

## Developing Design Methodology Practices for industrial design ' Students

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### Abstract:

This paper describes a new design methodology that depends on merging between method mind mapping for solving the design problem, and an alternative table (morphological table) as a method to develop ideas and to help students in forming and composing different design factors to achieve design creativity. The researcher tends to use Analytical descriptive to reach the suggested method of developing ideas through a deep study of various design methods to reach an effective and easy method, and then ascertain the extent of its effectiveness by experimenting with it practically. The researcher tries this model on about two hundred students for consecutive three studying years by working in a faculty of Applied Arts Beni-Suef University - Egypt. The researcher depends on constant distance between points to measure variables easily. This trial shows up Great results in the ability of students to reaching creative and innovative solutions and designs easily and simply that proved the success and effectiveness of the proposed methodology. The design process that has been used by students consists of three main stages as which is called "hierarchical design" which starts after the problem identification stage. When the researcher Measuring student results over three years through the main assessment criteria which represented in innovation; Shape Balance; Creativity and Aesthetic aspects, he ascertains the effectiveness of the proposed method and achievement of the main objective of the research which represented reaching an easy and simple way that helps students to achieve designs creativity with less time and effort.

### Keywords:

Mind Mapping,  
Morphological Analysis,  
Product Design, Design  
Process

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### INTRODUCTION

Many instructors and educational institutes are searches for how to help students in developing their designs simply by reducing design stages process forms to achieve design creativity. thus, The main essence in the educational process in products' design academies is the design process itself which includes a group of successive stages in which the designer moves according to definite steps starting with the understanding stage which about gathering information of the design to define and solve the main problem and how to solve it, Also depend on understanding challenges and problems where it can facilitate developing appropriate solutions. Although there are many trials to develop design progress stages to overcome different problems facing students within academic institutes there is no The final methodology can solve problems innovatively. Therefore, the main problem of the research is how to arrive at a simplified design method that enables students to reach innovative solutions to various design problems. To reach a design method that achieves the proposed object in

the research, the researcher relies on an analytical descriptive method by studying many different design methods to have a method that enables students in achieving innovation in their various designs. Therefore, searching for a design method capable of raising the level of creativity in design is one of the important issues that academic instructors and educational institutes are interested in.

After reaching the desirable method, the researcher experimented it with students of the first year over three consecutive years with monitoring and analyzing the results of the experiment every year and trying to update and develop it and confirm its various results by setting a set of fixed standards For measurement, the researcher also uses an electronic questionnaire to participate in the evaluation process to ensure the final results of the proposed design process. Recently, paying attention to innovation became an indispensable necessity in all life fields as innovators play a great role in changing history and reforming the present universe. Countries usually compete in innovation by encouraging

those who are interested in directing educational institutes to enhance students' innovation and creativity levels in all fields especially the industrial design field as it affects society's progress. A good design that serves society's needs can't be achieved without creativity and innovation. Looking at the concept of creativity as it is a complicated process of a mixture of mental processes which aims at developing ideas and turning them into facts, so there are many attempts to give a full definition of creativity to describe it as following: The English Encyclopedia defined creativity as "The ability to find a problem solution, a new tool, an artificial print or a new methodology" [Khairy, 2012]. Hence, innovation can be defined as everything that leads to improvement and development by activating new ideas and methodologies using innovative ways to improve a product or a service. Thus, the thinking process should be organized where creativity and innovation processes should be related to the student's analytical skills and knowledge to encourage him\her to be creative. In the academic field, especially the products' design branch, educational institutes, and their instructors seek to find new methodologies that help students to innovate, design, and develop their abilities to extrapolate new ideas to help them in solving problems easily and simply. The main essence in the educational process within products' design academies is the design process which includes a group of successive stages as shown in figure (1) in which the designer moves according to definite steps starting by understanding stage which inquires gathering main information about the design to define the main problem which will be solved using the design.



