
Material-Based Learning in Architecture Design Studio: From 'Beaux-Arts' to 'Bauhaus' into Current Educational Era

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Abstract. This paper presents the development of ways of learning based on material and materiality in architectural education. Some basic principles were founded in a material-based studio learning process when previously developed by Ecole des Beaux-Arts and Bauhaus, two architecture schools established along with the rise of new materials and technology introduced in the industrialization era. Since both schools implemented material thinking as part of their learning process, it has undergone a transformation following the development of new technologies. But there may still be some principles that exert a strong influence on some schools around the world. The critical question is what makes material-based learning still important to develop in architecture education?

The qualitative research in this article was conducted in a third-year architectural design studio that applies material-based design through a case study of two different types of materials. This study aims to see the relevance of material-based learning principles that were previously applied to the current methods and practices of architectural education. The analysis is carried out by investigating the development of the learning method in accordance with material issues that are resolved with a different approach. The results of this study indicate that the understanding of materiality is a fundamental thing that needs to be maintained in architecture education to develop critical thinking through material-based learning.

Keywords: material, learning method, architecture education

1. Introduction

Materials will always have an important role in architecture as the relationship between humans and materials began with the understanding of natural materials to build a shelter (Semper, 1989). We are living in a physical world surrounded by materials that are used to build what we need (Schröpfer & Carpenter, 2011). The concern for materials is not only for their functional properties but also for their social, symbolic, and ritual value. We also need to consider its meaning able to produce a place of identity (Coleman, 2020).

Material-based learning in architecture education and practices is important to explore material thinking regarding architecture's materiality. It describes work that explored theoretical frameworks for a variety of historical, technological, contextual, and subjective issues affecting decisions about materials. Materials are physical and their distinct characteristics become known to people through their senses in perception (Bell & Rand, 2006; Borden & Meredith, 2012; Löscke, 2016). More than their physical properties, materials can also be seen and touched, sometimes heard, smelled, and tasted, design education that leans toward framing the study of materials in terms of their abstract materiality (Ingold, 2007).

In the Ecole des Beaux-Arts and Bauhaus educational era, the material has become the basis for understanding technical aspects of architecture than the aesthetics (Ramzy, 2010). The Bauhaus way of learning and exploring material as part of the industrial-making process is a great reference for developing our knowledge of materiality. Through design and making, we

could understand the significance of materials in architecture and create frameworks of theoretical questions, rather than absolute answers that will only become an aid in design and critical analysis (Carlson-Reddig, 1997). Contemporary architecture is all about materiality, which is now widely viewed as a primary influence (Lösckke, 2016).

The development of digital technology has brought new ways of material exploration both in architectural education and practices of the 21st century. Advances in fabrication and digital technology have opened up unexpected possibilities for imitating natural construction systems (Oxman, 2012; Williams, 2022). New development of technology also allows architectural exploration to be limitless since materials can be engineered. Digital technology is considered capable of overcoming the problem of variable complexity in the architectural design (Hagan, 2020). The aesthetic of form becomes the main important thing, while the involvement of materials is often set aside as a limitation of the design process in the current practices. Within this condition, we questioned ourselves: what makes material-based learning still important to be applied in current architecture education?

The research in this article demonstrates a material-based learning method conducted in a design studio conducted by third-year students. The aim is to investigate to what extent the principles of material-based design learning in the past are still being used in current architectural education, referring to the 21st century to the present. The results of this study are expected to provide an overview of the benefits obtained in the learning process of a design studio that places material as the initial basis for design when compared to other design approaches.

2. Methods

The research study described in this article is the result of a reflective reading of the principles of material-based learning at Beaux-art and Bauhaus which are applied to the learning process of one of the material-based design studios at the architecture department of Diponegoro University. Studio projects are carried out by seventh-semester students through digital material exploration. This project aims to see the extent to which students' design thinking skills in placing materials as a starting point for design. This project is divided based on the various types of materials used, both industrial, local, and organic materials.

