

Ethical Perspectives on Implementation of Computer Aided Design Curriculum in Architecture in Nigeria: A Case Study of Chukwuemeka Odumegwu Ojukwu University, Uli

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Abstract—The use of Computer Aided Design (CAD) technologies has become pervasive in the Architecture, Engineering and Construction (AEC) industry. This has led to its inclusion as an important part of the training module in the curriculum for Architecture Schools in Nigeria. This paper examines the ethical questions that arise in the implementation of Computer Aided Design (CAD) Content of the curriculum for Architectural education. Using existing literature, it begins this scrutiny from the propriety of inclusion of CAD into the education of the architect and the obligations of the different stakeholders in the implementation process. It also examines the questions raised by the negative use of computing technologies as well as perceived negative influence of the use of CAD on design creativity. Survey methodology was employed to gather data from the Department of Architecture, Chukwuemeka Odumegwu Ojukwu University Uli, which has been used as a case study on how the issues raised are being addressed. The paper draws conclusions on what will make for successful ethical implementation.

Keywords—Computer aided design, curriculum, education, ethics.

I. INTRODUCTION

WHEN students of Architecture graduate from a course of training in the university, it is expected that they have acquired sufficient knowledge and required skills to practice the profession successfully. Though this training continues after graduation, it is anticipated that they have sufficient knowledge to justify their certification and be properly equipped to perform acceptably when employed. The in-course training should equip sufficiently for this.

The curriculum document for teaching Architecture usually sets out the goals for the training as well as the objectives and means for achieving this goal. In Nigeria, the National Universities Commission (NUC) is the body set up by the Federal government to regulate standards for Nigerian Universities. They have set out guidelines for curriculum formulation in undergraduate programmes in documents called Benchmark for Minimum Academic Standards (BMAS). The BMAS for Environmental Sciences programmes is the particular BMAS document that deals with architecture. This NUC document lists eight instructional

modules with 'Physical Sciences and Information technology' as one of them. Here, it sets out the following skill achievement goals for students for this module:

- To master the basic techniques, skills and principles of Physical Sciences as it relates to the building industry.
- To acquire the knowledge and skills in Information Technology and application of Computer to the building industry.
- To acquire proficiency in Computer Aided Design. Word processing. Data processing and Internet [1].

Furthermore, it states that "Of special significance to present day architectural education is Computer Literacy. The Physical Science module should provide courses aimed at providing familiarity with skills in the operation of and application of computer methods." [1]. It then lists amongst suggested course content the following two courses:

- 1) Introduction to computer science
- 2) Computer application to architecture. To implement this requirement, curriculum planners create courses that aim to impart skills in Computer Aided Design.

Various activities are necessary for the realization of the goals of the curriculum as proposed. These activities would include the introduction of the relevant content into individual university curricula as well as its implementation by faculty and students. They place the responsibilities of choice and action upon the different participants and as such invariably bring up issues of ethics in its operation. This paper seeks to examine these issues and proffer helpful guides towards successful implementation.

A. The Study Area

The Department of Architecture, Chukwuemeka Odumegwu Ojukwu University (COOU) is located in Uli, a town in Anambra State, Nigeria. It runs a 6-year, two-tier program in architecture. The undergraduate program is a four year program leading to the award of the Bachelor of Science degree, while the postgraduate program lasts for two years subsequently leading to the award of a Master of Science degree.

II. AIM

To examine, from an ethics perspective, the imperatives for implementing Computer Aided Design component of Architecture education in Nigerian universities with the view

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of causing strong motivation for implementers to provide the necessary components for its successful realization.

III. LITERATURE REVIEW

A. Computer Aided Design

Computer Aided Design (CAD) is simply the use of computer technology for design and design documentation. CAD software replaces manual drafting with an automated process [2].