Figure 1 The design process

Source: <https://discoverdesign.org/handbook>  
 Kokotovich said that a core responsibility of industrial design educators is to develop the

thought processes of novice designers mitigating the transition towards the thought processes of expert designers within the context of Industrial Design, literature discussing various aspects of the design process reveals a core activity of the design process is creative problem solving [Kokotovich, 2007]

So we find that many Educational Institutes are still searching for methodologies that can help academics and students to overcome design process challenges by developing simple and easy solutions to help in increasing design process efficiency and enriching the designers' creativity. So there are many trials to develop design progress stages and to overcome different problems facing students within academic institutes by finding updated forms that depend on reduction and integration of design process stages. Sometimes, the proposed problem is represented as a simulation process that does not have any relation with any company or working field to train students on how to solve problems innovatively as in Stanford Design Innovation Process Model which reduced design process stages to five stages as shown in figure (2), where the Double Diamond Model reduced them to four main stages as shown in figure (3).

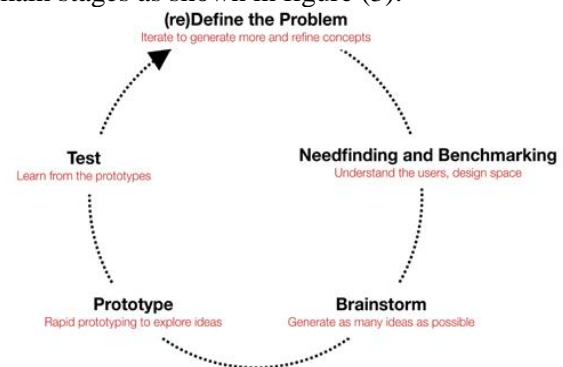


Figure 2 Stanford Design Innovation Process Model

<http://dstudio.ubc.ca/research/toolkit/processes/>

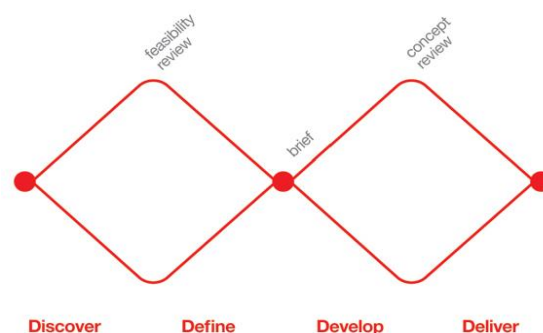
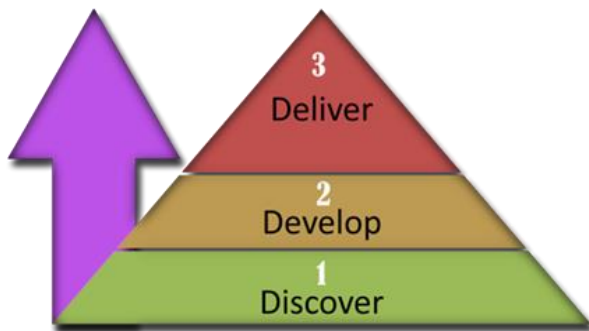


Figure 3 The Double-Diamond Design Process Model

<http://dstudio.ubc.ca/research/toolkit/processes/>

On another side the are many products' design instructors endeavor to move the industrial

designers thinking framework from novice to expert and to reduce the design process stage, So the researcher seeks to reduce the design process into three main stages as shown in figure (4), which is called “hierarchical design“ that started after the problem identification stage where Ho lends further support to the idea that expert designers tend to establish problem structure at the beginning of the design process, stepping back from the brief contextualizing the problem in their way, in which the researcher preferred to start design after identifying the problem. [Ho, 2001]



**Figure 4 Hierarchical design Process Model stages**

These design stages start with gathering and analyzing data followed by developing ideas then comes to the last stage which is selecting and carrying out final ideas. Hierarchical design is considered as the researcher's proposed model to teach design process for beginner students within design academies as it depends on design process reduction without defecting the main content simulating in this Stanford Design Innovation Process model, The D. School's Design Process model which reduced design process into four stages and Design Thinking Innovation process model which reduced design process into three main stages. The researcher found that the students' focusing increased by reducing design process stages and they achieved great results as he decreased dispersion factors which happened because of design progress stages diversity. Design process hierarchical model after problem identification by the instructor depends on three main stages as shown:

**- Discover Stage (Information analysis stage):**

Problem structuring requires the designer to depend on having knowledge and information to move towards and to develop a solution. So Information plays a vital role in the design process as it represents the cognitive side.

