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# Developing a New Framework for Integration and Teaching of Computer Aided Architectural Design (CAAD) in Nigerian Schools of Architecture

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**Abstract**
As a result of globalization of digital technology, intellectual discourse on what constitute the basic body of architectural knowledge to be imparted to future professionals has been on the increase. This digital revolution has brought to the fore the need to review the already overloaded architectural education curriculum of Nigerian schools of architecture to have substantial computing content. This paper seeks to propose a new framework of integrating teaching of CAAD into curriculum of schools of architecture in Nigeria. Covenant University, the best private university and the second best university in Nigeria according to the 2014 Webometrics ranking was selected for this study. Content analysis method was adopted for the purpose of this study. Best practice from a selected school of architecture was understudied and Covenant University architectural curriculum was used as a model for developing a new framework for integration and teaching of computer aided architectural design (CAAD) in schools of architecture in Nigeria. The study concludes that integration of the developed new framework into the curricula of schools of architecture in Nigeria will aid in effective teaching of CAAD and consequently lead to higher competency and global competitiveness rating of future professional graduates from the schools.
**Keywords:** architectural education, curriculum, CAAD, digital technology, globalization, Nigeria

## 1. Introduction

Intellectual discourse is on-going as to what constitute the basic body of architectural knowledge to be imparted to students at schools of architecture in this age of globalization of digital technology. The wave of digital revolution sweeping across all fields of human endeavour has brought to fore the need to review architectural education curriculum to have substantial computing content. This is necessary so that the course maintains its relevance in the ever expanding digital and globalized world. A view recognized and underscored by various scholars in different context. For instance, Olotuah (2000) identified architecture as a dynamic discipline that moves with current developments around the world. Sa'ad (2001) identified technological innovations, especially information technology (IT), concern for the environment, financial management and democratization of decision making as the main factors that will globally determine architectural development in the next few decades. Sa'ad opined further that the manifestation of the forces of change can be identified globally in the following spheres of operation: architectural practice and architecture, building industry and the educational system.

With regard to forces of change for embracement of new ideas in architectural practice and education, Florida (2004) asserted that a country's economic competitive edge and destiny to stay on top in this era of high-tech industry is tied directly to its openness to new ideas. By so doing, it will allow countries to mobilize and harness the creative energies of its people. Likewise, Cespedes (2008) noted that design students admitted into higher educations in this age have always lived in a digitally mediated world and that life without the internet, cell phones, email, social networking and geographic information system (GIS) were unknown to them. Equally, Novak (1998) argued for the relevance of digitalization of architectural processes concluding that current trends in the most advanced and the most dramatic solutions of architectural problems could not have been conceived without the computer. Specifically, Brown (2009) stated that Computer Aided Design (CAD) has changed the face of the design industry and has influenced the lives of designers and engineers worldwide. It can be inferred therefore that computerization of architectural processes has led to a change in design technology and will inadvertently continue to change the way designs are produced. Consequently, the change will also manifest in inter-personal relationship between the architect and his clients on one hand, and between the architect and contractors and other professionals on the other. To manage this emerging digitalization trend that the future professional (student) will be confronted with in professional practice, schools of architecture must train him with knowledge that will enable him to manage the multifaceted relationships required to practice in the cyberspace. This suggests a need for a wholesome integration of Computer Aided Architectural Design (CAAD) into the curriculum of schools of architecture in Nigeria instead of the current piecemeal approach. However, Brown (2009) observed that there are consequences that come with implementing new and revolutionary tools in

a dynamic culture. This unease is manifested presently among educator's worldwide and most especially architectural educators, who are confronted with challenges on how to integrate the demands of current best practices in architectural profession globally to these digital natives also referred to as NET generation.

Preliminary investigation of curricula of selected Nigerian schools of architecture revealed that one of the most crucial factor affecting the integration and teaching of CAAD is placement of additional work load on the already overloaded curriculum. Tzonis (2014) recognized that the duration for professional architectural education has been reduced in many parts of the world. In the Netherlands for instance, the duration of study has been reduced from fifteen years to five years thus "diminishing considerably available learning time". Secondly, there is a perceived dearth of qualified personnel to teach CAAD in the universities, even more critical is the fundamental educational issues of non-mastery of the digital technologies by design educators (Yildirim & Yavuz, 2012). Thirdly, Yildirim & Yavuz (2012) identified unavailability of necessary infrastructural base for production of hardware and software in schools of architecture to aid the teaching of digital drafting methods. Previous study by Bridges (1986) on how to address this issue resulted in posing a philosophical question, "Are we promoting Computer Aided Design (CAD) education or architectural education using CAD?" Thus, a review in curriculum that contemplates adding another subject to the already overloaded one may not be feasible in most schools of architecture in Nigeria. Two questions sprang to mind: How relevant is CAAD in the teaching of future professionals? How can teaching of CAAD be integrated into the curricula of schools without necessarily putting too much load on the already overloaded academic structure? To answer these questions, this paper reviewed literature on relevance of CAAD in architectural education. It then proposed a new framework of integrating teaching of CAAD into curriculum of schools of architecture in Nigeria. Covenant University (CU), the best private university and the second best university in Nigeria according to the 2014 Webometrics ranking was selected for this study.