The research was conducted in several stages. The initial stage is to study the principles of material learning at Beaux-Arts and Bauhaus which are developed as assignment briefs. The essence of learning is the development of constructive and creative thinking which is the principle of learning materials at those two schools. The second stage is the observation of the studio learning process which is carried out in two different cases, namely wood and precast concrete. The two samples were chosen to see differences of thinking in treating two materials that have different characteristics, which are natural materials and materials resulting from industrial products. The third stage is a reflective analysis of the learning process up to the detailed design development stage. The analysis was carried out to find out how far the constructive and creative process was carried out on material issues taken in each different case.

3. Discussion

This section discusses the architectural learning process in material-based design studios to see to what extent the ideas from Beaux-Arts and Bauhaus are still used in current architectural studio learning.

3.1. A Brief Search Principles On Beaux-Arts And Bauhaus

Architectural education began when Ecole des Beaux-Arts was founded by Cardinal Mazarin in Paris in 1819. It was formed with the development stage of two schools namely: Academie Royale de Peinture et de Sculpture in 1648 and Academie Royale d'Architecture in 1671. This school began to introduce the atelier (Drexler et al., 1977), which then become the popularity of Beaux-Arts's learning system. Behind the system, some principles include the subject of material-based learning.

The subject of understanding material and materiality had not yet been seen as part of the aspects which also determined beauty until the first half of the 18th century. At that time the academy continued to discuss the five orders as a universal principle to determine the ideal proportions of perfect beauty following rationalist (Drexler et al., 1977). In the end, they failed to conclude, because there was disagreement about whether beauty was something that was considered absolute or not. Architecture and planning were still a small subject and students' interest in construction was still lacking.

In the second half of the century, the academy reversed its principles. They gradually lost interest in theoretical questions along with the increment of physical and chemical knowledge which influenced the development of knowledge of construction. (Drexler et al., 1977). Every member of the academy began to hear various forms of technical reports on how to build (wood and stone dome techniques), the behavior of materials (cement, stone, iron), the plumbing system, heating, and lighting. Their interest in Gothic architecture was increasing to understand the logic of its construction. It was at that time that knowledge of material began to take a role in architectural learning.

The lesson of material-based learning in Beaux-Arts related to construction concours. There were four construction concours, one for stone, one for iron, one for wood, and one for general construction (Drexler et al., 1977). It then changes into a single concours with knowledge of mathematics, descriptive geometry, and stereotomy the prerequisite (Cret, 1941). The concours required attention to the detailing of stone, iron, and wood, and with mathematical calculations so that the building would stand.

After Beaux-Arts in 1919, the economy in Germany was very chaotic after the world war which drained all of Germany's power. In addition to changes in the community at the beginning of the design problem in the building also becomes increasingly complex. Architecture is no longer just 'The art of Building'. Since the building function has become more complex, then it needs another supporting knowledge that was needed in designing a building. Circumstances such as this arouse an architect named Walter Gropius to establish an educational design institution called the Bauhaus in Weimar, Germany (Whitford, 1984).

At the beginning of its establishment, the Bauhaus spread a manifesto explaining the purpose of the school. The manifesto is a collaboration between artists and craftsmen to create a future building together where everything unites in a form, architecture, sculpture, and painting. Gropius (1919) asked anything must return to craftsmanship. Some of the principles that apply in the teaching of the Bauhaus are the strong influence of the art of expressionism, a combination of artists and craftsmen, and using a rationalism and design approach to machines.

The field of architecture was not a special part in the first place. Discussion about architecture at that time was only visible from the branches of building material design. At first, workshops were set up to search for a new aesthetic utilizing modern materials and production methods, including fine metallurgy, printing, bookbinding, cabinetry, weaving, mural painting, and sculpture (Lerner, 2005). The goals are utopian, which is to build a new spiritual society. The knowledge about stained glass, wood, and metal was taught by artists and craftsmen, using

the line work methods, namely master (expert/teacher), journeyman (wanderer), and apprentice (apprentice student) as the basic foundation.

In the basic learning method, materials and techniques were considered in a rational, straightforward manner (Moholy-Nagy, 1947). Learning principles emphasized tactile perception, strength, weight, and density of materials, compositional balance, three-dimensional volumes, proportion, statics and dynamics, and qualities of light (Lerner, 2005). Students were taught to erase their minds of preconceptions so they could explore their responses to form the world about them. They gained knowledge of materials through play. In their explorations, they focused on learning timeless design principles. The manner of learning arises from the character of the workshop: organic forms developed from manual skills.