The researcher sees the main problem in this stage for the young student designer that they don't have a methodology of understanding the substantive issues related to the design problem and this reflected in the results of the final design process,

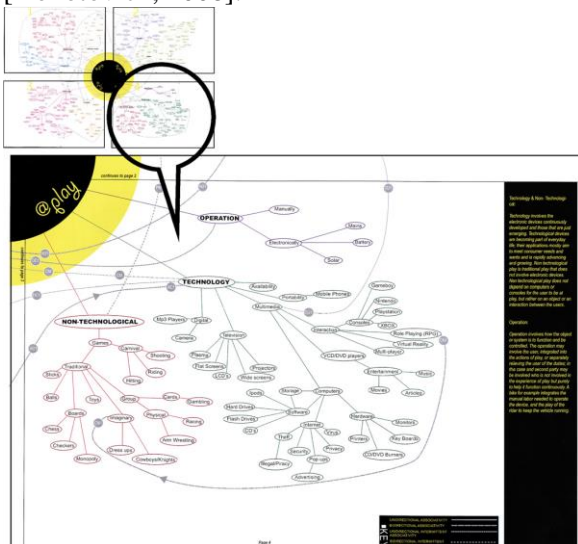
so Mathias said that novice designers tend to rush towards embodiments with undue haste and it can be argued that they lack an appropriately comprehensive methodology or thinking tool for mapping these complex dynamically interrelated issues that result in an adaptable and malleable problem structure. So, if we look to the creative mental synthesis experiments of Kokotovich we find that huge numbers of creative responses were generated when the subjects were forced to develop ideas mentally and forestall the embodiment of ideas, and if we studied the final results of empirical experiments that investigated creative mental synthesis in designers and non-designers, we can find that A central finding revealed when subjects separated ideas from the embodiment of ideas in the early stages of the design process, the level of creative output substantially increased for both. So, introducing industrial designers to problem structuring strategies/tools would prove beneficial, moving their design-thinking framework closer to the design framework of expert designers. [Kokotovich, 2008]

Therefore, the researcher suggested mind mapping methodology as a way to gather and analyze data related to design problems as it is the easiest way to save and organize information inside the human brain; it also helps to differentiate between positive and negative points easily. In Mind Mapping books by Tony Buzan, the owner of mind mapping theory, the writer mentioned that mind mapping is an old method followed by a lot of thinkers and scientists such as [Michael Angelou- Charles Darwin -Albert Einstein – Galileo - etc.].These geniuses used image language to organize and develop their ideas because the human brain remembers in a better way when it uses images in embodiment [Buzan,2009].

Mind mapping methodology is an alternative style that uses all brain parts instead of linear traditional thinking; it also helps us to gather all points of view about studying data. That is what is mentioned in Michael Michalko's book “Cracking Creativity” [Buzan,2009]. So, the researcher recommends using a mind mapping methodology in gathering and analyzing data due to its simplicity and non-boredom.

The researcher wasn't the first one who suggested using mind mapping for solving the design problem, he just tries to complete the experiments in this field. So we can say that this way was suggested by many researchers as a tool for industrial designers to structuring/analyzing design problems. for example, Kokotovich used

this way in his study for developing a vacuum cleaner as shown in figure (5) and he said that Using mind mapping can be considered a 'good start in developing a vacuum cleaner, and this tool-assisted the student in both representing and structuring a great number of salient issues germane to the main design problem they were asked to solve and allowed the student to construct their overall understanding of the problem and developing an overall analysis of the problem [Kokotovich, 2008].



**Figure 5** Sample of a first-year ID student's non-hierarchical mind mapping for developing a vacuum cleaner

(Source: Kokotovich, V (2007)

**- Develop Stage (Generate and Developing ideas stage):** in this stage, designers try to find the best solution for the main design problem by developing all available final solutions for the suggested design problem, Designers usually use more than one method to develop ideas in the design process such as brainstorming or elementary drawings which describe the idea. therefore, developing ideas process depends on trying and testing, as the designer started with identifying suggested solutions after the testing process, he proposed the best of them to solve the suggested problem which depends on a simplified model through detail removal, whenever it is needed, a geometry idealization by dimension reduction from "solid" 3D to "surface" or "linear" 2D or 1D idealizations [M. Belaziz, A. Bouras, J.M. Brun,1999].