B. What is Ethics?

Reference [3] defines ethic as rules of behaviour based on ideas about what is morally good and bad. Reference [4] defines it as the rule of conduct recognized in respect to a particular class of human actions or a particular group, culture etc. Also, [5] in its 'Ethics guide' describes it as being concerned with what is good for individuals and society and as moral philosophy. These definitions show the close association of ethics with morality, even though the two terms are not exactly the same. They also point to a guide or set of rules (sometimes formulated as a code) based on what has been reasonably accepted as good or bad behaviour/conduct. Arguing that consistent and well-founded reasons should be the bases for the formulation of ethics, [6] in a more comprehensive manner define ethics as referring to well-founded standards of right and wrong that prescribe what humans ought to do, usually in terms of rights, obligations, benefits to society, fairness, or specific virtues. These standards by their nature impose reasonable obligations upon those it sets out to guide, to refrain from such acts as rape, stealing, murder, assault, slander, and fraud. Standards which enjoin virtues of honesty, compassion, and loyalty and relate to rights, such as the right to life, the right to freedom from injury, and the right to privacy would also be classified as ethical. Reference [6] also saw ethics as including the study and development of a person's ethical standards to ensure that they are reasonable and well-founded. It affirmed that the idea of well-founded reason as a basis of developing ethical standards aids in dispelling general misconceptions about ethical conduct. Reference [7] agrees with this in stating that ethics encourages people to actually make conscious decisions and act according to what the philosopher Thomas Aquinas called a "well-informed conscience" i.e. to live an 'examined life'. Reference [8] adds that human beings in addition to being propelled by events of the past, are simultaneously drawn forward by their view of the possibilities of the future and that ethical wisdom is the product of applying the knowledge and experience of the past to fashion rules of conduct that will give that desired future. In clarifying what ethics really is therefore from the foregoing it can be stated, amongst other things, that even though it includes as its influence the following, ethics is not simply about,

- 1) feelings of right and wrong
- 2) religious beliefs
- 3) the law
- 4) standards of behaviour the society accepts

It can be summarized as agreed guides for behaviour based on consistent, well-founded reasoning and a "well-informed conscience" that give direction on

- a. what people ought to do
- b. what is right to do
- c. what people are obliged to do
- d. what will benefit society
- e. what is fair to do
- f. what relates to other specific virtues

C. Ethics in University Education

Inferring thus that the nature of men makes necessary the regular provision of these guides for acceptable behaviour to enable peaceful, virtuous and progressive execution of the activities with which they are involved, universities being a microcosm of such activities are no less faced with ethical questions arising from them. In Nigeria, this has caused these institutions to set up committees, usually through their Senates, to prepare suitable ethical guidelines for the student, teaching and non-teaching members of their respective communities. These guides are usually general in nature excepting in areas that are known to be chronic sources of problems and where members of the community are more likely to conduct themselves poorly. Such areas may include plagiarism, cheating in exams, dressing etc. A few examples of such codes are those of the University of Port Harcourt [9] and Ahmadu Bello University [10]. It is however important that in such intellectual communities that boast of the cream of academia that all possible ethical issues arising within be continuously examined not only for the community to reassure herself and the world she serves that her conducts are right but to improve on the specifics of those conducts wherever possible. The examination of ethical issues of implementation of CAD in Architectural curriculum within this context therefore, becomes imperative.

IV. ETHICAL ISSUES IN CAD TRAINING IN ARCHITECTURAL SCHOOLS

The curriculum can be said to be a living embodiment of the faculty and their ideas. It indicates the currency of knowledge taught and determines which aims of the education process can be achieved. In its creation and revision for architecture schools in Nigeria, the NUC-BMAS as stated, is the loose guide for preparing and creating relevant content for training students. Each individual school creates its own and depending on the nature of the faculty, it can be exciting or latent. It is therefore dependent on each institution to make it work to accomplish desired goals. The conduct of the faculty and students in this regard (and particularly with reference to CAD training), therefore raises ethical considerations in implementation.