Based on a brief exploration of the development of material thinking in the Beaux-Arts and Bauhaus educational eras, similarities and differences can be found between the two which are listed in table 3.1 below. The basic similarity between the two is in understanding the technical aspects of materials as the basis for designing practices and their purpose for finding forms. The difference is in the principle of development, Beaux-Arts emphasizes constructive thinking, while Bauhaus emphasizes creative thinking.

Table 3.1 Material-based learning of Beaux-Arts and Bauhaus (Author, 2022)

	Beaux-Arts	Bauhaus
Models	Atelier Concours	Workshop <i>Vorkurs</i> or basic foundation course
Principles	Liberalism, competitive condition, freedom of choosing patron, constructive thinking	Avoidance of all rigidity; priority of creativity; freedom of individuality, creative thinking
Knowledge goals	Proportion, decorative forms, emphasizing on the use of new materials	Creativity, form mastery New aesthetic, utilizing modern materials and production methods, Space relationship
Methods	Competition, exploration Construction concours (stone, iron, wood and general construction)	Experiment, exploration the free play of intuition and material knowledge Craftmanship

3.2. The Development of Material-Based Learning

The existence of a 'master' is still considered important in architectural education. The atelier system of Beaux-Arts is applied mostly in architecture studios. Meanwhile, there are not many architecture schools that apply material-based learning as a method used in Bauhaus. This fact can be seen in most curricula which set material knowledge separate from the studio learning system (Bell & Rand, 2006). It seems there is no important connection between material knowledge and learning 'designing architecture'. As also in most practices, materials tend to only be the final part of the design process, or even in the process of developing detailed designs for material selection. Material is seldom in the first place as a basis for a design approach.

The development of the Bauhaus ideology in several architectural schools was inseparable from Walter Gropius's move to America. Gropius introduced Harvard to the Bauhaus design philosophy incorporated into the curriculum. Although it cannot be fully implemented, this includes practical training. He also did not succeed in eliminating the history of architecture learning at the school. His innovation at Harvard eventually triggered similar educational reforms in other architectural schools in the United States. The ideology marks the end of the architecture that tends to 'imitate' the country of the previous time.

Other schools have provided a program that unites the material approach into the overall design process. Such as the Rural Studio program at Auburn University, United States, Studio 804 at the University of Kansas, or the Base Initiative Program at the University of Washington (Bell & Rand, 2006). Some of these schools demonstrate the effectiveness of comprehensive learning that combines design with materials, construction methods, programming, and even community service. All of these programs teach students about critical decision-making abilities that are comprehensively understood from various aspects.

The principles of Beaux-Arts and Bauhaus gave a big influence not only in education but also in the world of architecture and industry at large. Adaptation of the atelier-based training at the Ecole des Beaux-Arts offered a teaching model from a design discipline in which the functional and the structural, the social and the technical are blended. Along with Bauhaus principles which not only gave birth to material-based learning methods. This is seen in the learning method used, specifically in the application of the studio system model and the material-based program. Bartlett is one of the architectural schools which follows the principles of learning from Beaux-Arts while also modifying the making process method (Crimson & Lubbock, 1994).

The way of learning on materials has changed following the new digital era, but why Beaux-Arts and Bauhaus influences are still strong enough? It might be because the school system has changed, but the learning principle never changed (Salama, 1997). The fundamental concept behind Bauhaus learning is not divided into two different activities, but one thing in common with different diversity, between pure art and craft (building) (Whitford, 1984).

Material-based learning is now adapted to the development of computational technology. Bauhaus's core objective was a radical, and still unrealized, concept: the unity of art and technology (Doyle, 2016). The introduction of contemporary digital tools, techniques, and materials makes this unity possible in new and profound ways thereby extending the Bauhaus project into the present day as a meaningful model for architectural education and digital craft.