At this stage, the researcher tends to use a design of an alternative table (morphological table) as a method to develop ideas and to help students in forming and composing different design factors. There are a lot of studies that discuss the alternative table methodology in the designing field using importance [Hammed, Ahmed; Eid,

Yasser,2018]. for example, In a published study with a title (Efficiency and resilience in product design by using morphological charts), The researchers experimented by using a morphological method with students to design smart furniture and at the end of the experiment, the researchers concluded that using morphological charts was a reason to design more models at the same time, also in terms of quality, the morphological charts have the advantage as they make it easier for designers to have all data in front of them which make them able to improve the overall product quality through slight changes on some functions described in the chart. [M. Belaziz, A. Bouras, J.M. Brun,1999].

Based on the above, an Alternative morphological table is important in the developing ideas stage, as it helps the students and the designer to develop ideas easily depending on a scientific method besides the ability to analyze and create relations between inputs and outputs in that stage in addition to the huge number of creative ideas resulted within that method as all factors are distributed horizontally and vertically at the same time. Suggesting that the presence of four design factors, each one of them has four alternatives, using alternatives methods can develop 256 designs, so that method is considered as one of the easiest methods which help beginner students to pass the stage of developing ideas.

**- Deliver stage (Selecting and carrying out the final idea):** In this stage, the designer selected the best solution for the design problem. Selection happened after testing suggested ideas' models and evaluating where one of them may solve the design problem. After that, the designer tended to turn his imaginations into facts. That usually happens by using rapid prototypes technologies such as 3D printing or engraving machine, but we can say that using rapid prototypes technologies can remove the potential for the designer to actively engage in the definition of form through tactile interaction with a physical material (as when working with foam or clay) because When using workshop-based model-making techniques, industrial designers have the opportunity to use their hands in the tactile exploration and development of form. This physical interaction with the material can guide the designer in making decisions and direct, to varying degrees, the evolution of the design [E. Mark, W. David, C. David, S. Bahar, 2004].

Therefore, the researcher tended to use sample material where beginner students at the industrial design dept. can use it easily and it should be recycling with low so the researcher tended to use

clay as an environmentally available, cheap, and easy formed.

**I. The hierarchical model design applied for study review:**

In this section, the researcher used the suggested hierarchical design process to develop the suggested model by refining understanding of the variables involved and underpinning mechanisms of interaction in design and wrote results down to know what extent his model was successful.

The researcher tried this model on about two hundred students for about three successive studying years by working for nine studying hours within three weeks every year in a faculty of

Applied Arts Beni-Suef University - Egypt. The researcher depended on constant distance between points that enabled him to measure variables easily. Electric boiler design was the suggested design problem. In the first year, the researcher gave the students a chance to gather all available electric boiler models to select from, and then the researcher analyzed their elements to reach the final alternative table form to develop ideas. In the second year, the researcher selected eight different designs as shown in figure (5) to be able to measure ideas' volume and quality in case of information factor constancy.



**Figure 6 The proposed set of designs at the information-gathering stage.**

**The proposed design program is developed as follow:-**

Pre-sampling preparation was dealt with for three years starting from 2017 until 2019, and the researcher was adapting and checking the application of work sampling in each year then he

wrote the results down to know to which extent his model was successful. The suggested hierarchical design process which has been applied to industrial students consists of three stages as shown in figure (7).



**Figure 7 Hierarchical design Process Model (Source: researcher)**

The first stage (Discover): Proposed design analysis by identifying the main parts of each design by students during three years using mind mapping methodology In easily analyzing

products by identifying the main parts as shown in figure (8), where students drew the suggested design in the information gathering stage, then they identified its primitive elements, finally, they

draw it in details. After completion of the proposed design, the students developed a mind

mapping assembled for all parts that had been drawn through previous designs.

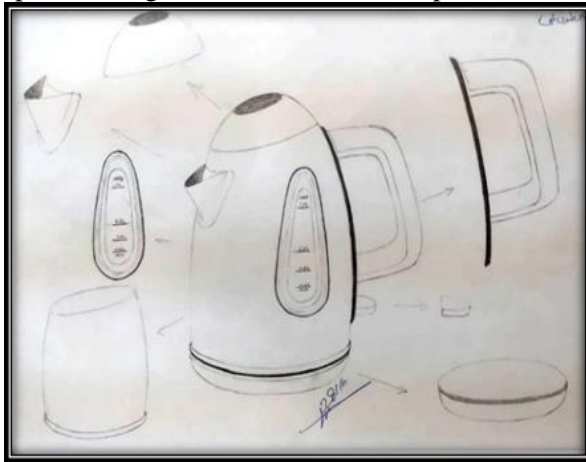


Figure 8 Sketches of students' work in the analysis stage

After assembling all parts in one mind map, each student developed an alternative table as shown in

figure (9) that would be used at the next stage to develop ideas.