## 2. Historical Perspective of the Development of CAAD

The modern concept of CAAD was introduced by the scholars Sutherland and Coons in 1963 by developing a graphical system called 'Sketchpad' (Sutherland 1963). This system formed the basic concept for first generation CAAD and it was designed to integrate the evolving design (from sketch drawing with a light pen then refining it with built-in shape assumptions into a neat drawing) and analysis programs (various numerical analyses). Through the process, the designer could interact with an optimization procedure (Coons 1963 cited in Kalay 2004). Also this could be seen as one of the integration concepts between computing analytical capabilities and architectural design. In contrast, the Architectural Machine Group (Negrponte & Groisser 1964 cited in Kalay 2004) at MIT took an artificial intelligence approach to developing architectural computing applications. With this application, the environment itself could originate actions on its own by sensing the needs of building inhabitants and incorporate changes without any interference from the designers. These two approaches are the beginning of the research argument over CAAD. It is obvious that the main argument between the two approaches is the designer's role in a computerised environment. Studies by Achten 2003; Al-Qawasmi 2004 and 2005, have extended this argument to include the need to develop new skills, rethink architectural design education in the light of the emergent developments in CAAD software programs, and how this might bring change to the traditional setting. From the foregoing we could synthesize two broad issues in CAAD research: the computational and architectural issues. Achten (1996) assigned a common ground in so-called computational issues (e.g. database structures, exchange formats, programming techniques, interface design, etc.) to both systems and a different ground in so-called architectural issues (cost calculations, facility management, production drawings, simulation, evaluation building analysis, design synthesis, form generation, etc.). CAAD researchers and developers either emphasized the formal computer science point of view or the architectural design point of view (e.g. Kalay 2004) in developing or designing new or appropriate CAAD systems.

A computer systems classification was developed by the Design Methods Group (Achten, Dijkstra, Oxman and Bax) of the department of architecture of Eindhoven University of Technology. Their work detailed four distinct classifications of computer systems in education: social systems, professional systems, educational systems and innovative systems (Achten 1996). Social systems are computer tools which all students should be able to use within any higher education curriculum. Professional systems are computer tools which are used in architectural practice (e.g. AutoCAD software). Usually these systems are off-the-shelf software, that is, software developed by standard software companies (e.g. Autodesk, Graphisoft, Google, Microsoft). Educational systems are modified professional systems to convey specific pedagogical purposes and are developed within or for a specific architectural institution and sometimes are result from research. Innovative systems are computer systems that reach beyond current state of the art of professional systems (e.g. automated plan recognition, virtual reality design systems) and always are the consequence of research work; hence they are so-called home-made software.

*2.1 Digital Drafting and Architectural Education*

Alagbe *et al.* (2014) noted that architectural education is distinguished from other disciplines being one anchored on apprenticeship. The design studio represents the confine within which the apprenticeship of the future professionals is shaped and modelled. Therefore, the design studio is the pivot and gathering point of all knowledge and skill accreted throughout the architectural curriculum (Mostafa & Mostafa 2010). There are a lot of scholarly articles that have addressed the issues of need for changes in architectural education in a globalized world. A study by Tzonis (2014) conceded that the world is undergoing global changes at a scale and kind never encountered before which is reflective in unprecedented technological innovation, economic might and global accessibility. Subsequently, he pondered whether schools of architecture are providing the right knowledge required for design and construction. Tzonis acknowledged that endless lists of subjects have to be introduced in architectural education to keep up with the needs and aspirations of the global changes. However, he was concerned about the modalities of fitting the exploding lists of subjects into an "already over-eclectic overblown curriculum without widening the gap between architectural knowledge and practice, theory and reality". This same concern is apt with the current trends of over-loaded curricula in schools of architecture in Nigeria. While the future professionals are craving for changes in curricula that will be reflective of the NET generation, it should be noted that schools are also desirous to embrace these changes. However, any change in curricula that will lead to increase in the duration of architectural education in Nigeria will not be welcomed. Presently, the architectural education operating in Nigeria is a two-tier system divided into four years (or five years for Universities of Technology) undergraduate study and two years of postgraduate study. Hence, change in curricula particularly as it relates to teaching of CAAD in schools of architecture in Nigeria needs the development of a new framework that will act as a policy guide to all schools. No study is available in this light hence the need for this study

