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Abstract

This paper explores the articulation of tectonic as a potential basis for developing and understanding architectural programme in the context of architectural education. The piece delivers a reflective discussion that puts tectonic beyond the art of joining. Instead, tectonic, which informs the way material performs, insinuates a capacity in supporting the students to generate the spatial programme and atmospheric quality for the development of their architecture project. In particular, the study suggests the importance of tectonic articulation in generating the above spatialities. The study investigates such tectonic articulation by reflecting through a second-year design studio project in Universitas Indonesia, which focuses on developing dwellings designs driven by tectonic-based architectural design method. Through reflecting the students' projects this paper put forward three aspects of tectonic articulation, each of which explores the formal iteration, the tectonic-programme relationship, and the tectonic-atmosphere relationship. The study demonstrates contribution in understanding how tectonic is explored throughout the design process, informing multiple stages of design.

Keywords: tectonic, programme, atmosphere, articulation, design studio

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Tectonic and its architectural capacity

Architecture understands tectonic as the art of construction (Kim, 2009). It is a conception that puts forward the role and performance of materials, emphasising construction as material joins, hence the architecture. Tectonic especially put forward the notion of understanding architecture through its intrinsic spirit. Frampton encapsulates such an idea, suggesting that "the built is first and foremost a construction and only later a discourse based on surface, volume and plan" (Frampton in Barata, 1999, p. 141). As evident through his many publications, including *Studies in Tectonic Culture*, Frampton's thinking probably has turned many of us on comprehending architecture. He invites us to return to the fundamental understanding of architecture which resists the over-exposure of architecture culture (Barata, 1999), arguing that "architecture is as much about structure and construction as it is about spatial experience" (Hensel & Cordua, 2015, p. 135).

Discussion on tectonic can help us to engage with a broader school of thoughts. Exemplary studies reflect such a notion through referring to a certain aspects of a particular architectural building, usually designed by a renowned architect. For example, Hansel and Cordua (2015) point out the importance to revisit how tectonic emanates the discussion on locality. Meanwhile, Tramontin (2006) chose to expand the discussion of tectonic by extending Semper's interest in textile—the 'textile tectonics'—and emphasises the development of generative textile form for creating various topotectonics that is "a definitive tectonics of continuous elements, which is curious and paradoxical" (Tramontin, 2006, p. 59). Another study by Samuel and Jones (2012) extensively discusses how architectural elements in Le Corbusier's *Villa Savoye* and Hans Scharoun's *Schminke House* were interacting with one another, orchestrating the promenade in the respective houses. Another case concerns the logical construction of architectural buildings and their ability to revamp our perception towards the site, as discussed by Dodds (2001). Nevertheless, one that probably quite interesting out of all is Hansel and Cordua's article titled *Conviction Into Tectonics*, in which they call out the idea of tectonic sensibility, whereas tectonic "resides in the sensory memories the architects evoke and in their capacity to recall deeply stored atmospheres" (Hensel & Cordua, 2015, p. 77).

Nonetheless, these studies all resonate in an understanding that tectonic is "a capacity of materials to realise effect" (Benjamin, 2006, p. 29). They start with the premise that tectonic is an art of joining (Frampton, 1995) and further coin out that there is more to tectonic; there are consequences as the materials joined, performed, and manipulated in specific ways. The notions indicate the fundamental role of tectonic as a means "to effectively utilise building materials as carriers of architectural meaning" (Weber, 2018, p.1). On the matter, Weber (2018) further suggests that we need to make sure such importance is penetrated deeply in the architecture pedagogy as tectonic is an essential language in teaching architecture.

Unfortunately, there is a limited number of discussions on how to teach and learn tectonic in architectural education. At least, there are two approaches known for learning tectonic through a real-act construction (Chun & McDonald, 2002; Erdman et al., 2002; Schwartz & Ford, 2017) and precedent study (Schwartz, 2015; Weber, 2018). Each of the approaches offers specific excellence. However, the studies rarely disclose and discuss how students build up sensibility and understanding of tectonic comprehensively throughout the process of designing a project.

The above discussion leads us to the venture of revealing the incorporation of tectonic further in the learning and teaching of architecture. In achieving this aim, the study will first discuss learning and teaching tectonics in architecture institutions to comprehend the challenge and urgency for integrating tectonic in the architecture pedagogy. Secondly, we will further discuss the notion of articulating tectonic ideas as an essential act for learning and fathoming tectonic and its consequences. Thirdly, this paper will draw a reflective discussion on tectonic articulations towards a project performed by students in the context of an interior architecture studio.

Learning tectonic in architecture pedagogy

Architectural design "is not just concerned with appearances, but also with the development of the relationships between systems, components, ideas, and contextual influences. Architecture, after all, is systemic;[3] it is the weaving of physical (structure, plumbing, construction), nonphysical (circulation, light, security), and even metaphysical (time, weight, embodiment) systems into spatial constructs" (Schwartz & Ford, 2017, p. xxv). This is why tectonic discourses suggests that one needs to step back to understand the construction of a building before fathoming the architecture itself (Barata, 1999). Construction, which results in the presence of surface, volume, and plan, allows us to weave the tangible and intangible spatial aspects that create the architecture itself. It is evident that architecture education institutions in many parts of the world have been attempting in ensuring that students understand such importance.

