HARMONISING SKETCHING, DRAFTING AND CADD IN ARCHITECTURAL EDUCATION IN NIGERIAN POLYTECHNICS: CASE STUDY OF YABA COLLEGE OF TECHNOLOGY

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Abstract: This article discusses the impact of the almost total dependency on the use of Computer Aided Design (CAD), deviating almost completely from the traditional freehand sketching and drafting in architectural training programmes in Nigerian polytechnics. In order to test the impact of freehand sketching and Computer Aided Design and Drafting on the standard of designing capability of the students of architecture in a typical Nigerian polytechnic, one hundred and eighty(180) students in the department of architecture, Yaba College of Technology were tested. Test evaluations depicted that conceptualization in students' architectural design studio works was negatively affected and handwriting of mostly final year students were not as legible and regular as expected of young graduate architects. The paper concluded that students' over dependence on CAD impacts negatively on level of proficiency in design concept formation and use of pen and pencil on paper. It therefore recommended that freehand sketching and practices should be expanded and spread across almost all the semesters to positively harmonize the use of CAD and its applications.
Keywords: Architectural Education, CADD, Drafting, Drawing, Sketching, Students.

INTRODUCTION

Architectural practice like any other human endeavour in contemporary world is wholly embedded in computer and its applications. Computer Aided Design and Drafting (CADD) is the most employed computer application in the architectural profession for drawing production and construction job administration. The advantages are numerous and surpass the manual drawing practice previously employed as computers are simply better than humans in executing such tasks, not as good in conceptualisation or idea formation. A common criticism of CAD is that it causes the designer to focus on details instead of the underlying principles (Utterback, 2006). It is written that "sketching by hand allows a designer to capture an idea quickly; it concentrates on the essentials rather than on bells and whistles (Utterback, 2006)". Another drawback is in the limitations entrenched in the training of young architects, who may at the onset be carried away with the 'fake' design results obtainable from the use of computer. This is so because an excellent computer presentation can make a poor design look

good. According to (Steele, 2001) architectural training, involving the wrong use of computers will fail to produce architects that are capable of handling practical office matters or even construction problems in a conventional manner.

Sketching (drawing freehand without aids) is an essential tool every designer, especially the architect must possess to facilitate the generation, as well as recording of ideas and concepts. This could be evidenced from the huge sketches of past and present famous and successful architects, like Frank Lloyd Wright, Le Cobusier, Santiago Calatrava and Herman Hertzberger. Sketching and drawing are easy means of creating visuals and it has been identified that a designer's spatial ability is improved through sketching (Chester, 2007). Sketched diagrams focus on general information and encourage the designer to explore alternatives. Students' over indulgence in the use of computers in early formation of their minds as architects is detrimental to their fluency in sketching and thus their true creativity proficiency.

While the importance of the use of computers in contemporary architectural practice cannot be overemphasized, sketching as well must not be relegated to the background because of its relevance in the training process of the student. This paper, therefore, focuses on the impact of computer (CAD) usage on the students ability to sketch and design proficiently. In this paper, computer aided design (CAD) and computer aided design and drafting (CADD) is used interchangeably, unless otherwise stated.

ARCHITECTURAL DESIGN PROCEDURE

Almost everything designed; including architectural schemes are first sketched. Sketching is a freehand expression of the graphic language. It is a valuable tool, "worth a thousand words", used as a means of communication for a designer or architect. There are various schools of thought and philosophies regarding design principles and approach. However, initial concepts and ideas are generally recorded with simple sketches, which allows for easy manipulation and further changes at no costs. CAD usage limits the ability of the architect/designer to visualize in three dimensions and to simulate aspects of performance.