In a related study, Ibrahim (2007) elucidated on the challenge of teaching BIM based CAD in today's architectural curricula. Cheng (2006) cited in Ibrahim (2007) who noted that BIM had impacted on the profession by providing the ideal catalyst needed for rethinking of architectural education. Cheng posited that designing intelligently with BIM requires a significant level of expertise. He suggested that "serious consideration must be given to how it can be taught". This study is in support of this suggestion noting that the current piecemeal approach of teaching CAAD in schools of architecture in Nigeria is insufficient in training future professionals that can compete favourably with her counterparts worldwide.

Another study that made a case for the integration of CAD in architectural education was conducted by Ismail, Mahmud & Hassan (2012). They demonstrated that the integration of CAD technology increases the number of ideas in the synthesis activity and the number of simulation in the simulation activity. Furthermore, the study revealed that students' desire to gain more knowledge and design ideas to produce creative architectural product was enhanced through the introduction of CAD technology in the design process.

Alagbe *et al*. (2014) investigated the relevance of manual drafting in the training of architecture students in design studio education in Nigeria. The study noted that architecture students in most schools of architecture in Nigeria are still faced with the institutional policy of using manual drafting at the undergraduate classes for their design studio projects. It is ironical that while the schools permit the teaching of CAAD in their curricula, students are not permitted to design or present their studio projects using these media particularly at the undergraduate classes. The paper observed however, that it is becoming increasingly difficult to keep students away from flouting the rules. Result of the study shows that students at the undergraduate classes are of the view that manual drafting is still relevant but express more desire to explore CAD in their design studio courses. The study revealed that students' perceived that manual drafting had fewer advantages than CAD. The study supported the call for review schools of architecture curriculum to adopt digital drafting method for designing and presentation beginning from the undergraduate classes.

The papers reviewed brought to the fore the importance of digital media tools in the training of future professionals. Studies have recognized that due to the globalization of architectural practice, curricula of schools must change to accommodate the wind of changes brought about by globalization. Thus, there is an advocacy for the integration of CAAD into architectural education curricula. While the idea was welcomed, it was noted that curricula of schools are already overloaded making it difficult to accommodate a holistic integration of teaching of CAAD. Few studies have focused on how this laudable idea can be achieved. Thus, this study aimed at developing a new framework for teaching CAAD in schools of architecture in Nigeria is apt.

## 3. Research Methodology

The research methodology adopted for this study was content analysis of the curricula of selected schools of architecture. The curriculum of Covenant University (CU) was used as a model for developing a new framework for integration and teaching of computer aided architectural design (CAAD) in schools of architecture in Nigeria.

 

*3.1 Study Area*

Covenant University, Ota, Nigeria started operation on 21st October 2002. It is a growing, dynamic vision-birthed and vision-driven University, founded on a Christian mission ethos and committed to pioneering excellence at the cutting edge of learning. In the last ten years of operation, the university has instituted a learning context that is rich in educational opportunities, research and scholarship. This is evident in all programmes of study in the university. Architecture is one of the pride programmes of the university and has received all supports to make it emerge the best amongst its equal nationally and internationally.

## 4. Findings and Discussion

The findings and discussion from the content analysis of the curriculum of the CAAD courses taught in CU is summarized under the following sub-headings: CAAD Curriculum: CU experience; reviews of CU's CAAD curriculum; and the infrastructural base for teaching CAAD in CU.