In addressing such importance, many of the programmes offered by architecture education institutions focus on the idea that construction requires a bearing in mind that it is not just a product but also a process of making (Schwartz & Ford, 2017). Chun and McDonald (2002) briefly explain that the knowledge of tectonic needs to be accompanied by real-act of construction. Erdman et al. (2002) also coined out similar thinking, whereas a hand-in experience is necessary for a student to understand tectonic through the nature of construction of their project. Studies conducted by Chun, McDonald, and Erdman et al. can formulate a discussion about making as a way for a student to understand tectonic. However, they are not quite explicit in exposing the design development stage of the project. This is unfortunate considering that revealing more in-depth thinking

of construction—the art of joining—would provide knowledge of the design's interwoven spatial aspects.

In contrast to the real-act of construction, studies conducted by Weber (2018) and Scwhartz (2015) see an opportunity for learning tectonic through a form of precedent study. In Weber's case, students were invited to analyse the performance of a design through plan analysis. Students investigate the design through a series of wall studies (e.g. cladding, sliding panel). The analysis aims to understand the spatial performance of the surfaces, thus unfolding the spatial problems in the precedent design. Schwartz (2015) advises a similar approach, arguing that the precedent analysis offers excellent potential for investigating tectonic. Such a process "involves seeking out critical information, breaking it down into component parts, and reassembling the necessary elements to convey specific idea about the object or situation" (Schwartz, 2015, p. 2).

However, when it comes to a design process, the above studies were not able to explain how the two approaches allow the students to comprehend tectonic. There is still a question on how students perform tectonic thinking in the design process, delivering their thinking in a particular form of representation, and, therefore, allows them to understand tectonic itself gradually. Arguably, tectonic ideas need to be communicated. In order to do so, one is required to perform tectonic articulation as a means of visual communication of "the architectural selection and utilisation of technically motivated, engineered forms and details" (Schumacher, 2017, p. 113). As one articulates their tectonic thinking, his/her capability on performing tectonic as a design approach can then be evaluated. Tectonic articulation would allow the student to project the proceeding spatial aspects resulted from their proposed tectonic idea.

Articulating tectonic ideas

To communicate tectonic ideas, one needs to keep in mind that tectonic gives materials to effect. The joined materials, which then transform into surfaces, would allow a programme to work (Benjamin, 2006).

> Once a surface can effect—ie, it can bring something about—then it can be undestood as that which works to distribute programme. The effect will not be instrumental; rather it will be inherent in the opreation of the surface itself. ... Once the surface can be construed either as that which distributes programmable space, or functional concerns, or the elements of architecture (eg, walls and columns), then what is at work is a form of production; hence the surface effect. (Benjamin, 2006, p. 3)

Benjamin's argument suggests that one can then regard communicating tectonic ideas as venturing architecture programme upon surfaces—as the result of materials' joins. In retrospect, this indicates the first aspect of tectonic articulation a student needs to carry out. Arguably, thinking about the

performance of tectonic makes programmatic thinking available. As the process develops, students can project how the architecture of their project works. After all, as future architects, students must learn to "embrace the programme in all its complexities, to develop denser readings of what architecture could become" (Noero, 2018, p. 28).

However, one needs to remember that a surface of an architectural element actually carries two different surfaces. The first one is upon which we place a programmatic alternative, the one that we discussed above. The second surface is the literal surface of the element that is "the reciprocity of materials and geometry" (Benjamin, 2006, p. 23). It means that a surface has certain properties it brought as materials before they are joined together—the quality of the properties might or might not be changed after the materials meet one another. These properties are helping the surfaces to convey a certain quality that we regard as atmosphere. Such thinking is essential because understanding that surface, as a result of a tectonic expression, indicate the relation between tectonic and spatial occupation resulting from sensorial experience. Both the material and its geometry bring out atmosphere to space. We suggest that this notion becomes our second aspect of tectonic articulation. Communicating tectonic expression means that one has to render its possible atmospherical consequences: how we might feel when we experience the space?

Lastly, the tectonic articulation requires architects to perform a comprehensive investigation before selecting the most suitable response to the project brief (Schumacher, 2014). For students, this means conducting an exploratory process of joining elements and materials as an iteration of tectonic expression which would help them decide the befitting one. Tectonic articulation also suggests that "the selected formalism has been derived from selected engineering logic" (Schumacher, 2014, p. 49). In consequence, students have to show the logical thinking behind the performed iteration. Our discussion will further be drawn with the above three aspects revolving around the tectonic articulation to reflect how one uses tectonic thinking in his/her design process.

Interior architecture design studio 2: Designing a dwelling

From here on, we will discuss the tectonic articulation by reflecting through an academic project performed by the second-year interior architecture students in a design studio 2 course at Universitas Indonesia. The brief of the project is to design a dwelling for a small core social group: a house for a family. The project particularly asks students to demonstrate design as a comprehensive interrelationship between tectonic, programmatic, and atmospheric slant. In general, the project begins with students analysing a real family who lives in a house. Students were asked to obtain data regarding the family, their daily activities, and how they inhabit the house. Through the data, the student then formulates a design proposition that will address aspects of living that the family needed, pinpoint any

problems with their current house and aspiration of a kind of house that the family desires. The point of disembarking of the main design process is when the students propose a design statement as a foundation before students further engage with tectonic exploration. Following the exploration is a process where students interrelate the tectonic aspect with the programmatic aspect of the design. Here, the students try to see how their tectonic ideas would be ideal for their house programme. Lastly, the students further explore how the spaces' atmosphere in their house design would complete their project. Although here and further in the following section in this paper we would discuss our focus on tectonic articulation in a more structured manner, the actual process of design performed by students is not linear. Instead, there is a complex forward-backwards attitude towards tectonic, programmatic, and atmospheric exploration.

Several students' works will explain how the studio project aims for the students to design through tectonic thinking. Each of the three tectonic articulation aspects that have been previously discussed will be unfolded to extend how the students use tectonic as the primary approach for their dwelling design.