Material exploration is shifted from traditional to new methods, from handmade to digital craftsmanship. The growth of digital tectonic appears as a new approach in the application of materials and technology. The old opposition between a digital culture of sensuous, ephemeral images, and a tectonic culture of pragmatic building has given way to a new collaboration. Computer-linked fabrication techniques of many kinds have become an integral part of the design process, while new digital tools are allowing engineers and architects to understand in far more detail the behavior of materials to generate new architectural forms (Leach et al., 2004).

In the 21st century, we are witnessing an increase in digital technology that is heavily involved in the design studio curriculum and practices. These various computation technologies are not only useful in the preparation, calculation, modeling, and analysis of the main education nodes in the design studio. In some architecture schools, this development also helped shape the structure of the architecture education curriculum as a whole. Computational knowledge is considered important as a supporting skill for developing learning methods. Especially in terms of material exploration as a basis for design. Oxmann (2012) brought digital tectonics into morphogenesis which appears as an attempt to characterize digital tectonics as a change in the thinking of digital design, which increases the importance of structure and the materials that lead to the synthesis of architecture and structural engineering

3.3. Material-Based Learning Method on Design Studio

The case studies discussed in this article show an architectural design learning process that places materials as an important part of the design. The final design resulting from the design process in this studio is not the main focus of the discussion of this article. In contrast, the discussion focuses on the architectural programming process. There are three important

processes in the architectural programming process carried out in this design studio, which is divided into material understanding, critical thinking, and developing models.

a. Understanding the Material

The first stage in the programming carried out in this studio is to determine one main type of material that forms the basis for compiling the program. This stage is important to do at the beginning of the program development process because it can affect the design methods and models at a later stage. The type of material chosen in the material-based learning process is not the most important in the learning process. One thing that is most important lies in the depth of any type of material chosen as the basis for programming.

In the learning process of this studio, the material categories used as the basis for the design are categorized into two forms, namely organic materials and non-organic materials with different characteristics. In particular, the materials discussed in this article consist of steel, wood, bamboo, and precast concrete. The process of understanding material includes material characteristics, both physical and non-physical, including the materiality of the material itself.

The process of reading the material starts from unraveling the basic characteristics of the type of material selected through various kinds of literature, case studies and previous research that has been done. This process becomes an important part of learning so that material-based exploration does not start from scratch. The purpose of this reading is to open up various exploration possibilities that can be carried out on each type of material. As well as to build critical thinking on the type of material selected.

