama (2005, pp.25) indicates the role of information analysis as "Instruction occurs through facilitating the processes of exploration, acquiring and analyzing information, personalizing the program, and developing design imperatives." As a principal reflection of the modernist age, analysing process superimposed on a deconstructivist approach has oriented design education theories through sequential thinking from the beginning of the 20th century. This tendency has induced a quite linear treatment by focusing on a holistic apprehension while overlooking the multi-dimensional cognitive network that the interactive transmission amongst its components should act as the primary source for multi-directional optimization. In this manner, "if we further accept the fact that the canonical, linear, causal, and instrumental model is no longer adequate to describe the complexity of the design process, we are invited to adopt a new model whose theoretical framework is inspired by systems science, complexity theory, and practical philosophy" (Findeli, 2001, pp.16). Considering its chaining structure is composed of correlated rings that each one is derived from and involves the previous through a definite objective, a systematic approach appears as a proper one for constructing an educational model in product design studio courses. Attaching importance to predictable creative student outputs, "structuring the teaching in the studio in a series of activities and events that require specific tasks would lead to design experiences that successfully integrate systematic design thinking while at the same time not compromising the formal qualities of the students' final designs." (Salama, 2005, pp. 29).

Processing Phases of the Framework

Undercover the compilations and inferences above, it would be reasonable to state the consistent route that design education under the sway of design thinking has been tracking over a century in two main phases: The constant final aim of providing creative outputs and insistence on denying the exclusion of intuitive thinking through a quasi-formulated educative process. Unswervingly engaged to linear but holistic inductive approach, the process substantially has doomed to a mentor system that more or less has to have diverged with the academic treatment of the modernist age. So that, expectedly, educative processes concerning design discipline extensively tumbled into a doctrinally applicable but theoretically indescribable process, blocking many researchers' effort on quantifying the productivity of educative output. Adopting an analytical approach to a process conducted by equable dominancy of sequential and intuitive treatment principles would pave the way for the target outcome of this research, which is to define an outline guiding the construction of a system-based educative model focused on design activity.

As a conceptual essence of modernist philosophy, analysis can be attributed to subphases that are relevant for being classified by various means. The stated subphases of the guideline are classified and prepared to be identified in correlation with each other in a systematized structure.

Decomposing the components: The decomposition process is designed to be performed through a qualitative classification procedure. Components to be decomposed are identified under titles based on Tang and Gero's specification (2002), putting forward four aspects: Physical, functional, conceptual, and perceptual levels. These aspects are rearranged considering the research aims focusing on predictable creative output and emphasizing specialized stages of the analysis process. Dealing with these aspects focusing on educator–student communication, we have considered a potential problem from the students' viewpoint on identifying and processing the sensitive components concerning both the user and the producer. Consequently, eliminating perceptual resolution, we have settled to perform the classification process upon three titles: 'Stylistic / structural' for expediting the decomposition of physical components, besides 'functional' and 'conceptual' components.

Updating and enriching the utile components towards substantiated scenarios involving justifiable prescience: Update and enrichment operations are conducted in the light of a reasonable future foresight. Being filtered through the resolution levels, components discovered to be proper for the stated projection are retained, whereas uncertain components are redesigned, and the functionless are eliminated. This subphase makes sense primarily by the setup of a cognitive network through the settled components. What makes the fundamental sense is the innovative denotation produced by the interactive information flow, more than the qualification and positioning of individual components.

Classifying the output and generating pre notions: The descriptive distinction of Howard-Jones and Murray (2003) between the traditional consideration of critical analytical thinking basing sharply focused attention, and the thinking process superimposing on defocusing or broadening of attention, notably corresponds to this classificatory stage. Qualificative classification criteria withhold the prior significance in this subphase. Various paths or potential connections within the cognitive network enable specialized cognitive channels of imagining and idea production, paving the way for discussing optional solutions for common problematics. A specific taxonomic approach may be clarified as maintaining a wide range of association probability to keep up the possibility of attaining creative prenotions.

Identifying product ideas: Transformation of prenotions into admissible and applicable product ideas will be discussed in the proposed scheme, initiated by making sense through correlating conceptual components and proceeding by the concept visualization phase that can be identified with the visual scenario building process.

Associating product ideas with historical, environmental, and identical determinants: The relativistic structure between product ideas and the determinants that are in interaction with them has a decisive role in the innovativeness quality of the output—considering the fixation that "human understanding of not just the relationship between documents in a collection, but the "reasons" for the hypothesized relationships" (Chan et al., 2018), every specific hypothesized relationship defined in between, is predicted to act as a potential to trigger a creative quest.