Tectonic articulation #1: Formal iteration

In the project, students' first engagement with tectonic was to generate various form as they explore their tectonic ideas. In this stage, the exploration was delivered through a manual model making, whereas the development of the tectonic idea from one model to another resulted from the reflective thought that the student obtained each time one model is finished. Interestingly, as a set of iteration, the students showed how their tectonic idea might be developed one complexity higher each time a model is created. In order to articulate their tectonic, the student must create several models until they obtain the desired tectonic complexity. The exploration mainly aims for two things: 1) To study the possible forms generated from student's tectonic idea, and 2) to traverse a tectonic identity for their design.

Students' attempts to achieving the two aims can be seen in the works of Sitaputri. In Sitaputri's work, her tectonic exploration disembarked from a tectonic idea that focuses on manipulating openings in the design by elevating their positions (see Figure 1). The idea is, in particular, to respond to the needs of the inhabitants. Such information was previously gathered by interviewing her client—the project requires each student to look for a family who is willing to be a client for the project—and observing how the client inhabits their current home. Before creating the models, Sitaputri first translated her idea into spatial vocabularies from which she could compose elements to make up 3D models. Sitaputri's spatial vocabularies encompass a specific mechanism and/or rule or spatial qualities that she needs to achieve (see Figure 2). The spatial vocabularies were each accompanied by a simple diagram that shows how the mechanism would work three-dimensionally. Students were all required to perform such a task to make sure that they have a framework for their model explorations, although

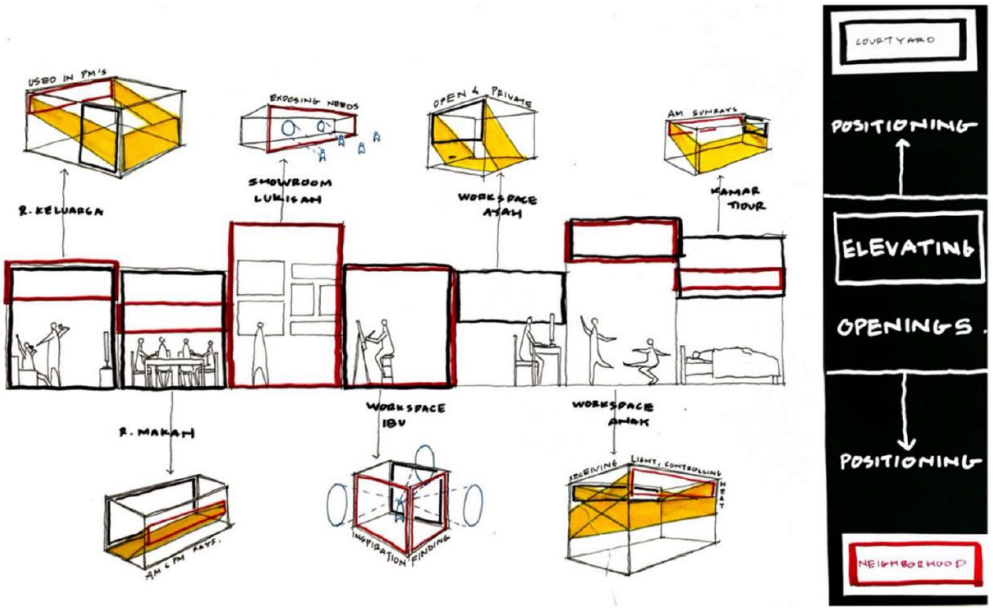


Figure 1. Lintang Kirana Sitaputri's initial tectonic idea (Image by Lintang Kirana Sitaputri, 2020)