*4.1 CAAD Curriculum: Covenant University Experience*

The study found out that CAAD education in CU is system based and tailored after the available software's (AutoCAD and Revit Architecture) donated to the university in 2006 by Autodesk. A review of the curriculum revealed that CAAD was first integrated into the architectural curriculum at CU in the 2004/2005 academic session at 300 level (3rd year) of 4 years of the undergraduate programme. Two dimensional (2-D) drawings with digital media was taught at that level. At the 2005/2006 academic session, the 400 level (4th year) students were taught three dimensional drawings using digital media. The computer tools used for these courses were the AutoCAD and Revit Architecture software donated to the university by Autodesk. Findings revealed that teaching emphasized on students mastering the use of the software with examples on how to use it to represent architectural design solutions. In 2006/2007 academic session, Autodesk and the National Universities Commission (NUC) conducted a training programme aftermath of which building information modelling (BIM) was introduced at the 4th (final) year of the undergraduate programme. The introduction of BIM led to the restructuring of the curriculum of architectural education at CU; two-dimensional AutoCAD was moved to 200 level, three-dimensional AutoCAD was moved to 300 level and building information modelling was taught at 400 level. At the 2007/2008 academic session, a course titled The Theory and Practice of Design Computing was introduced at the second year of the Master of Science (M.Sc.) architecture programme of the university. This course is basically to prepare the students for life in architectural practice by introducing them to the principles of solving architectural issues using the principles of CAAD and also enlightens the student on the principles of digital fabrication. It can be deduced therefore that CAAD courses taught at the undergraduate (200, 300 and 400) levels focused basically on impacting students with the technology of computing while at the postgraduate level, the teaching focus is on mastering CAAD for professional practice.

*4.2 Review of Covenant University CAAD Curriculum*

A content analysis of the course synopsis for CAAD courses in CU is presented in Table 1. The table shows the CAAD courses offered at different years of study (levels) and the course synopsis which stipulates the summary of what is to be taught and by extension, a measure of yardstick for expected learning outcomes.

 

Table 1. CAAD Courses Synopsis at Different Years of Study from 2006/2007 to 2012/2013 Academic Sessions

| Year of Study | Semester | Course Title | Synopsis |
|---|---|---|---|
| **200** | 1st | Introduction to AutoCAD | Introduces the students to the mechanics of operation of AutoCAD |
| | 2nd | AutoCAD Workshop Practice | Introduces students to the deployment of AutoCAD in more detailed architectural representation including architectural working drawings and detailing |
| **300** | 1st | AutoCAD 3D- 1 | Introduces the students to the mechanics of operation of AutoCAD 3D and how to deploy them in generating exterior architectural 3D models including topographic surfaces and rendering |
| | 2nd | AutoCAD 3D- 2 | introduces the students to the mechanics of operation of AutoCAD 3D in generating interior architectural 3D models including modelling furniture's, interior design elements and animation |
| **400** | 1st | Building Information Modelling -1 | Introduces the students to using Autodesk Revit Architecture as a tool for Building Information Modelling.<br>It provides the students with the techniques of developing a building model.<br>It also covers the basics of presenting the Building Model and working in teams on a project using Autodesk Revit Architecture. |
| | 2nd | Building Information Modeling -2 | It builds on the concepts introduced in the Building Information Modeling-1.<br>The students learn about site design, construction documentation, advanced rendering techniques, phasing and design options, how to create families of custom components, and how to collaborate on a design |
| **500** | 1st | Nil | Nil |
| | 2nd | Modeling | The course introduces the student to Autodesk 3ds Max. It provides the student with the techniques of modeling and editing in 3ds Max. It also teaches the student to create photorealistic views of architectural projects using 3ds Max rendering feature. |
| **600** | 1st | Advanced CAAD Workshop Practice | The course introduces the student to a new level of sophistication in the use of Autodesk 3ds Max. It provides the student with the techniques of creating lights and animating in 3ds Max. It also teaches the student to use third party plug-ins in 3ds Max rendering operation. |
| | 2nd | Nil | Nil |

It can be deduced that the CAAD curriculum is robust enough to equip students with knowledge that will improve their professional competency base and their competitiveness in a globalized world. However, it was observed that the introduction of the CAAD courses had some negative effects on the curriculum and on students' performance which led to a curriculum review in the 2013/2014 academic session. The first reason adduced for the restructuring was that students at the 200 level are not well equipped with enough architectural knowledge to handle CAAD projects and should rather focus on learning through first principle methods of manual drafting. Secondly, the curriculum became overloaded so much that students hardly have any space to include any failed course (carry-over course) per semester. Thirdly, it was observed that students spend more time with CAAD courses at the expense of other courses. The review as shown in Table 2 was such that teaching of CAAD courses started at the 300 level (3rd year) of four years undergraduate study. With this curriculum review, Introduction to AutoCAD and AutoCAD workshop practice previously taught at the 200 level first and second semesters was compressed into the first semester of the 300 level while AutoCAD 3D-1 and AutoCAD 3D-2 taught at the 300 level first and second semesters was compressed into the second semester of 300 level.

