CAD, BIM, Parametric and Their Use as Auxiliary Tools in Design Studios
(Case Study: Final Year Students at Department of Architecture, Institut Teknologi Nasional Bandung)

Ardhiana Muhsin[1,*] Erwin Yuniar Rahadian[1]

[1] *Department of Architecture, Institut Teknologi Nasional Bandung, Itenas, Bandung, Indonesia*
Corresponding author. Email: dade@itenas.ac.id

ABSTRACT

The development of digital technology in the past two decades has a major impact on various sectors including architecture and construction. In Indonesia, Computer-Aided Design (CAD), which began to be known around 1990-1994 as a tool in drawing, had pros and cons compared to manual drawing methods. In line with the emergence of Building Information Modeling (BIM) technology towards the beginning of 2000. BIM also experienced a period of pros and cons like when CAD was first present. The presence of a parametric-based design method then seems to reverse the drawing method that has been known by computer users as a drawing tool. However, the world of practitioners, which is moving faster, requires universities to always make adjustments to the needs of competence through the courses offered, and students as the main object in the world of architectural education are required to keep abreast of the latest technological developments. This paper tries to examine the comparison of the methods of drawing aids for students, by examining the majority of software used by final year students. The results of this study can then be used as input for the curriculum team in improving the curriculum in the Institut Teknologi Nasional Bandung architecture program.

Keywords: Architecture, Digital, Method, Student, Design.

1. INTRODUCTION

Architecture as a tangible form of architect's work cannot be separated from the role of technology that supports it [1]. Starting from the initial stage of initiating a design idea, implementation or construction stage, even to the management or use stage. The development of digital technology greatly affects these stages until there are many changes in their implementation. The depiction stage as the first step in a series of implementations of the construction of a building also underwent changes. If in the past the drawing process began with a sketch followed by a measured image, the initial physical form was a building model with a certain scale. The inclusion of CAD as a drawing tool changes the hand line pull into a line command and its length and direction by entering the data through the keyboard. This situation then gave rise to conflict. Some argue that the idea is conveyed through the coordination of brain, hand and paper, some argue that even though the media is replaced, the

essence or value of the design is not affected by the instructions for describing a software. However, technological developments cannot be stopped, according to Angelil in Soliman, Taha and El Sayad, computer technology should be involved in the educational process to replace conventional methods in the teaching and learning process at least in the last three years of architectural school education [2].

The next development is Building Information Modeling (BIM). This technology tries to correct various difficulties and obstacles encountered during using CAD [4]. Various conveniences start from simple ones such as making cut and visible images that no longer need to be done manually, to quite complex things such as getting the volume of a building and detecting the meeting of two building components that are in the wrong position, for example between a beam and a utility network pipe. BIM has also expanded its services from making work schedules, cost estimation, building analysis to building management.

The latest development is the inclusion of a parametric method of drawing. The update drawing no longer follows the availability of commands on the device, but everything is determined by parameters that can be added to get more dynamic or more complex results.

2. CURRICULUM AND ITS APPROACH TO DESIGN STUDIO

2.1. Institut Teknologi Nasional Bandung Architecture Program

The architecture program of the Institut Teknologi Nasional Bandung, in general, like other architecture schools, consists of 8 semesters with 7 design studios and 5 structure and construction studios to support the design [5]. Basic Architectural Design to Architectural Design Studio 3 which still draws manually is dominated by simple building materials and forms, with the supporters being the Basic Structure and Building Construction courses to Structure and Construction 1. Structure and Construction 2 which is given in semester 3 study about 4-story buildings. will be the right support for Architectural Design Studio 4 with a retail theme but is in semester 5 or exactly 1 year after undergoing support. The difference between the main and supporting studios is filled with a 2-story building depiction in the Computer Architecture 1 course with a digital depiction. The continuation is Computer Architecture 2 in semester 4, as well as repeating or reminding what has been taught in Structure and Construction 2. Structure and Construction 3 and 4 in semester 5 and 6 will then be themed on wide-span buildings and multi-story buildings which will be applied to Architectural Design Studio 5 and 6 in semesters 6 and 7.

2.2. Digital Technology in Institut Teknologi Nasional Bandung Architecture Program

Digital technology was introduced in the Institut Teknologi Nasional Bandung architecture program in 1996, with architecture program curriculum in the same year. Through the Computer Architecture and Computer Application courses which are set in semesters 3 and 4, the expected target in these courses is 2D and 3D CAD capabilities based on AutoCAD. It was further developed in the 2003 curriculum, through the Computer Architecture course 1, in the form of an introduction to 2D AutoCAD drawing, and Computer Architecture 2, in the form of an introduction to 3D modeling and visual presentations based on Virtual Building ArchiCAD (BIM) in semesters 2 and 3.