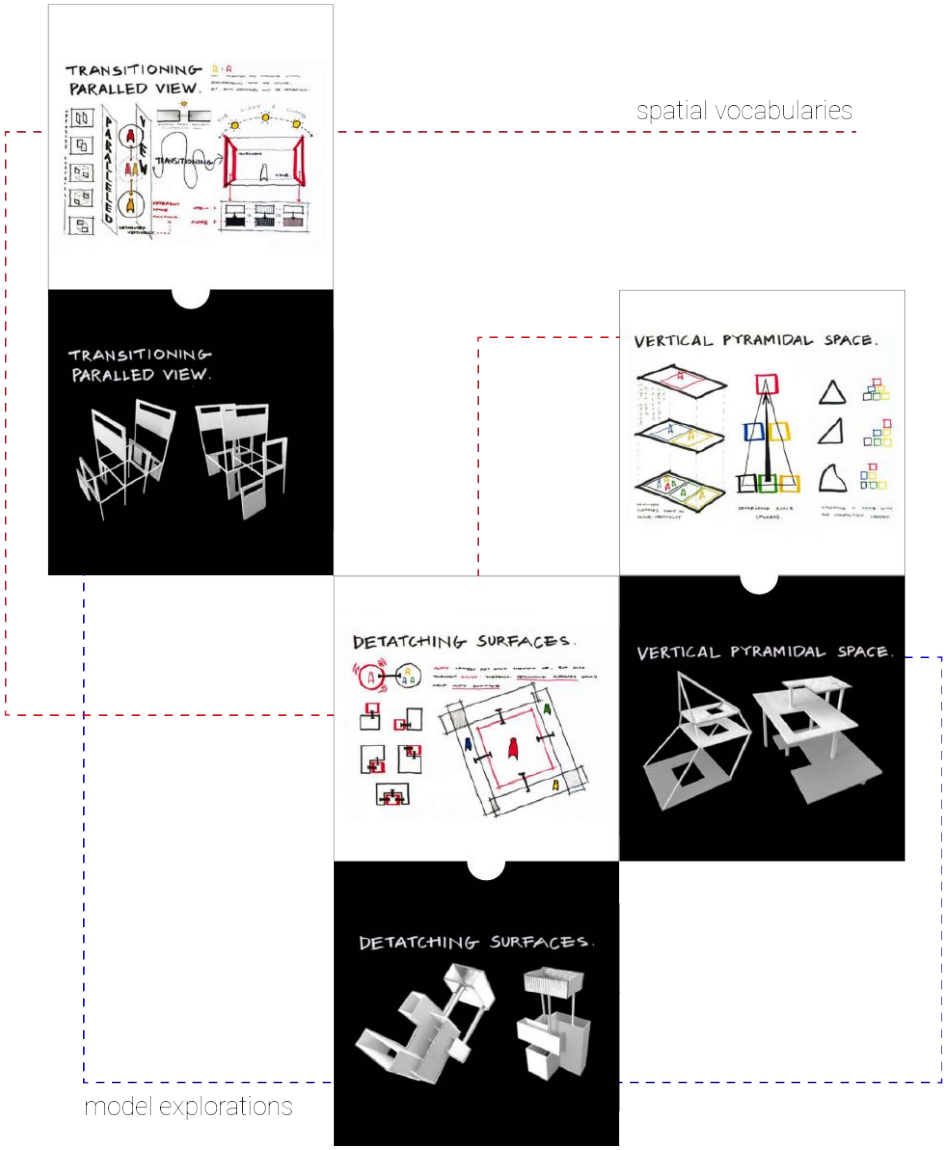


Figure 2. Lintang Kirana Sitaputri's spatial vocabularies and basic models based on the spatial vocabularies (Image by Lintang Kirana Sitaputri, 2020)

there was no limitation to the vocabularies. Instead, students were encouraged to make sure that their vocabularies would be succinct yet explorable enough. This part of the exploration was essential as this would affect how students would achieve the two aims of the model exploration. The success of their iteration in achieving the two aims of the iteration stage—was influenced by how they translate their tectonic ideas into spatial vocabularies. As students obtained their spatial vocabularies, the model creation could then proceed.

Students were initially briefed to create some basic models that show how their vocabularies appear in simple 3D compositions. From here, the process was relatively straightforward. Students were further asked to create more complex models; the complexity of which can be addressed by adding more elements to the composition or further considering their tectonic idea. As a result, by the end of the task, students would have an iteration that shows the development of their tectonic idea in the form of 3D compositions (see Figure 3).

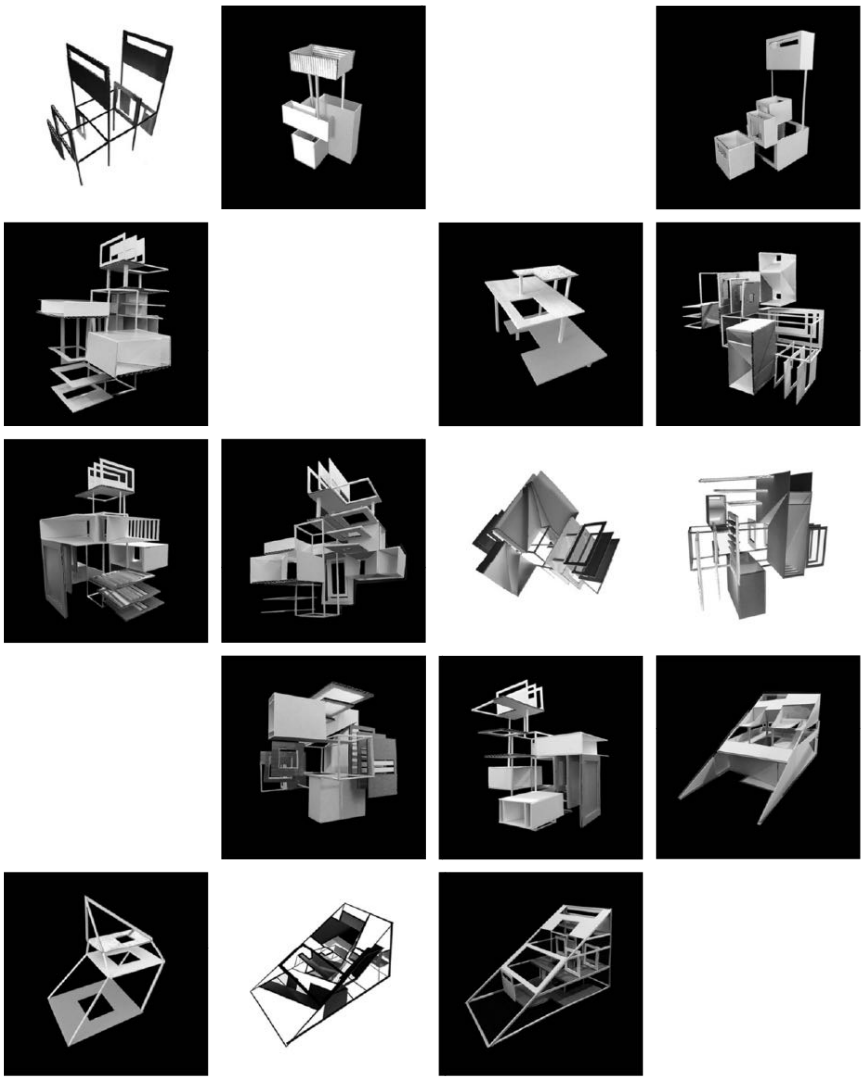


Figure 3. Tectonic exploration by Lintang Kirana Sitaputri (Image by Lintang Kirana Sitaputri, 2020)