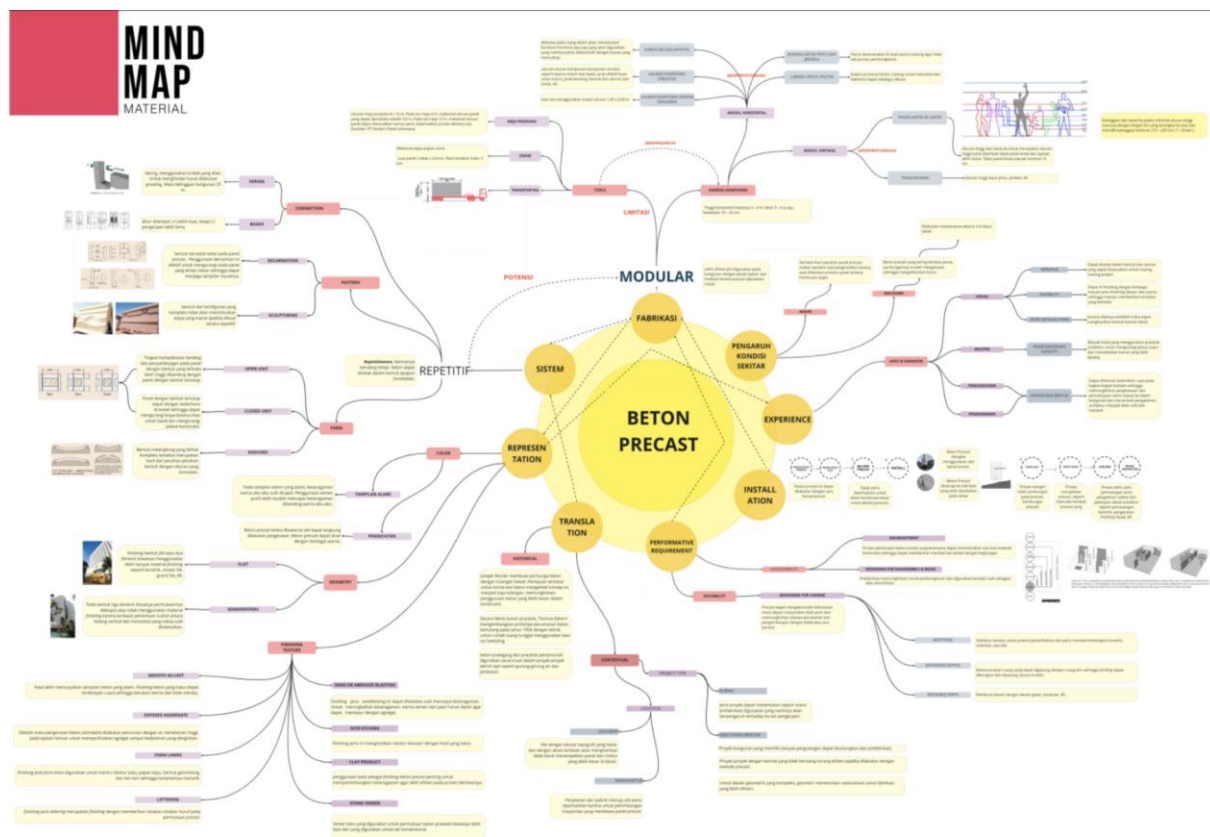


Figure 3.1 Mind map material process of precast concrete made by Nabiila Aulia A. (Author, 2022)

The reading process in the design studio is carried out through the preparation of a material mind map. Figure 3.1 shows the search for the selected material, including the type, nature, character, and function of the material. A search was also carried out on several precedents using the selected material type. An in-depth study of material precedents aims to see various possible strategies for using the same material to be applied to different project cases. The results of reading the material at this early stage form the basis for critical reading of the material carried out at the next stage.

The stages in the learning process show the importance of material understanding as the beginning of the material-based design process. This principle was also applied to the Beaux-Arts and Bauhaus eras but was carried out in a different way. In the Beaux-Arts method, which is done through direct exploration, the Bauhaus does it with additional experiments. In this studio, it is mostly done through literature searches.

b. Critical Thinking on the material

Critical reading of the material is the next step that must be carried out to build critical thinking on various knowledge about materials. This process also aims to see the possibility of important material aspects that can be applied according to the context of the design being done. In the Bauhaus era, this learning principle was carried out to build creativity and freedom of thought to process designs based on material elaboration that had been done previously.

The critical reading process carried out in this studio begins by looking at important issues related to the design case. In-depth design issues as an important part of critical reading of materials do not aim to limit creativity in designing. On the contrary, this stage is to determine the right choices to answer design issues. So that the material elaboration can be done in more depth.