The 2011 curriculum returns the positions of Computer Architecture 1 and 2 to semesters 3 and 4 so that their use can be directly applied in the following

semester. In addition, according to Kara [3], the delay in using this digital device turned out to provide an opportunity for mastering more depiction material so that students did not have significant difficulties when moving to digital methods [3]. In the same year the development of Building Information Modeling and Parametric began to develop in Indonesia. In the end, the architecture program at the Institut Teknologi Nasional Bandung decided not to study Parametrics in its courses and switched to Building Information Modeling which would later support digital construction.

In 2017 an elective course on Building Digital Modeling was added in semester 6 which focuses on cost calculations and collaboration in working on images using Building Information Modeling (BIM). This early introduction to digital technology is intended so that students are given knowledge about these drawing aids and have time to train and develop them so that they can then be used in the Architectural Design Studio 4 course which is in semester 5. Another consideration is to give choices to students. students, what software skills will be honed as a provision after graduating from the Itenas Architecture study program. This curriculum is prepared as a response to the needs in the field of work, the development of existing technology as well as conformity with the Architecture study program of the Bandung National Institute of Technology whose character prioritizes engineering in designing a building (see table 1 and figure 1).

Table 1. Digital technology in curriculums

| Curriculum	SKS	Semester	Course Status
Curriculum 1996			
KTA 306 Komputer Arsitektur	2	5	Mandatory
KAP 434 Aplikasi Komputer	2	6	Optional
Curriculum 2003			
KTA 323 Komputer Arsitektur 1	2	5	Mandatory
KTA 324 Komputer Arsitektur 2	2	6	Mandatory
Curriculum 2011			
AR 116 Komputer Arsitektur 1	3	2	Mandatory
AR 215 Komputer Arsitektur 2	3	3	Mandatory
Curriculum 2017			
ARA 207 Komputer Arsitektur 1	3	3	Mandatory
ARA 208 Komputer Arsitektur 2	3	4	Mandatory
ARA 351 Pemodelan Digital Bangunan (Building Information Modelling)	2	5	Optional
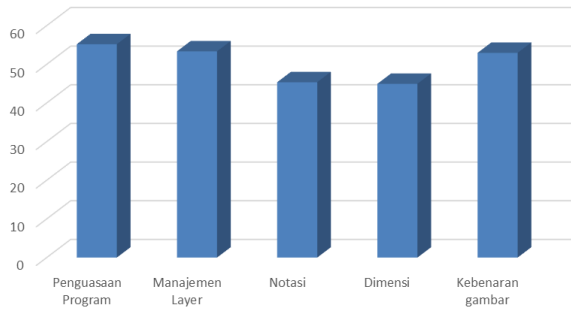
Figure 1 Evaluation of the achievement of architectural computer competence.

3. DISCUSSION

Based on the conditions described previously, this study then looked for 137 respondents to find out the extent to which students used these drawing aids and how they responded to the development of these digital imaging tools that occurred outside the campus both at home and abroad. Respondents who were randomly selected were students who had attended the advanced or final stage of the design studio, starting from the Architectural Design Studio 4 to students who were or had followed the Final Project (figure 2).
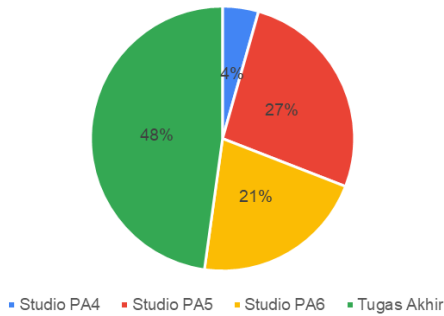

Figure 2 The last design studio taken.

At the initial stage of the questionnaire, students were asked to provide an assessment of the mastery of drawing on image products that were commonly asked for in assignments or on real projects after they had worked one time. The majority of respondents really like to draw both exterior and interior perspectives. The pleasure of 3D drawing for final year students is also supported by their experience in undergoing Internships at consultants who are always asked to help them draw exterior and interior perspectives. For those who work with contractors, apart from serving as supervisors, students are generally assigned to revise drawings using 2D CAD. These things then divert their attention to explore other software even though it is not taught in the curriculum of the architecture program at the Institut Teknologi Nasional Bandung to support its ability to produce 3D images. Students find it easier to operate 2D CAD for drawing which is converted to the SketchUp program for 3D drawing (see figure 3 and 4).
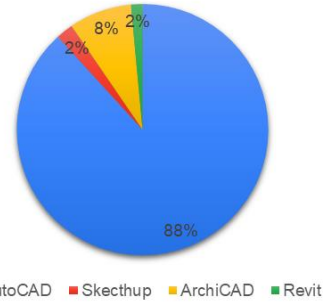

Figure 3 Applications commonly used in making 2D images.
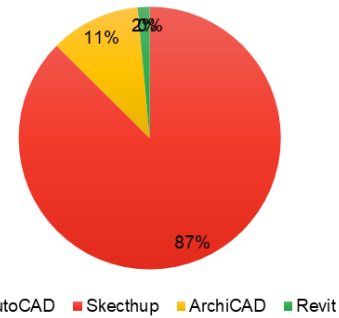

Figure 4 Applications commonly used in creating 3D models.