Figure 9 some alternatives' tables forms that used in the ideas development stage

**The second stage (Develop):** Each student created a group of alternative relations between suggested design factors within the alternative table to develop 36 proposed designs as shown in figure (10) as a solution of design problem regardless of any definite standards that increase the students' creativity and innovation. After developing ideas, the instructor selected the best designs for the students to start later development as shown in figure (11) following the standards and requirements to be achieved in the design. The researcher has relied on the process of selecting ideas on a set of major factors such as:

- Shape Balance.
- Creativity.
- Aesthetic aspects.

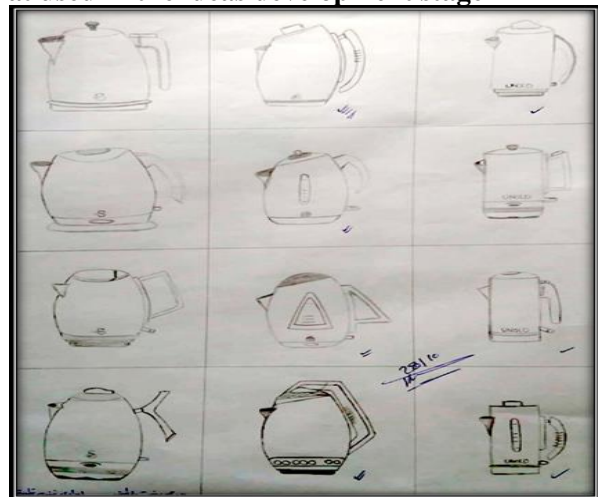


Figure 10 A set of designs made by students in the ideas development stage

Ease of implementation with clay material. Besides students' participation in the selection process and the exchange of opinions, therefore, all ideas that were chosen over the three years during the experiment period with students achieved the previous principles as a constant criterion for the evaluation process, whether the ideas or the final results of the experiment.

**Third stage (Deliver):** after completing the proposed design models that would be used to improve the elementary design, the instructor reviewed all of these designs to select the final idea which would be carried out using clay as an environmental available, cheap and easy formed material as shown in figure (12) that shows a group of students' designs.