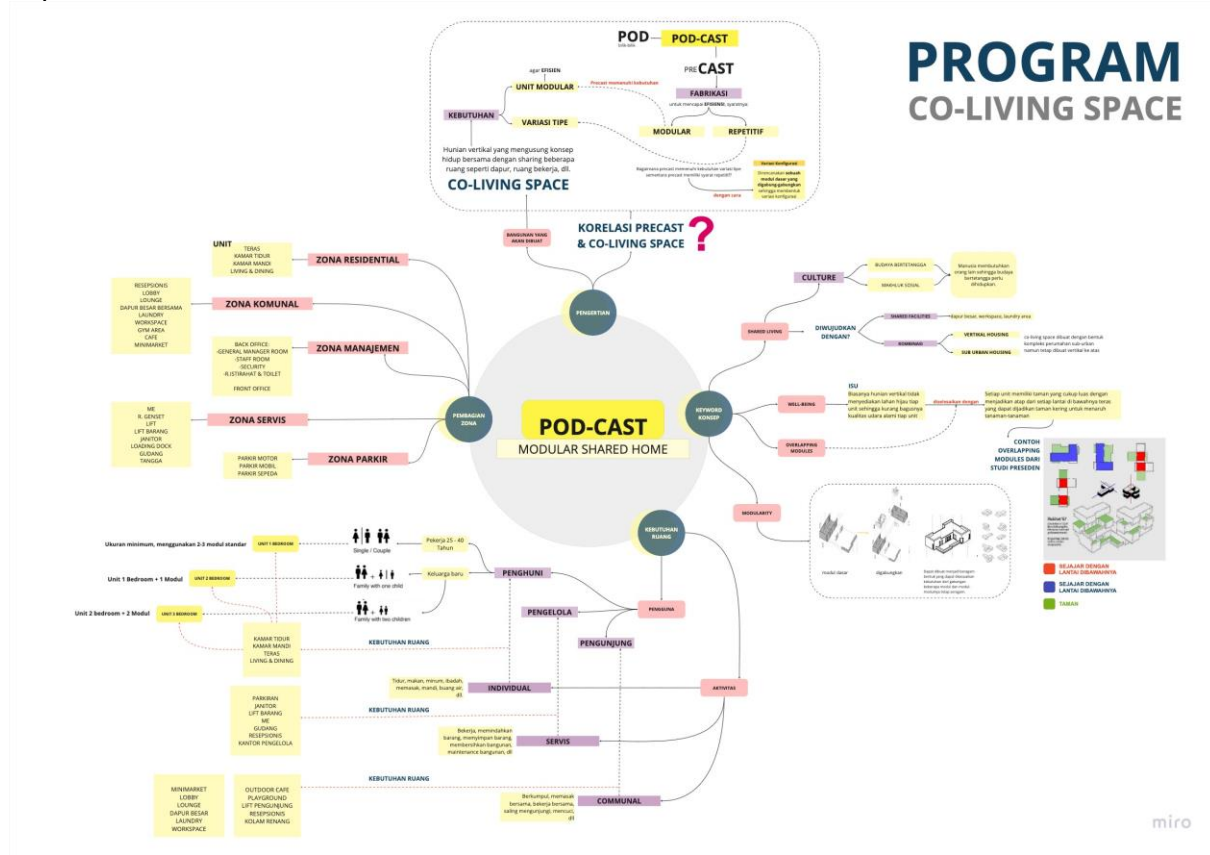


Figure 3.2 Diagram process material thinking made by Nabila Aulia A. (Author, 2022)

The results of a critical reading of the materials selected according to each design case indicate that there are different important issues to address in different contexts. Important aspects of the same type of material may not necessarily be applied similarly as a design basis for different cases. For example, the critical reading of precast concrete material applied to residential functions in this studio shows several possible aspects of the material. However, one that is close to being precise is a precast concrete construction system to address the issue of material efficiency and optimization of residential space (figure 3.2). The characteristics of precast concrete materials that allow them to be custom-made provide opportunities for the development of modular concepts.

Critical readings on organic wood and bamboo materials also show different things (figure 3.3). The different characteristics of wood and bamboo materials even though both are organic materials can determine differences in design elaboration even though they address the same issues. In the case of this design studio, wood and bamboo were chosen as basic materials to address the issue of wide-span spaces. This issue is related to the main structural system based on the characteristics of each material, so an in-depth study of the material tectonics of both wood and bamboo is very important for further exploration.