Tectonic articulation #2: Surface effect, programme

Discussion on the second tectonic articulation is drawn by looking at how the students reflected towards their exploration models in the iteration stage. Although we decided to explore the second tectonic articulation separately, the process of articulating how the surfaces from the tectonic exploration might allow for the proposed programme to work is intertwined with the iteration process. Interestingly, the moment the students performed the second articulation, he/she was helping him/herself to carry on with their design process. In particular, as suggested in the first tectonic articulation discussion, the complexity of the exploration was significantly influenced by how the students articulated the tectonic-programme relation, which was then further regarded as the surface-programme nexus. The aim of the students in examining the relationship between the surfaces that appear in their 3D models and the programme that might be placed upon the surfaces was to help the students select the most suitable form for their design. It is why the second tectonic articulation becomes inseparable from the first one. Together the two make up the whole iteration process.

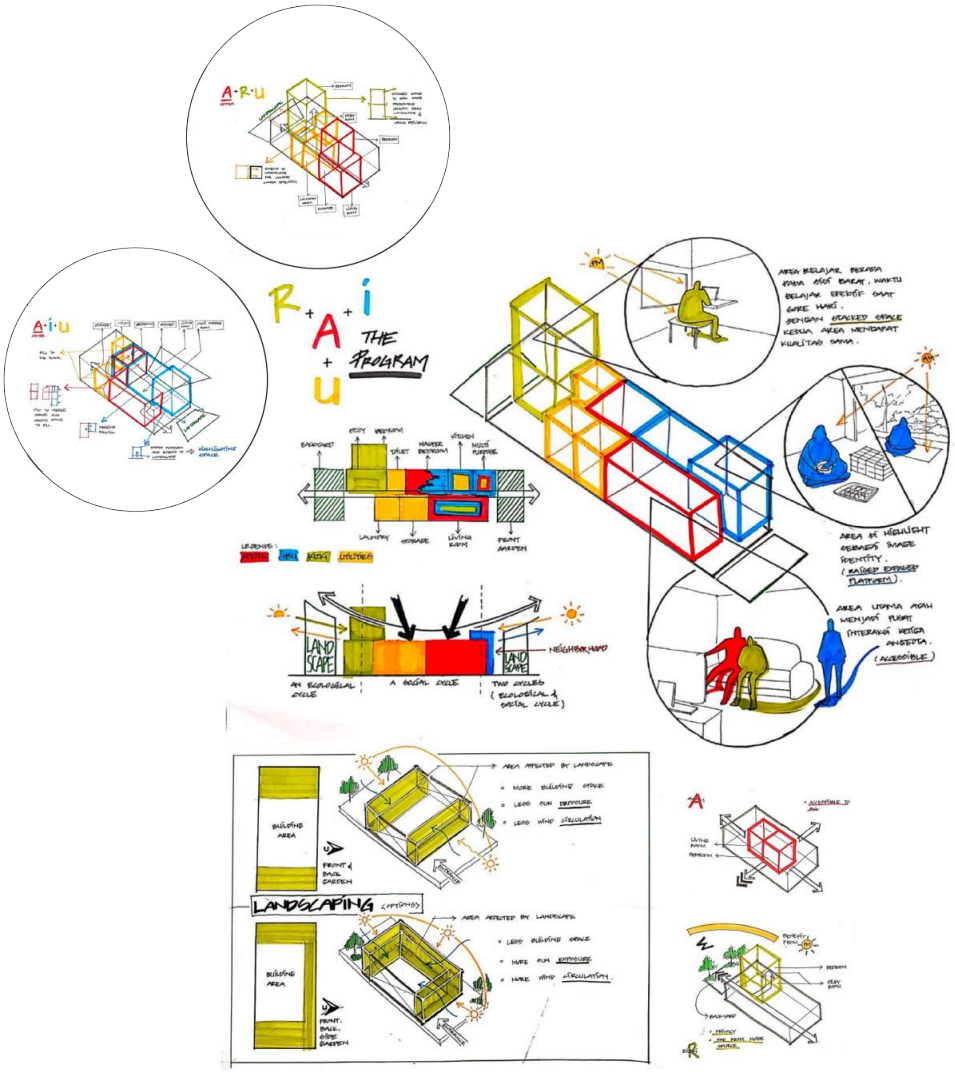


Figure 4. Adika Ramaghazy's proposed programme (Image by Adika Ramaghazy, 2020)

Around the same time with the stage where students proposed the tectonic idea based on the analysis of the data obtained from interviewing and observing their clients, the students were also asked to propose a programme that would address problems and aspirations of house design' needed and wanted. Supposedly, the proposed programme would have to insinuate how the spaces of the designed house might work. Aspects of spatial performances and qualities became the basis for the proposed programmes, including but not limited to natural lighting, visibility, accessibility, inside-outside relations, and other aspects. Students, however, could choose the most relevant aspects that respond to their respective clients' needs. An example of this task can be seen in Adika Ramaghazy's work in Figure 4. Here, Ramaghazy proposed a design programme through diagrams that inform his programme and the responding spatial aspects, including the spatial connectivity, flow, and the integration between the design with the landscape.

Before going deep into the part where students realise and make an effort to understand the tectonic-programme relationship, the project requires the student to propose how their tectonic idea and their programme proposition would merge. Another Ramaghazy's works in Figure 5 shows an example of how the students oversaw this task. The diagram illustrates his thinking towards the attainability of his tectonic ideas in addressing the architectural programme. In the diagram, Ramaghazy showed how each of his chosen spatial vocabularies (elevating space, centralised space, and extending beyond the façade) would explore the nexus.