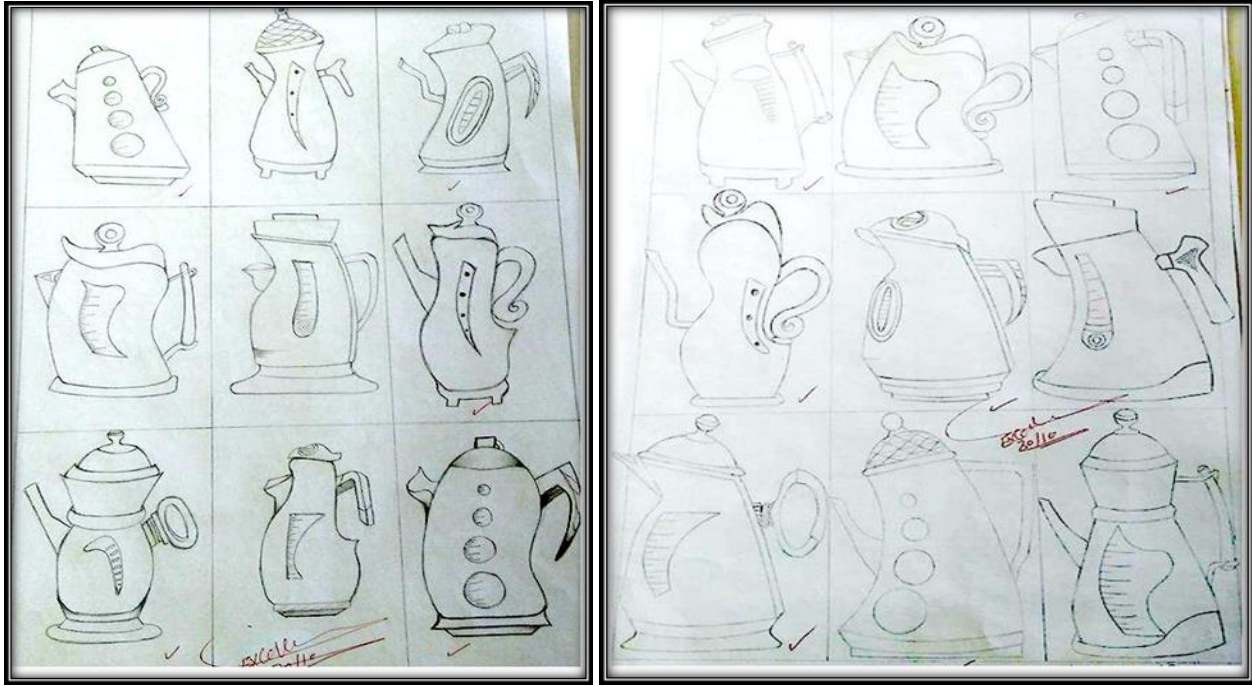


Figure 11 Some students' final designs while developing their initial ideas



Figure 1. Photos of some final models that had been implemented by the students

During three years, the researcher noticed great progress in the students' innovation and creativity especially those who thought that they wouldn't be able to develop their first designs to solve design problems. By asking students after the project, they appreciated their experiment which was characterized by flexibility and simplicity.

#### CONCLUSION:

Academic institutions seek to develop design process stages and integrate or reduce some of them to reach an easy and simple design process through which the student can carry out the first design process easily, creatively, and innovatively. Therefore, the research aims to reach for the suggested design method model that enabled students to solve the design problem by developing and reach for designs characterized by

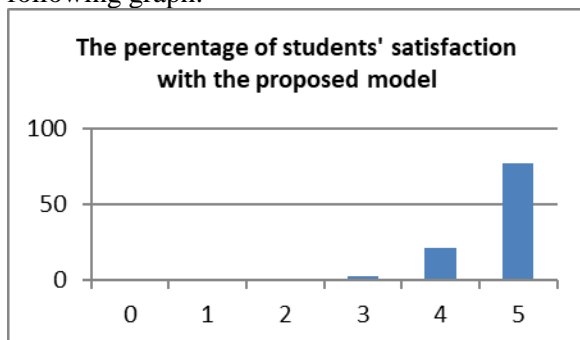
creativity and innovation.

The researcher tended to use Analytical descriptive to reach for the suggested method through A deep study of the various design methods to reach a more effective and easy method.

Subsequently, the researcher had illustrated the design process by his suggested hierarchical model which includes three stages after the problem identification stage by the instructor. These stages are [gathering and analyzing data and information stage, developing ideas, selecting and implementing final idea]. The researcher has chosen mind mapping methodology as a proposed way to collect and analyze data because of its simplicity and non-boredom, besides the ability to analyze and collect information easily and simply. The researcher also used the design of an

alternative table which is called Morphological Table as a suggested method of developing ideas, in addition to using clay as an easily formed material in the third stage to carry out ideas. The researcher experiments the proposed model of the design process on 221 students of the first year in the faculty of applied arts as they are divided into three consecutive years where the experiment results in a set of innovative designs in no time which has been evaluated according to defined criteria that proves the effectiveness of the proposed model.

The researcher also surveys 67 students to know students' satisfaction with the experiment where it ranks from zero to five as number zero indicates a full dissatisfaction with the experiment while number five indicates satisfaction. The questionnaire reveals satisfaction from students' side with the experiment as shown in the following graph:



From the previous results, it can be concluded that in addition to reaching more innovative designs, more than 97% of the students who participated in the experiment feel satisfied with the experiment and its results, which indicates the effectiveness of the proposed model, whether in terms of results or use by students, which confirms access and achievement of the main research goal And represented in reaching an easy design method that can help students to reach innovative ideas and designs.

#### Results:

- Mind mapping methodology is the easiest way to save information within the human brain and to differentiate between positive and negative points easily.
- Using morphological alternative (design alternatives) table as a proposed method to develop ideas enables students to compose different design elements.
- The Design process hierarchical model enabled students to solve the design problem by developing a great group of designs

characterized by creativity and innovation.

- The Design process hierarchical model reduces design time to reach final results by combining stages
- The Design process hierarchical model reduces the cost of the design process by reducing the time spent during the process as well as using inexpensive materials to show results.
- The Design process hierarchical model contributed to preserving the environment by using non-polluting environmental materials to show the final results.

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