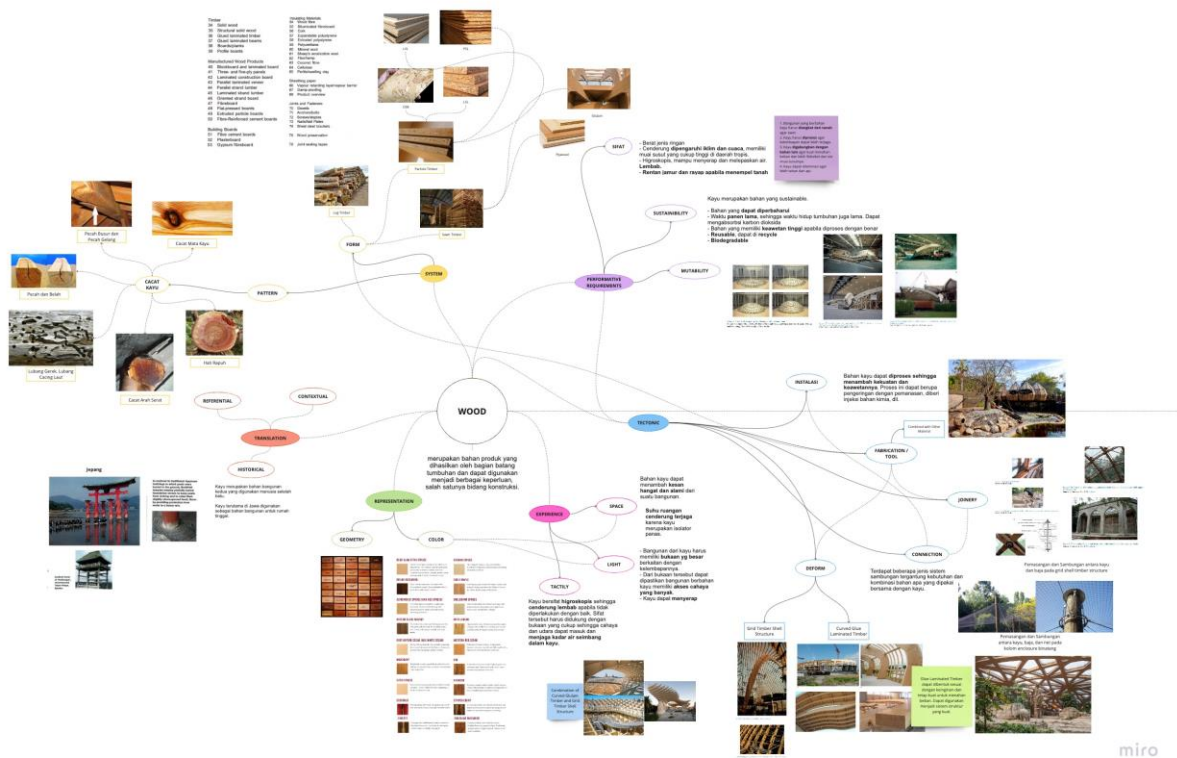


Figure 3.3 Diagram material study made by Larasati Embun Putri (Author, 2022)

c. Program development Based on material thinking

The third important learning stage is program development according to the selected design context. Program development is carried out iteratively with the limitation of material knowledge used to address design issues in the previous process. The iterative approach allows the development of designs that are more focused and in-depth on one particular concept.

This stage is carried out to explore various possible material processing scenarios related to spatial arrangements or shape exploration. Form and spatial scenarios are important things

that are explored at this stage to determine design decisions that are close to being appropriate to the design case. The spatial shapes and patterns developed through this process are no longer simply generated intuitively. Every step and design decision taken is based on a rule-based and in-depth material system developed.

One example of its application in this studio is the development of the modular concept of precast concrete material which is carried out through scenario exploration to see various possible patterns for the arrangement of efficient modules (figure 3.4). Various module shape scenarios are generated from the rules obtained based on tracing precedents and material limitations of precast concrete. The module arrangement system is carried out by looking at various considerations related to the material and space being explored. This stage relies on the designer's critical reading of the consequences that arise as a result of the drafting pattern as is the design process in general.