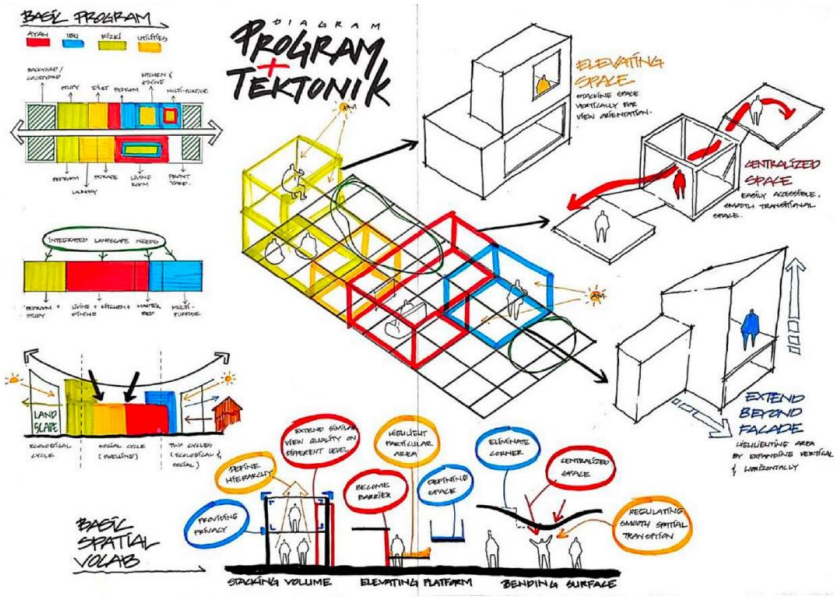


Figure 5. Adika Ramaghazy's analysis on the relationship between his tectonic idea and the proposed programme for his house design (Image by Adika Ramaghazy, 2020)

Further in the process of the 3D model exploration stage, the tectonic-programme relationship becomes a surface-programme nexus. The project requires the student to observe and analyse their models and imagine themselves being

inside their models. The analysis was delivered in the form of diagrams that incorporate architectural drawings such as plan and section. Ramaghazy's works in Figure 6 show his attempt on revealing the surface-programme nexus of his 3D models. In Ramaghazy's analytical diagrams, we can see how he tried to understand how the spaces within each of his models—indicated in the image as a sequence from Model 1, Model 2, Model 3, to *Model Proporsional* (Proportional Model)—giving ways for various spatial performances which correspond to his proposed programme to emerge. The section and plan drawings that Ramaghazy used in his analysis allow him to interpret the possible spatial relations better. All of the students were inquired to do the same level of analysis. Students repeatedly analysed a model right after they made it, learnt from it, and used the knowledge to create another tectonic model.

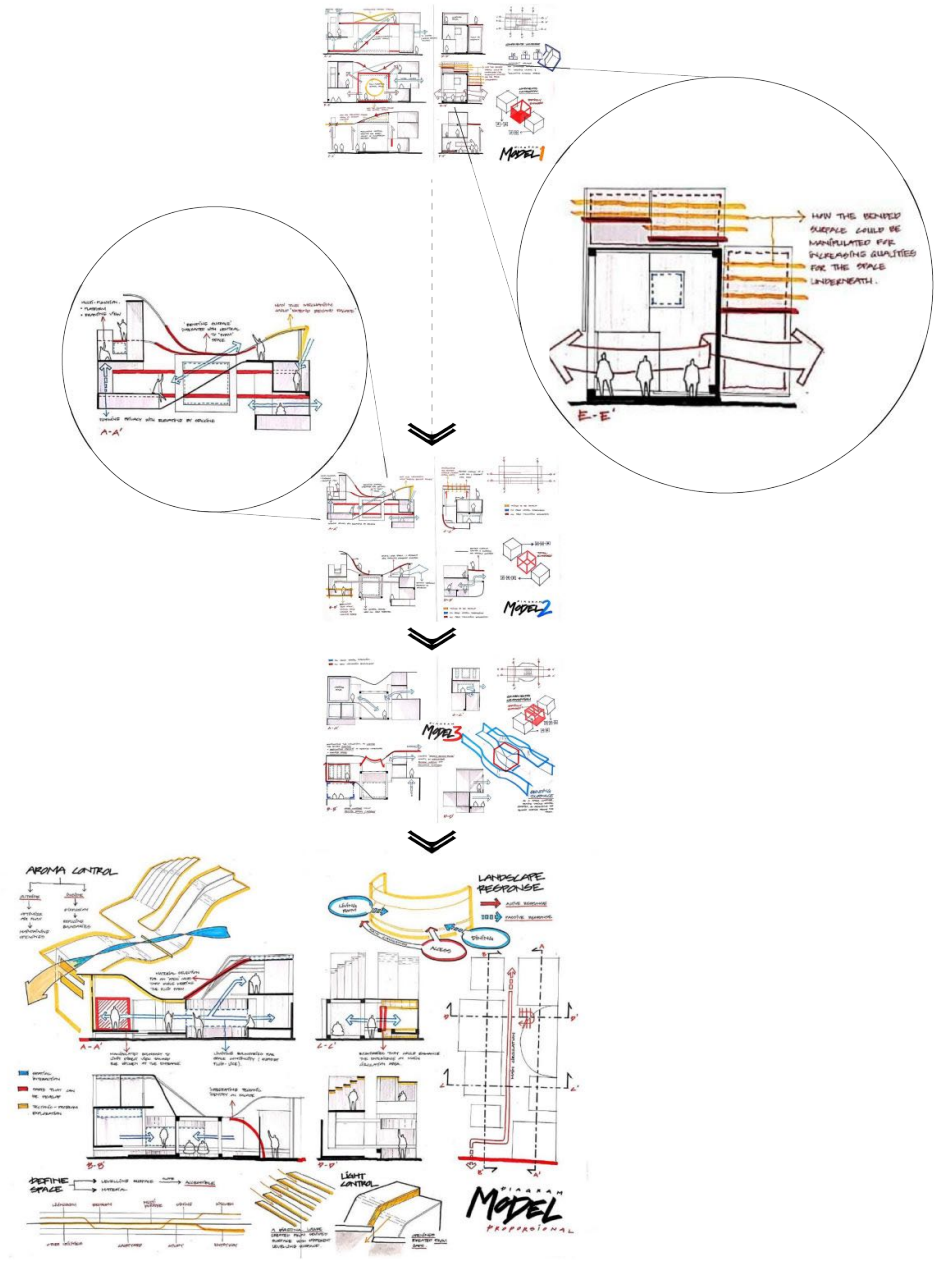
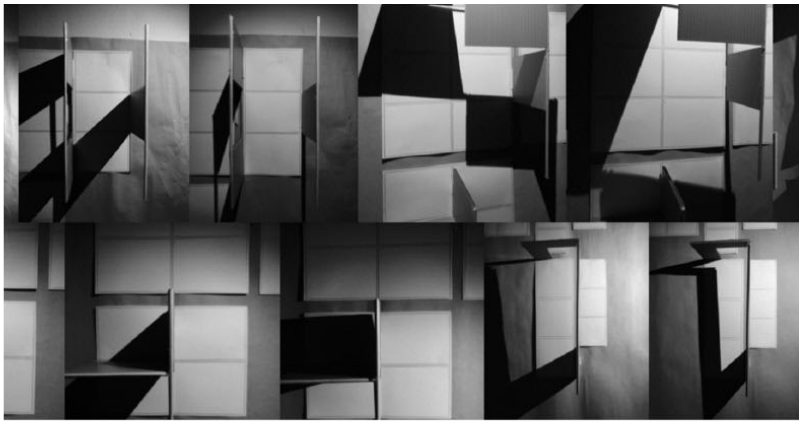