Central to the design process in architecture is the process of drawing. According to (Lawson, 1994), the pencil should work after the brain. That is to say, you have an idea, you think and then you score by means of words or drawing what you think. But it could also be the other way round: that while drawing, your pencil, your hand is finding something, a seemingly wrong approach for the architect, as design is about solving problems. This justifies the existence of the architectural draftsmen alongside architects in a typical firm. The architect

does the thinking, scribbles or sketches on paper and passes on to the draftsmen for further detailing. Though in some design schemes consisting irregular shapes and forms physical models may employed to completely convey the design idea. To follow the true design process and achieve real creativity some architects like Santiago Calatrava, who practices in France and Switzerland, and Dutch architect Herman Hertzberger, have made deliberate decisions not use CAD in the early design stage or as a creative tool. Does the creativity come from computer or the architect, who uses the computer? The computer as machine/tool cannot think or conceive ideas, but humans do and therefore the sole designer.
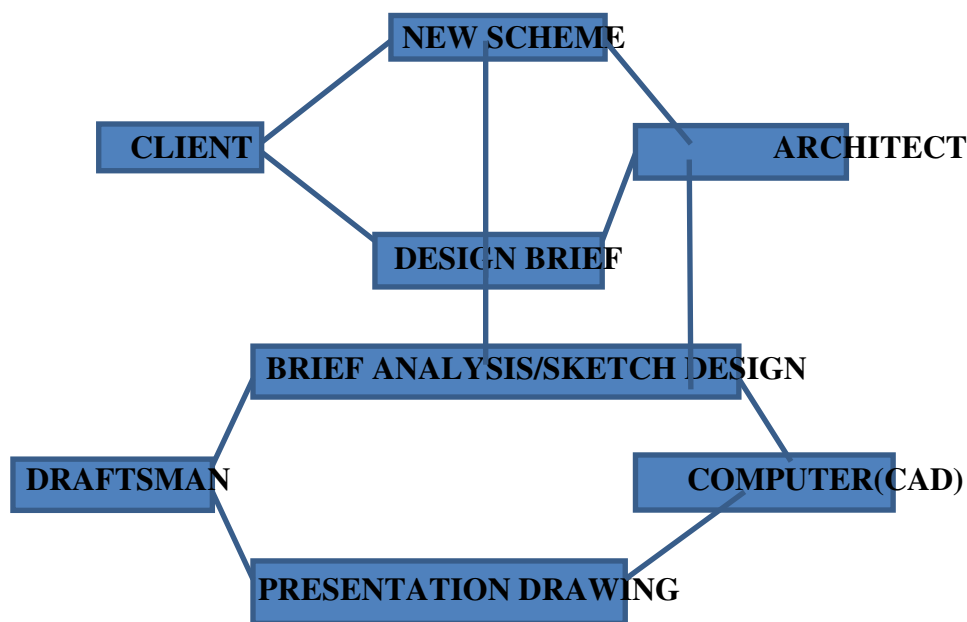

FIGURE 1. Traditional architectural design process.

2. COMPUTER AIDED DESIGN AND ARCHITECTURAL EDUCATION

How does CADD affect architectural education?

Computer usage in architectural practices in gained popularity in late 1980's. CAD has been used primarily as a tool to enhance design by producing graphically defined concepts, and working drawings. It was also used as an information processing and communication tool and as a visualisation tool during the creative design process. At the same time, architects rely on free-hand sketches and physical cardboard models as important conventional tools that are combined with digital ones during their design process (Szalapaj, & Chang, 1999). Then, what was taught in schools of architecture, as part computer education in the curriculum were mainly the programming languages like Fortran or Cobol and simple computer

applications. This situation is against the present day system where CAD is predominant in both the educational concerns and real practice. The reason is not far-fetched: this is the computer age. As noted by Ye, Peng, Chen, & Cai, (2004) Computer aided design (CAD) is ubiquitous in both engineering education (and industrial application (Field, 2003; Robertson, Walther, & Radcliffe, 2007).This trend is detrimental to the effective training of students and practice of design professions like architecture and engineering, as research asserts that CAD tools have the potential to negatively impact the design process (Robertson, Walther, & Radcliffe, 2007) through the following ways.

Circumscribed thinking: (I) occurs when the design tool limits the designer through interfering with the designers' intent. (ii) Premature fixation: The designer becomes resistant to change as the model takes on a high level of complexity or detail (iii) Bounded idealization: Over-use of CAD tools decrease the designers' motivation and creative abilities. Generally, visuals are created to enhance personal cognition about information or concepts encountered. Sketching and drawing are easy means of creating visuals and it has been identified that a designer's spatial ability is improved through sketching (Chester, 2007). A designer's ability to successfully generate technical artifacts is positively correlated with their spatial ability (Tseng & Yang, 2011). Sketching ability is an essential tool every architect must possess from the onset, whilst the strategic position of CAD in today's architectural profession cannot be overlooked.