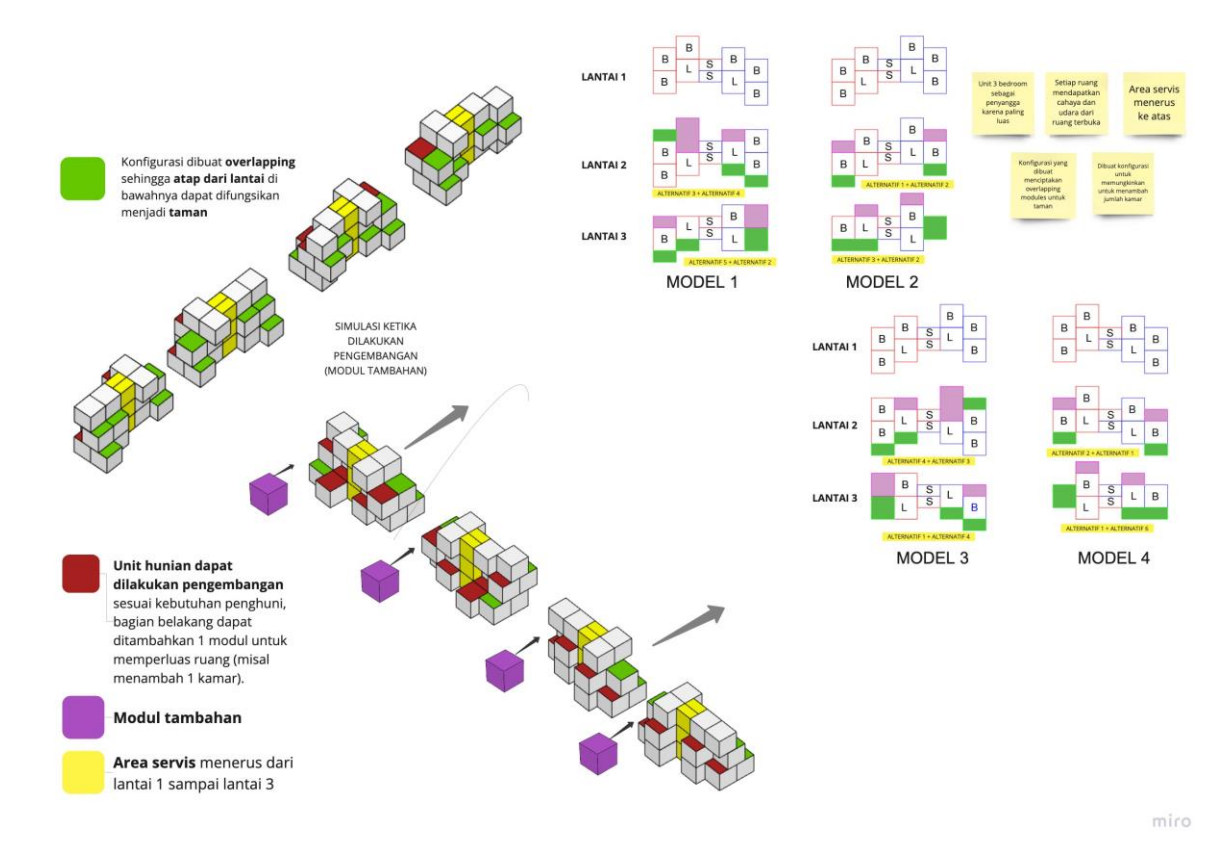


Figure 3.4 Diagram of program development by Nabiila Aulia A. (Author, 2022)

The three stages of learning above show some of the learning processes that apply the principles of material-based learning at Beaux-Arts and Bauhaus based on the results of previous research on learning principles in the two schools. However, the principles applied are not separate to both natural materials and industrial products. Both of them show that creativity can be developed from systematic constructive thinking through an iterative process. The difference is only in the form of creativity achieved to answer each material issue related to the project case taken. On the use of wood materials for bird cage projects. Creativity to achieve the wide-span shape concept is an important consideration. While in the use of precast concrete for residential functions, exploring the modular concept is important to address the limitations of precast concrete materials.

The two cases above also show that in material-based design, the design process can be read more clearly and directed based on the development of an architectural program in accordance with materiality in-depth related to the design issues at hand. The learning process carried out also shows that the combination of learning principles carried out at Beaux-Arts and Bauhaus is still important to be applied to current architectural learning to build constructive and critical thinking.

4. Conclusion

The findings of this research clearly show some principles of material-based learning that have the possibility to be extended in architectural education. Even though the atelier system based on Beaux-Arts and Bauhaus principles is still relevant to be developed with the ease of technology that exists today, there is one thing that must be considered, the essence of architectural learning is about critical and creative thinking. The tendency of digital technology, which is currently more widely used as a form search system, tends to produce uniformity because it explores almost the same material. This is important knowledge that will guide our new ways of developing materials-based design approaches.

The discussion in this research article is still focused on learning case studies and material exploration with the limitations of the digital tools used. In the future, it is necessary to think about the potential for applying digital technology as a learning method in the material-based design process. The aim is to broaden our knowledge of how far exploration of material properties through digital machine and fabrication can go further to enrich materials-based learning methods in architectural design.

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