Figure 6. Adika Ramaghazy's analysis on surface-programme nexus (Image by Adika Ramaghazy, 2020)

Tectonic articulation #3: Surface effect, atmosphere

The last tectonic articulation focuses on students' attempt to reveal another form of consequential nexus of the tectonic-programme relationship, that is surface-atmosphere. In the process, student were actually thinking through such notion around the same time when they analyse their models for understanding the surface-programme nexus. In the process, tutors encouraged the students to do so, although the portion of focusing on the third tectonic articulation mostly lies in the latter stage of the overall design process, that was when the students became more firm with their explored form. Surface-atmosphere nexus appear as the students were asked to look at how the elements composing their models bear a certain effect and properties, hence affecting the spatial qualities of their composition models. We can see the exploration of the two aspects in the works of Reyna Ananda Harsono, as seen in Figure 7 and Figure 8.



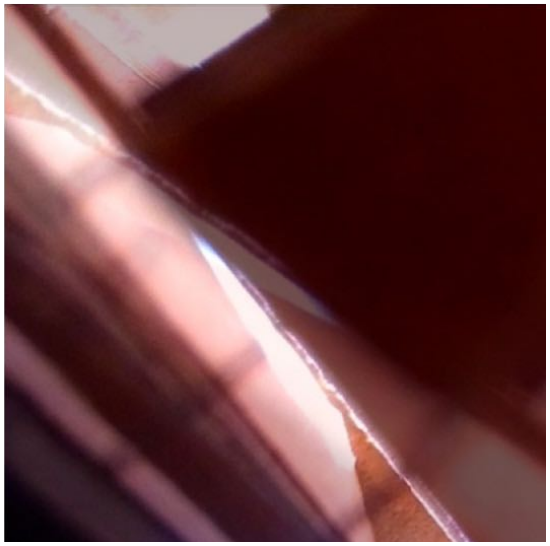


Figure 7. Study of light and shadow by Reyna Ananda Harsono (Photographs by Reyna Ananda Harsono, 2020)