Process Chart of the Framework

Once, Goldschmidt (1997) has stated that in design problem-solving, solutions are seldom predictable; continuing as this turns designing into an indeterministic process which is challenging to model and even more difficult to prescribe. As we question this reliable assignation via actual discourses and circumstances, the self-identity of this study appears around the discussions induced by the aim of composing the guideline of a model that would ensure an opportunity for attaining admissible and applicable output through a sustainable and iterative design process. Thus, a higher-rated sustainable sequence of computable and predictable creative ideas is produced by product design students. The utmost systemic treatment by analytic subprocesses generally harbors a pretty massive gap among the initialization of creative ideas obtained by a holistic, inductive approach. Herein, the critical question occurs for filling the gap: "How can these two dominant processive qualifications be engaged consistently to formulate a model that would provide creative output with a systematic structure composed of defined stages and subphases?" We have found the expediency to answer this question by defining the framework for a systematic operation model that does not contain any linear or prerequisite components and can support a wide variety of visualized prenotions and product ideas. Defining the outline for the model, we anticipate the domestication of intuitive components for the sake of predictable and sustainable creative output.

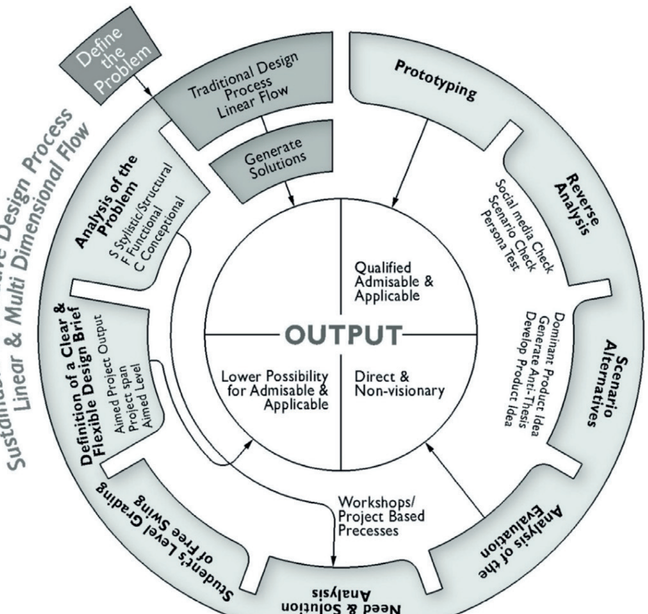

Figure 1 Process Chart of the Framework

The operating process portrays a multi-linear flow that should be formulated with a linear structure, whereas to illustrate the comprehensiveness across the timeline along the traditional track through a systematic vision, it is defined by a rounded path in Figure 1. A critical point of view here is the adaptation intuitive thinking aspect to a systematic operational flow as a component of the cognitive network. We concentrate on designating the structure and operation principles of the model guideline by composing a specific scheme by this stage.

According to the scheme context, the design process starts with a design brief. An adequately defined design brief appears as an initial condition for the constitution of a conceptual flow that would shade off into a scenario. Definition of a clear and flexible design brief entails defining project output aims in the light of requirements and expectations. Also, a timetable exposing the planning about project span and a determined existing and aimed level should be settled in this phase. The student's level of free swing is clarified by three-level grades according to the proposed framework, by a rough handle:

1st level: A clear product category by a defined generic identification: Market information, consumer awareness level, cost range, or even scenario format of a defined product is given by the brief content.

2nd level: A generic product category with an open-ended conceptual framework: The categorical name of the product is given, whereas commercial or productional information is resigned to the student's association, justification, and resolving capacity.

3rd level: A generic needs analysis, paving the way for novel solution processes: The student is expected to define the name, category, target market, cost range, and production details, as well as sales, distribution, and after-sales processes.

These three-level grades facilitate using decisive criteria concerning the instructors' way of setting the conducted design process up to convey the brief. The instructor would have the opportunity to adapt these grades according to the course context or the procedural stages of the project. Leaving the proposed design flow may cause a lowered possibility for achieving admissible and applicable output.

A critical factor through the analytic approach appears as the definition and correlation of the solution components. To compose expressive links through the association of concepts in the network, environmental, historical, and identical components must be identified, classified, and positioned for being related to categorical product components. This phase helps the students to find design solutions to the next phase. The same point enables a higher creativity rate, whereas lower possibility for admissible and applicable product ideas, which is the primary aim of the framework.

Considering that design practice is defining a design problem and fulfilling it with an embodied vision, students are expected to associate/relate the concepts, keywords at the beginning and then generate new design ideas. Accordingly, the design process continues with the student's interpretation of a conceptual flow by associating the decomposed components in the interactive network they have designated. Tracking this treatment, the conceptual flow of the student is expected to be multi-dimensional. In contrast, the flow of visual expression should follow up a recognizable and traceable path in compliance with the framework.

Designers should conceptualize, select, test, and revise their ideas for tentative solutions to better understand the problem, supporting realizing an innovative solution (Hutchinson & Tracey, 2015). Thus, the students should transfer the intangible to the tangible stage of the design process with the cause-effect relationships between the concepts/narratives. This transition partially enlightens the conflict on transforming an ideation flow into a down-to-earth product idea. To emphasize, this malfunction of the transition process appears to be a principal deficiency of the conventional design process. Thus, the design approaches that will differentiate students in their design careers usually begin to take shape at this stage. The framework proposes an interactive cognitive network generated by the students, requiring a target-oriented connection modality, directing the student towards a substantiated elimination process by focusing on a coherent idea flow. This self-elimination stage produces theses and anti-theses before starting to transfer their conceptual ideas into their visual outputs. With this self-elimination, students discuss the strengths and weaknesses of the alternative design ideas they put forward. Adding this elimination process in the existing design process may increase the quality of the final product and indirectly the juries' quality in evaluation.