ACADEMIC CURRICULUM, ARCHITECTURE, YABA COLLEGE OF TECHNOLOGY

The academic curriculum of the department of architecture, Yaba College of Technology consists of the regular 2-tier Nation Board of Technical Education (NBTE) in Nigeria of 2-year National Diploma (ND) and another 2-year Higher National Diploma (HND) programmes. Each of the programmes runs four semesters in two academic sessions, that is, two semesters per year. The ND programme has a total number of 48 courses while the HND has 46.

Architectural Design, like any other school of architecture is available in the entire eight semesters, that is, four semesters in either programmes. While freehand sketching is only available in the first semester of the first year in the National Diploma programme.

A few years back, design as the core course of the Higher National Diploma architectural education programme had generally used the manual method (sketch pad, Tee-square and Drawing board) of presentation by sketching at the conception or idea formation

stage and then progressing the the presentation stage and final production drawing. This is now replaced with the output of CAD plotter through a design process supported by keyboard and mouse.

LITERATURE REVIEW

The use of computers in modern life is inevitable in almost every aspect of human endeavour ranging from the minutest chore to the most ambiguous situation. Computer Aided Design (CAD) and other applications are used in architectural practice and education these days. This unhealthy trend is relegating freehand sketching, an important tool, in the design process to the rear. This can be seen in the aspects of the process of design that might be affected by the introduction of computers.

According to Purcell and Gero [1998] design research knowledge is based on the function of drawings. They conclude that drawings and sketches usually embody abstract design ideas and allow for imprecision regarding material attributes of the designed object necessary in the early design phases. Studies have shown that words predominantly activate conceptual and abstract knowledge, while images activate perceptual knowledge, for example about materials, forms, and analogue cases. Purcell and Gero [1998] agree that, most of the time, the work in design teams is successful because the integration of sketching and discussion in teams automatically activates both types of knowledge. Drawings and sketches enable us to put differentiate representational levels next to each other, to mix them and connect them [1983]. It also allows for alternatives to be sketched in and textual annotations and details inserted. These options can be done on architectural /engineering drawings, despite formal rules for draughtsmen [1999]. As long as the drawing is not analysed by software, it is up to the human reader to tweak apart informal and formal elements and to interpret their relation. The ambiguous nature of sketches promotes true imprecision that is essential to the process of idea generation, as studies into effects of the introduction of CAD in construction planning have shown. CAD systems force the designer to start from concrete, exactly specified details, building up larger elements from core elements. Sketching on the other hand can start from a holistic picture and slowly become more precise [1999]. CAD, because it is based on numeric data, requires exact data input.

Lawson (2002) noted that CAD might inhibit creativity, sitting examples of two very creative and successful architects, Santiago Calatrava and Herman Hertzberger who deliberately avoid the use of computers in the early stages of their design. Though, computers are simply much better than humans at some tasks, such as calculation and are also quicker at

looking up information. Also, computers do not forget things, as humans do. Actually, much architectural design is actually done through drawings and conversation both between members of the design team and with their clients and others Lawson and Loke (1997). An important fact that has largely been neglected by those who design CAD systems, as most computer applications intended to assist with architectural design involve an intensely graphical process. Another problem as Lawson (2002) noted, is that the software is usually a generic 3D package that can only handle form in the abstract—it does not address or comprehend the construction or materiality of the objects represented. The impact of CAD creativity, as noted by Robertson & Radcliffe, (2009), is yet to be addressed to any logical conclusion by researchers.

Another common criticism of CAD is that it causes the designer to focus on details instead of the underlying principles (Utterback, 2006). It is written that "sketching by hand allows a designer to capture an idea quickly; it concentrates on the essentials rather than on bells and whistles. Again (Chester, 2007) noted that a designer's spatial ability is improved through sketching, further attested by (Tseng & Yang, 2011) in their finding stated that a designer's ability to successfully generate technical artifacts is positively correlated with their spatial ability.