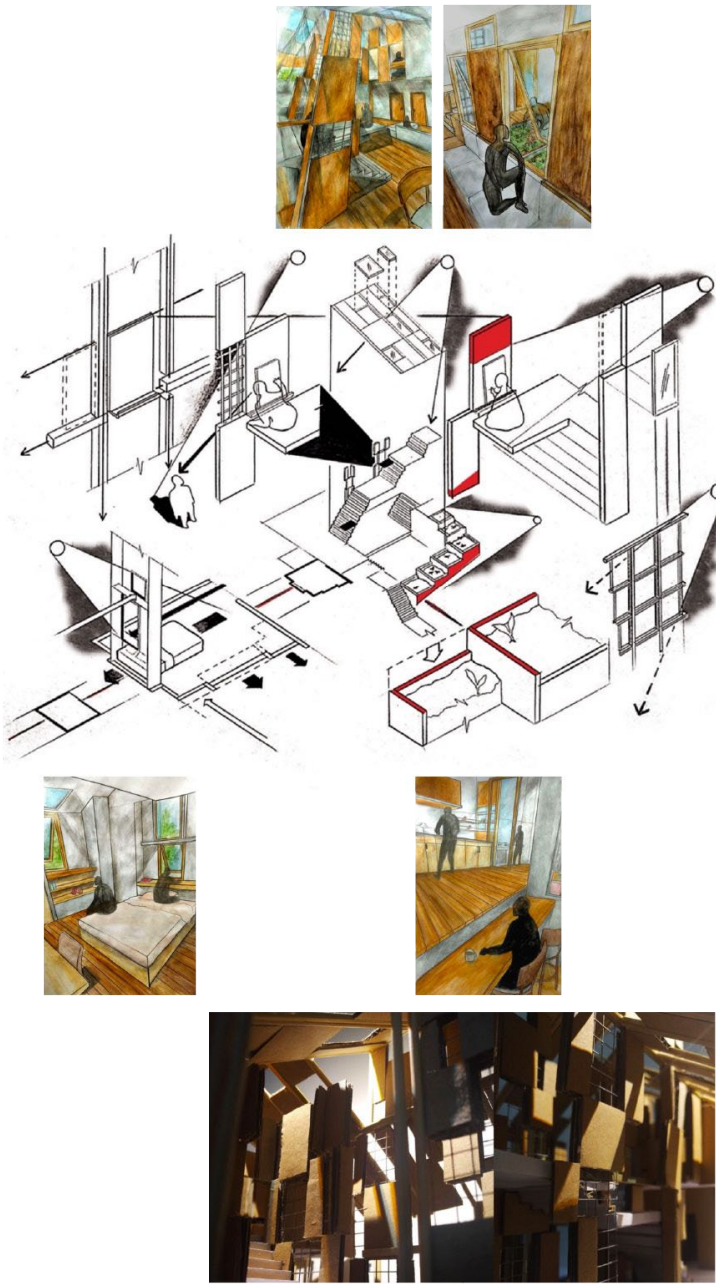


Figure 8. Reyna Ananda Harsono's design shows the atmosphere of the spaces within the house (Images and photographs by Reyna Ananda Harsono, 2020)

When it comes to the tectonic effect, students could easily see it as they, for example, the direct light towards their models or photographs of the spaces in a particular condition. As shown in Figure 7, small observation towards their tectonic exploration models would explain that different joins allow for different spatial qualities to emanate. In Figure 7, Harsono showed her investigation towards the performance of shadows in her tectonic exploration models. Meanwhile, when it comes to the surface properties, students were asked to consider the possible use of various architectural materials in substitution to the actual materials they use for their composition elements. As the art of joining, tectonic was further explored as they started to see that the joins are joins of different materials. Once they explored the possibilities, they would then be able to see how the atmosphere of the spaces might appear. Here, the students

were invited to realise how to enhance their design through different material composition. Students were invited to develop their design further as they started to choose the materials for their design. Harsono's work in Figure 8 shows her proposition on the architecture material selection for her house design. She accumulated her knowledge on how the shadows work as a result of her tectonic expression, relating them to the spatial needs as her proposed architectural programme suggests, then created the overall image of her design that shows the performance of the atmosphere.

Learning tectonic articulation

The reflection provides us with a piece of knowledge on the extension of tectonic articulation and how it might be incorporated in a design studio. As students are invited to think through the three tectonic articulations, they will learn to understand the importance of tectonic and its potential to be used as a design method. In the reflection, the Interior Architecture Design 2 Studio in Universitas Indonesia shows how each of the three tectonic articulations offers a specific learning experience for the students. Although, the authors must address, again, that the three should not be seen separately but as a set instead.

The articulation of tectonic starts through an iteration process. From the presented student's work, we can see the importance of tectonic exploration and selection to understand the potential of tectonic as a design approach (Schumacher, 2014). As the 3D model was created from the iteration, students started to realise the surfaces of the elements in their composition models and how they make up various spaces in their models. Nonetheless, the first articulation indicates the initial part of the whole process of understanding and exploring the tectonic. This articulation mainly introduces students with tectonic as a strategy to compose elements. It is a critical phase in the overall idea of learning tectonic because such thinking helps the students to comprehend tectonic as the basis of their design approach.

In subsequent, students were invited to realise the potential effect of surfaces towards their proposed programme and atmosphere—referring to the surface-programme and surface-atmosphere nexus. Collectively, students could then seek the most suitable form for their design. By performing the iteration and realising the potential effect of the surfaces, students can see potentials and flaws in their tectonic ideas (Wynn & Eckert, 2017). The projects particularly allow the students to think reflectively towards their works, and this is particularly important to enhance student's understanding of tectonic as a concept and as a knowledge that could be used as a problem-solving in a design process (Hatchuel & Weil, 2009). The two nexuses forms the last two of the triad articulations, indicating the potential of integrating tectonic in architecture pedagogy. As elaborated in previous sections, the tectonic way of thinking is beneficial for understanding the intrinsic aspect of architecture

and its potential effects. Besides, it can also be a powerful way to introduce the students to the wicked side of the architecture design process that requires a balance between creativity and logic; to think back and forth (Harahap et al., 2019). Consequently, the tectonic articulations presented in this paper reflect the students' attempt to construct design knowledge by directly involving her/himself in the design process (Roggema, 2016).

Although this study only selects several students' works to coin out the focus of this paper, the author suggests that we need more documentation and publication that further explore how tectonic is incorporated in our architecture education. In particular, the study on tectonic articulation itself is still open for further exploration. The study only reflects a single studio project with a specific brief and constraint for the student to follow. Different brief and design constraint might inform us on another discrete form of tectonic articulation. For example, the models created by the student in this paper were all produced manually. Digitally generated models might pinpoint different kinds of tectonic articulations.

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