This process also applies the opposite, namely making 3D modeling first after that it is converted into 2D images. Two-way image coordination like this is actually a hassle, especially when it comes to timing. This is also reflected when answering questions about the time allotted in working on the studio. In general, on a scale of 1-5 where a value of 1 means very less and 5 means very sufficient, there are still many respondents who stated that they lacked time with assessment numbers ranging from 1-3 (figure 5).
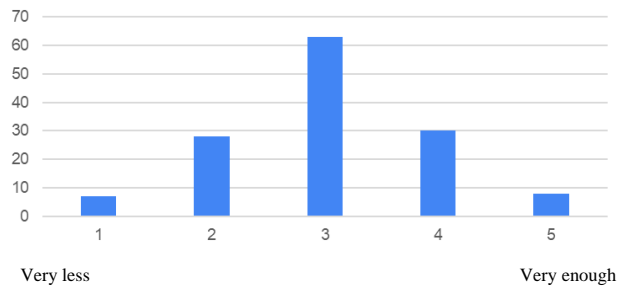

Figure 5 Task completion time.

Another interesting finding is that the majority of respondents also strongly dislike drawing section and structural or utility isometry. In 2D CAD the drawing of the pieces is done manually so that it becomes something that is not liked by students. On the other hand, many architectural designs are then solved in detail or connection problems through cut drawings. Uniquely, the problem of drawing this piece, as well as the isometric drawing of structures and utilities, can

actually be solved by the drawing tools that have been taught in the Computer Architecture 2 course, namely through Archicad with the basis of Building Information Modeling, but very few students rely on this Building Information Modelling-based software as a tool for depiction (see figure 6).
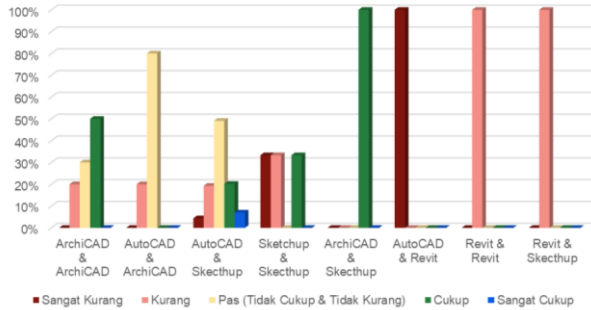

Figure 6 Comparison of completion time against 2D & 3D CAD software.

4. CONCLUSION

In general, architecture students in Institut Teknologi Nasional Bandung are very enthusiastic about learning the method of drawing by adopting digital technology. This can be seen in the early stages of design studios 1 or 2 quite a lot of them can operate SketchUp even though this knowledge is not acquired through teaching on campus. However, to keep up with further developments in imaging technology such as Building Information Modeling, students look to the opportunities offered by the job. There are still many consultants in Indonesia who also have not used Building Information Modeling as a technology or drawing tool in their offices. This makes students less interested in learning new things. In fact, parametric design seems far beyond the students, so that this knowledge stops being just a theory.

REFERENCES

[1] R. A. Putra, "Peran Teknologi Digital dalam Perkembangan Dunia Perancangan Arsitektur", Elkawnie Journal of Islamic Science and Technology, UIN Ar-Raniry Banda Aceh, Vol. 4, No. 1, 2018.

[2] S. Soliman, D. Taha, Z. El Sayad, "Architectural Education in the Digital Age Computer Applications: Between Academia and Practice", Elsevier Alexandria Engineering Journal, Faculty of Engineering, Alexandria University, Egypt, 2019.

[3] L. Kara, "A Critical Look at the Digital Technologies in Architectural Education: When, Where, and How?", Elsevier, Procedia - Social and Behavioral Sciences 176 (2015) 526-530.

[4] M. K. Karen, N. Douglas, Building Information Modelling, BIM in Current and Future Practice, John Wiley & Son, Inc., Hoboken, New Jersey, 2014.

[5] Program Studi Arsitektur, Fakultas Arsitektur dan Desain, Institut Teknologi Nasional Bandung. [Online] Avai;ab;e at: https://www.itenas.ac.id/akademik/fad/program-studi-arsitektur.