 Most of the researchers above confirmed the essence of sketching in the architectural design process and the advantages of CAD and other computer applications in architectural drawing production and construction management but silent on the real impact of the sudden shift to the use of CAD for architectural design studio works in schools of architecture and particularly in polytechnics in Nigeria. This research therefore addresses the gap being created by this trend.

METHODOLOGY

In order to test the impact of freehand sketching and Computer Aided Design and Drafting on the standard of designing capability of the students of architecture in a typical Nigerian polytechnics, one hundred and sixty(160) students in the department of architecture, Yaba College of Technology were tested and actively participated in research. This is 89% of the entire students population in the department in the 2012/2013 academic session, and as such represented an unbiased outcome. Forty students were tested from each of the second, third and final years, that is, National Diploma year two (NDII), Higher National Diploma year one (HNDI) and Higher National Diploma year two (HNDII) on how much freehand sketching/CAD were employed in executing their design assignments. The students indicated

their preferences in the use of either CAD or freehand sketching at the initial or conceptual stage of their architectural design assignment. Also, their handwriting/lettering were examined and scored. The results are recorded in tables 1, 2 and 3 below.

TABLE 1: STUDENTS' CHOICE OF DESIGN PRESENTATION METHOD

CLASS	FREEHAND DRAWING (percentage)	CAD (percentage usage)	CAD + FREEHAND (percentage usage)
HND II	28%	66%	6 %
HND I	41%	42%	17%
ND II	100%	--	---

Source: Fieldwork, 2013

TABLE 2: STUDENTS' HANDWRITING/LETTERING PROFICIENCY

CLASS	GOOD (percentage rating)	AVERAGE (percentage rating)	POOR (percentage rating)
HND II	48%	18%	34 %
HND I	61%	22%	17%
ND II	76%	18%	6%

Source: Fieldwork, 2013

TABLE 3: HND II AVERAGE DESIGN STUDIO RESULT/ SCORE

CADRE	CONCEPT	PLANNING	SECTIONS	ELEVATIONS	DETAILS	GRAPHICS
GOOD	38%	57%	55%	55%	51%	71%
AVERAGE	52%	22%	26%	28%	32%	20%
POOR	10%	21%	19%	I7%	17%	9%

Source: Fieldwork, 2013

DISCUSSION

Students appear to be more attracted to the use of CAD in the upper classes, especially in the final year. As could be seen from table 1, only 28% of the students in HND II class used freehand drawing and drafting to execute their design assignments, while 66% opted for CAD. Just 6% combined the two alternatives. In the HND I class, 41% of the students used freehand drawing and drafting, while 42% used CAD. Only 17% combined both freehand CAD. In the last class, ND II, all the students used freehand drawing and drafting.

Handwriting proficiency test result is presented in table 2 as it is considered to be directly related to freehand sketching. 38% of students in the HND II class had good handwriting, while 18% write averagely. 34% had poor handwriting. Also, in the HND I class, 61% had good handwriting, while 22% had average handwriting and 17% poor handwriting.

Table 3 shows the average design studio result of HND II class in 2013in the first and second semesters. Only38% had good design concept presentation, while 52% scored averagely and 10% poor in concept development. In planning, 57% were rated good, 22% average and 21% poor. 55% were rated well in both sections and elevations and while 26% and 28% were respectively rated averagely. In sections, 19% scored low and 17 % low in elevations. Scores in detailing ranged respectively from 51%, 32% and 17% good average and low. In architectural graphics and presentation, 71% scored well, while 20% were rated averagely and 9% poor.

Most of the students in the higher class, particularly HND II have adopted the use of computers and CAD in executing their assignments. This has limited their manual use of both pen in writing and pencil in drawing. Also, their only practical exposure to freehand sketching and handwriting/lettering practices took place since three of four years back. Again most of their study materials are either printed or photocopied. Thus, their poor performance in concept formation in their architectural design studio and poor handwriting in their class note takings. The ND II class performed well in their architectural design studio through manual drafting for obvious reasons. Firstly, freehand sketching course and practices were done only a few months back and secondly, the use of computer and CAD applications is still very limited their activities. The HND I class logically fall in-between and most likely to tilt to the HND II class standards in the near future following same trend.