A. Relevance of CAD Content in Curriculum for Architectural Education

As stated, the NUC-BMAS for Environmental Sciences requires that courses in Computer Application be introduced into the curriculum for Architecture schools. Despite this,

ethical questions may still be raised about the propriety of this instruction, its rightness and benefit to the student and society. In examining the issue, the advantages and necessity for the teaching and acquisition of CAD skills come into focus. It is documented that using CAD conveys several advantages over the traditional manual drafting method. This appears to support the argument for propriety in its inclusion into curriculum. These perceived advantages are most likely the cause of its popular and widespread use in industry. Some of these can be summarized thus:

- Increased speed of production: computer automation of drawing tasks leads to shorter production times
- Ease of corrections and revisions: mistakes are easier to correct and revisions to drawings quicker to make
- Increased accuracy: numerous tools are available that increase the accuracy of a drawing no matter the size or complexity
- 3-D modelling: visualizing in 3-dimension is quicker, easier and can lend itself to Simulation etc.
- Ease of transmission and collaboration: digital drawing files can be transmitted to collaborating professionals or client through the internet. Equally a digital model can be worked on by different persons in different locations simultaneously
- Reduction in area required for storage: hundreds of drawing files can be saved digitally on a tiny drive or in the cloud in multiple locations simultaneously.
- Environment friendly: Invariably smaller amounts of paper are used as drawing is digital so a reduced carbon footprint is maintained [11], [12].

The widespread use of CAD technologies in the marketplace has been affirmed in literature by [13]. This is corroborated by [14] with analysis of survey from selected countries in Africa, Europe, and America acknowledging a widespread global use of CAD systems. Reference [15] establishes that the use of computers in the construction industry in Nigeria is widespread. These show a strong case in literature for propriety and necessity in the inclusion of training in these technologies in the education of the graduates who will operate in this environment. It is therefore vital that the graduate of architecture whose practice is situated within it be adequately equipped with these skills that are relevant and needed.

B. Ethical Issues Relating to Faculty

As members of an academic institution, academic staff are expected to seek to be effective teachers and scholars. As teachers, they are to practice intellectual honesty and encourage the free pursuit of learning in their students. They are to hold before them the best scholarly and ethical standards of their discipline [16]. Ethical issues arising from the context of discussion would be in the areas of:

1. Curriculum Planning

It is curriculum planners within faculty that take the first step in implementation. It is important that they continually evaluate the extent of compliance with the implied instruction

in the BMAS to incorporate CAD content. Also, akin to this are the issues of adequacy, relevance, and currency of content. Content ought to be adequate in terms of number of courses within the study period and expected content to be covered to see to the realization of desired training outcomes. It is to be noted that there are no specifics on desired outcomes in the BMAS; hence, faculty planners are expected to determine these and plan content to meet them. As knowledge is not static, the planned content ought to be relevant to the goals and be current in the body of knowledge at the time. Whereas, there is the effort during NUC accreditation/reaccreditation visits to examine compliance with its minimum standards, it does not appear that there are standardized measures for checking adequacy, relevance, and currency. Academic integrity and intellectual honesty require that it be done in such a manner as to avoid tokenism and ensure effectiveness.

2. Evaluation of Case Study

Survey results from COOU affirm the expectation of faculty that a basic proficiency level be achieved at the undergraduate level while an expert proficiency level is attained at the master's level. It also shows that curriculum has followed the NUC-BMAS in incorporating introductory course in computing as well as three computer application courses in the first and second years of the undergraduate level. However, there are no computer application courses at the postgraduate level. Also the application of CAD in the undergraduate level to other parts of schoolwork outside these courses are discouraged because of perceived ethical issues discussed later in this paper. Whereas it is possible to achieve the expected level of efficiency for the undergraduate program with the CAD content in the curriculum, it is not evident how the same can be achieved at the postgraduate level.