In this thesis-antithesis process, students can test their ideas using various methods. They may question whether their ideas are cliché or exaggerated. They can also examine and analyze offered problem solutions and how that product has developed and evolved historically. This comparative analysis is planned to facilitate the student to correlate the product with stylistic/structural, functional and conceptual historical, environmental and identical determinants. As a result of this examination and analysis, students could critically review and evaluate their design ideas under different headings such as 'preferred materials,' 'production methods,' or 'user-product interaction.' After eliminating the students' alternative ideas with different methods, they should start designing the final product using their interchangeable design skills. In other words, at this stage, students should start to check the suitability of their suggested ideas with different scenario fictions, such as product installation scenarios, product usage scenarios.

It is essential to encourage students to use their interchangeable design skills while creating scenario fiction and finalizing design decisions. Using these skills together accordingly through a defined target in the current design process is ignored chiefly in design projects by students. However, there might be a need to switch from modeling to freehand drawing for a project to improve. As a result of these design skills' interchangeable use, students get closer to finalize their design idea by using different presentation techniques. While getting closer to finalize the design ideas, the students must crosscheck the recommended material, colour, and production methods. Since this stage is the last stage before prototype production, it is necessary to clarify the design decisions' harmony and applicability.

The prototyping process in this model outline has decisive but also a certain extent, unusual semantic context. The framework covers prototyping as a prudential process where the whole scenario fiction is discussed in the light of justifiable future prescience. This phase entails an interrogative poof checking involving potential slips or setbacks. All the phases are emphasized as to be completed by visually composed outputs to be evaluated. The final evaluation jury is a symbolic field of the contest to observe the deficiencies and inadequacies. Students should apply the appropriate improvements proposed for their projects after the final jury.

Students who cannot complete a phase through the guideline may prefer to leave the framework chart or keep handling the same phase due to self-evaluation. There are several exits of the framework that could be used by the educator's guidance or by the self-moderation of the student.

The first exit is fixed to position before the definition of the design brief, which would pave the way for entirely coincidental creative outcomes that are much risky and less probable to provide admissibility or applicability. Positioned at the same point, a shortcut appears connecting to the need and solution analysis phases. This transition could be possible by workshops or project-based processes. An exit can be activated after the definition of the design brief, which would possibly induce a lower possibility for admissible and applicable product ideas. The phase of defining the problem establishes a ground for an exit to the traditional operative process, causing a predictable creativity rate, just as the exit is positioned after illustrating scenario alternatives. There are also two exits defined at the endpoints of explaining the problem and reverse analysis phases. The first possibly end with direct but possibly non-visionary outputs because of a restricted scale of associative components, and the second refers to non-sustainable processes.

Constitutive Discussions and Inferences Referring to the Framework

The proposed framework is a compiler guideline that enables provisional circumstances for a specific system structure that effectuate sequential or cyclic, intuitive, and holistic components due to design education. In this way, predictable possibilities are provided due to the attainment of admissible and applicable student output. Besides, it has the potential to pave the way for creative student works as a side effect. Considering the accumulations and resources of traditional design education approaches, it proposes a flexible procedural treatment formulation with specific interpretable exits or shortcuts. Design education approaches, in general, refers to an operational model based on the practical implementation of theoretical information forming a collective media that is called design studio courses.

Design studio courses are usually structured over a collective set of interrelating components. Covering this set as a system's network would very likely facilitate the use of an expansive universe of activation through design practice or research. While having the potential for being adapted to various educational doctrines, the framework keeps a unique opportunity for the educator to decompose the interrelating components of experimental processes. This circumstance would expectedly render a studio course to evolve into a contextually interpretable and iterative formulation. In other words, this structure is planned to guide the formulation of an enhanced design process interaction map for the educator, improving the process recurrently by catalysing focused usage of various advantages.

As a unique systematic guideline constituted by a structural base of conventional design thinking components, the framework submits a purposive usage of specified focuses, steps, stakeholders, or tools through a goal-directed design process. By denying sequential hierarchies or indissoluble prejudices, this guideline refers to a close interaction between alternative acceptable discourses or guidelines concerning design education.

The framework composes a qualifiable base for design educators, students, and researchers in various aspects while ensuring our statement that invariability comes from an internal precondition of the systemic process. Inspirational outcomes of non-designers have to be interpreted in the light of external experiences, just as intuitive outcomes of designers.

The process chart of the framework is designed to be adapted to every design studio–based process that is receptive to independent interrogation via applied research. As a preferential claim, this would require an adaptation practice for using the framework as a tool for specific educative processes of various studio-based design disciplines. This course is proposed to be conducted by covering the chart as an interactive network. Each base component can be modeled as interchangeable design aspects regarding specified focus literature, referred to as various disciplines basing on studio education.

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