CONCLUSION

The need for appropriate tie/synergy between the two essential aspects of modern architectural practice procedure, especially in the training of new architect while in school, to enable students attain their maximum proficiency is therefore obvious. Sketching in architectural training and practice can never be outdated or overrun by the use of computers and their applications. The use of computer or CAD is equally important and must as well be mastered but leaning towards the computer almost entirely will limit their practical use of pen and pencil on paper as architects in training and may reduce their efficiency as graduate architects.

RECOMMENDATIONS

The following suggestions are put forward to ameliorate the consequences of the situations above.

• Freehand sketching and drawing, even at zero course units, should be introduced into the remaining six semesters, apart from the final one to boost students' proficiency in drawing and drafting.

• CAD application should be limited to final presentation drawings and detailing. In this way, students will be exposed to both the use of drawing board and CAD.

• Emphasis should be placed on the use of freehand sketches for idea generation to follow the design process to the core.

• Full exposure to in-depth knowledge on general computer usage, software writing and management so as not to be enslaved to just what is in the market.

References

[1] Chester, I. (2007). Teaching for CAD Expertise. Journal of Technology and Design Education,

[2] Cherubini M., G. Venolia, R. DeLine and A.J. Ko, (2007) "Let's go to the whiteboard: how and why software developers use drawings", Proceedings of the SIGCHI conference on Human factors in computing systems.

[3] Danieland M.P. Lee P, (2003)"Sketches for design and design of sketches", Human Behaviour in Design: Individuals, Teams, Tools,

[4] Ferguson, E.S. (1994) Engineering and the Mind's Eye, The MIT Press.

[5] Field, A.D. (2003). Education and training for CAD in the auto industry. Computer Aided Design,

[6] Fischer, G. and Boecker, H.D. (1983). The Nature of Design Processes and How Computer Systems Can Support Them. Proc. of European Conference on Integrated, Interactive

[7] Goldschmidt G., (2003), "The backtalk of self-generated sketches", Design Issues, vol. 19,

[8] Henderson, K. (1999). On Line and On Paper – Visual Representations, Visual Culture, and Computer Graphics in Design Engineering. Cambridge: MIT Press,

[9] Kirsh D., (2010),"Thinking with external representations", AI &; Society, vol. 25.

[10] Lawson B. and S.M. Loke, (1997) "Computers. Words and Pictures," Design Studies Sketching is a popular practice in software development, both in programming and in prototyping.

[11] Levine, S.L. & Wake, W.K., 2000. Hybrid Teaching: Design Studios in Virtual Space, Paper presented to National Conference on Liberal Arts and the Education of Artists, SVA, New York, 20 October

[12] Macomber, B. & Yang, M. (2011). The Role of Sketch Finish and Style in User Responses to Early Stage Design Concepts. Proceedings of the 2011 ASME INtl Design Engineering Technical Conferences. Washington, DC.

[13] Purcell, A. and Gero, J. (1998) Drawings and the Design Process Design Studies Computer Systems (ECICS), Amsterdam: North-Holland,

[14] Robertson, B. F., & Radcliffe, D. F. (2009,). Impact of CAD tools on creative problem solving in engineering design. Computer-Aided Design,

[15] Schütze M., Sachse P. and Römer A., (2003) "Support value of sketching in the design process", Research in Engineering Design, vol. 14.

[16] Tseng, T., & Yang, M. (2011). The Role of Spatial-Visual Skills in a Project-Based Engineering Design Course. Proceedings of the 118th ASEE Annual Conference & Exposition, 2011.Vancouver, BC, Canada: American Society for Engineering Education.

[17] Utterback, J.M. (2006). Design Inspired Innovation. World Scientific Publishing Co.

Ye, X., Peng, W., Chen, Z., & Cai, Y.Y. (2004). Today's students, tomorrow's engineers: an industrial perspective on CAD education. Computer Aided Design.