3. Infrastructure Provision

The curriculum cannot be achieved without the provision of requisite infrastructure, equipment, and materials. Where sufficient effort and resources are yet to be provided by school administrators for the building of computer rooms and purchase of computer workstations, software licenses, etc. required for training in CAD courses, there can be no real expectation that the goals of CAD training will be achieved. Where this occurs, graduates are certified as having received the required training when they did not. They are forced to obtain this vital aspect of their training at additional costs after graduation. Such situations border on institutional dishonesty. It is noteworthy that institutions increasingly encourage their students to acquire their own equipment. These however cannot become substitutes for institutional resources for obvious reasons of control and management.

4. Evaluation of Case Study

Here a computer room dedicated for lectures and practice exists. It contains over 40 computer workstations for an average class of 40 students and multimedia projectors for teaching, so appears adequate. There is the existence of regular power supply for school times as well current software with original licenses obtained through the Autodesk

educational software licensing scheme. There also exists a departmental library, although with dated CAD literature. There is also dedicated institution staff for maintenance of equipment. There is however a need to replace aging equipment. There has been effort at providing the necessary infrastructure to implement CAD curriculum by COOU. The Department's ability to continue to do this will depend on continuous replacement of aging equipment and dated literature, while maintaining the awareness created. Allocation of more funds is therefore imperative as an ethical issue as well as an administrative one.

5. Content Delivery

Impartation of the recommended knowledge is dependent on the availability of competent and knowledgeable faculty who can effectively teach CAD content. It may be that amongst the present faculty there is none knowledgeable. This creates the need to train staff or hire new staff on permanent or part-time basis. This implies additional costs for implementation of the content. Where this cost is not made readily available by relevant authorities or an incompetent staff is assigned with the responsibility, a similar situation to the one described under infrastructure provision may result.

Evaluation of Case Study: In this case, only one member of faculty teaches the CAD courses. Presently, because the number of such courses in the curriculum are limited, it is managed. This however cannot be to the advantage of the Department or the students. Further recruitment and pairing of staff for teaching should be done. This is to avoid the scenario where this part of the program suffers a setback when one member of faculty is unavailable for any reason.

C. Ethical Issues Relating to Students

It is expected of students amongst other obligations to conduct coursework with honesty and integrity, refraining from cheating, plagiarism, or falsification, in accordance with the Academic Honor Code [17]. This expectation is reasonably of universal application in all schools and more so in computer related courses where there is the perception that computing makes for easy duplication of materials and hence encourages cheating. Deriving from this, ethical issues that arise from implementation of CAD curriculum would come under:

1. Loss of Integrity

According to [18], in the United States, more students are caught cheating in introductory computer science courses than in any other course on campus. The cheating is predominantly in unauthorized code reuse, excessive collaboration and other forbidden ways of completing homework assignments. However, [18] also states that computer science professors say their students are not more dishonest than students in other fields; they are just more likely to get caught because software is available to check for plagiarism. Using this example, it can be said therefore that copying or other forms of cheating are not peculiar to or more likely to occur in computer courses because these are issues that go beyond computing. However, it can even be said that computing lends itself more to easy

detection of copies and hence has an advantage over other areas in combating cheating. The same can be said to be the case for CAD courses in Architecture schools. Where group assignments are given, the temptation to copy is strong for the lazy student. It is however relatively easy for the conscientious teacher to detect. This occurs as well in exam situations because of the relative ease of transfer of digital files with flash drives, mobile phones etc. It is therefore incumbent upon those who teach to create the necessary environment that will make it extremely difficult for this to occur. Part of this environment is created when the issues highlighted under infrastructure provision are addressed. Management and control of the study/exam environment is practicable when the required equipment is provided by the school.

2. Evaluation of Case Study

Survey of experience of the CAD tutor at COOU shows corroborates the assumption that students are the same everywhere in their propensity to leverage technology negatively for cheating in assignments and exams through copying. This has however been curtailed by applying such measures as programming computer-room workstations not to accept flash drives, reducing the value of off-site assignments in final grades etc. It is indeed an ethical issue that the tutor, with the support of faculty, institute and deploy strategies to maintain the integrity of the education process.

3. Loss of Creativity

There is a view that the use of CAD technologies can inhibit creativity in design work of architecture students and architects. This opinion is held by [19] which describes examples of students combining impressive and convincing computer presentations with poor design. This is informed by observations made during design examination in half a dozen universities in three countries. The designs looked extremely convincing, original, but were not good. They were perhaps accepted by their creators as impressive because of the great visual impressions that CAD tools can make. While explaining the cause of this trend, [19] postulates the influence of two factors: - (i) The tendency for any information that is presented in a televisual medium (and CAD uses such a medium) to be automatically considered authoritative. This arises because such medium instinctively inspires awe and respect; (ii) The complete mastery of such computer systems is still sufficiently rare and novel so that there is the tendency to admire them in the way animals taught to do tricks are admired. It therefore becomes possible to prepare computer presentations which look attractive and even dazzling, that seem authoritative, but in which architecture so represented is awful. Whereas these arguments have veracity, ample scientific data has not been gathered on this trend to justify any action towards limiting the use of CAD in training or after graduation. It would appear that the benefits of the use of CAD technologies (which buoys its popularity in the industry) sufficiently outweigh any disadvantages hence its inclusion in the curriculum guide. Besides, there exists scientific data showing that CAD can indeed help creativity. This is also

acknowledged by [18]. It would appear then that CAD as a tool is not a neutral influence but one capable of exerting a positive or negative influence upon learning outcome. It can only therefore be expected that the faculty who oversee design training will closely monitor this trend in order to create guidelines that will expose and discourage the negative while strengthening and encouraging the positive. A similar example is the scenario where color productions are banned in design presentations at certain levels to ensure that the focus is on explaining design rather than creating fascinating pictures.

Evaluation of Case Study: The survey shows that the influence of the negative opinions about the effect of CAD on the quality of design education held by significant parts of the professional regulatory bodies in Nigeria (Architects Registration Council of Nigeria; Nigeria Institute of Architects) is very much evident in implementation of curriculum here. Evidences of any influence (positive or negative) appear anecdotal and empirical research is required. This is considering the fact that poor outcomes can result from varying factors including poor students and poor mentoring. The use of CAD in design or any other assignments outside of the courses in which it is taught are banned at undergraduate levels and officially limited at postgraduate level. This is further encouraged by the Architects Registration Council of Nigeria examiners who enforce the bans at final year design juries across the country. It is important that a sound basis for making judgments on the influence of CAD be empirically established."

V. CONCLUSION

Ethical issues do exist in the implementation of CAD curriculum in Architecture education. These range from the propriety of its inclusion in the curriculum for training, to the obligations of different participants in the implementation process to make it successful. They also include questions arising from improper use of computing technologies and perceived negative influence of its use. It can be stated that in no case are these issues unresolvable or constitute sufficient known negative impact on the learning process or outcome to warrant CAD exclusion from or restriction within the curriculum. It is rather the case, as in other areas of learning, that if the implementers of the curriculum (administrative and faculty) conscientiously fulfil their roles, the desired positive outcomes of the curriculum will be realized.

VI. RECOMMENDATIONS

Drawing from the foregoing, the following recommendations are made as being imperative from an ethical point of view:

- 1) Curriculum implementers must evaluate expected outcomes for the program and ensure that relevant courses (in sufficient quantities) are included to enable their realization
- 2) A CAD implementation budget should be specifically established as part of the larger Departmental budget with funds regularly and sufficiently allocated to it to ensure

the provision and maintenance of infrastructure.

- 3) Institutions should employ CAD-proficient teachers in sufficient numbers to ensure that content delivery to the students is not compromised.
- 4) CAD tutors, with the support of faculty should institute and deploy strategies to discourage the leveraging of technology to cheat and hence maintain the integrity of the education process.
- 5) Further empirical research should be conducted to establish the effects of CAD (positive or negative) on design learning and therefore inform the limitation or otherwise of its use within the curriculum.

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