 

This move has observed in this study, supports postulation by Brown (2003) that teaching of CAAD has been a case of promoting CAD education rather than teaching architectural education using CAD.

Table 2. CAAD Courses Synopsis at Different Years of Study from 2013/2014 Academic Session to Date

| Year of Study | Semester | Course Title | Synopsis |
|---|---|---|---|
| **300** | 1st | Introduction to AutoCAD | Introduces the students to the mechanics of operation of AutoCAD and the deployment of AutoCAD in more detailed architectural representation including architectural working drawings and detailing |
| | 2nd | AutoCAD Workshop Practice | Introduces the students to the mechanics of operation of AutoCAD 3D and how to deploy them in generating exterior architectural 3D models including topographic surfaces and rendering The students are introduced to the mechanics of operation of AutoCAD 3D in generating interior architectural 3D models including modelling furniture's, interior design elements and animation |
| **400** | 1st | Building Information Modeling -1 | Introduces the students to using Autodesk Revit Architecture as a tool for Building Information Modelling.<br>It provides the students with the techniques of developing a building model.<br>It also covers the basics of presenting the Building Model and working in teams on a project using Autodesk Revit Architecture. |
| | 2nd | Building Information Modeling -2 | It builds on the concepts introduced in the Building Information Modeling-1.<br>The students learn about site design, construction documentation, advanced rendering techniques, phasing and design options, how to create families of custom components, and how to collaborate on a design |
| **500** | 1st | Nil | Nil |
| | 2nd | Nil | Nil |
| **600** | 1st | Theory and Practice of Design Computing | The course introduces the student to the application of design computing in architectural practice and construction. The students learn about the concept of seamless transition between design computing and digital fabrication. It also teaches the student the practice, techniques and programming environments in architecture. |
| | 2nd | | Application of teaching of CAAD on Architectural Design Thesis |

In order to evaluate the import of this curriculum review on competency rating of CU students, a survey was carried out in August, 2013 amongst the 300 level class of the department who participated in the Student Industrial Work Experience (SIWES). The 300 level class was purposively selected because it has the highest number of students per level (105 students out of an average of 60 per level). Result shows that 80% of the class participated in SIWES during the summer vacation. 90% of the students worked in architectural firms that engaged the use of CAAD in carrying out their office tasks while 10% of the class worked on construction sites. 5% of the total students that participated in the SIWES program were compelled to work on construction sites because their preferred position in the office was only available for students who are competent in use of digital media for architectural design. The implications of this survey is that the lesser the CAAD content in the architectural programme of schools of architecture in Nigeria, the lesser the competency rating of future professionals and the more the vacuum created in the profession which will have great consequences for a rapidly urbanizing cities.

*4.3 Infrastructural Base for Teaching CAAD in CU*

The infrastructure base of CAAD education is one of the crucial areas of CAAD in other to achieve quality

 

delivery of lectures and expected learning outcomes. A study of the CAAD teaching infrastructural base in CU was undertaken. The result revealed that the computers in the Digital Design Studio (DDS), Department of Architecture was procured in 2005/2006 academic session and it has served the department for seven years. Despite the enormous amounts of money that the university has expended in developing the infrastructural base for effective teaching of CAAD, it is observed that available computer software and hardware including the supporting paraphernalia is still inadequate. The systems were procured when we were using our present data room as our computer studio and the space was able to take thirty (30) systems, which we are still using till today. The old computers have undergone repairs repeatedly and are presently no longer able to host the leading edge software's deployed in teaching and learning CAAD in CU. To cater for this shortcoming, the Department by way of policy made it mandatory for architecture students in CU to have personal computers (laptops) to aid there learning. This move subtly increases the burden of high cost of architectural cost that students have to bear. This is the situation that is prevalent in most schools of architecture in Nigeria. While the effort of CU (a leading private institution in Nigeria) at investing in infrastructural base for the effective teaching of CAAD is commendable, many of its contemporaries in the Federal and State universities cannot boast of the same. The consequence is that the competency and global competitiveness rating of future professionals from Nigeria schools of architecture will be negatively affected.

## 5. New Framework for Integration and Teaching of Computer Aided Architectural Design (CAAD)

This study recommends a new framework for integration and teaching of Computer aided architectural design (CAAD) based on three broad classifications similar to a program structure developed by Silva (2000) for the University of Brasillia shown in Figure 1.

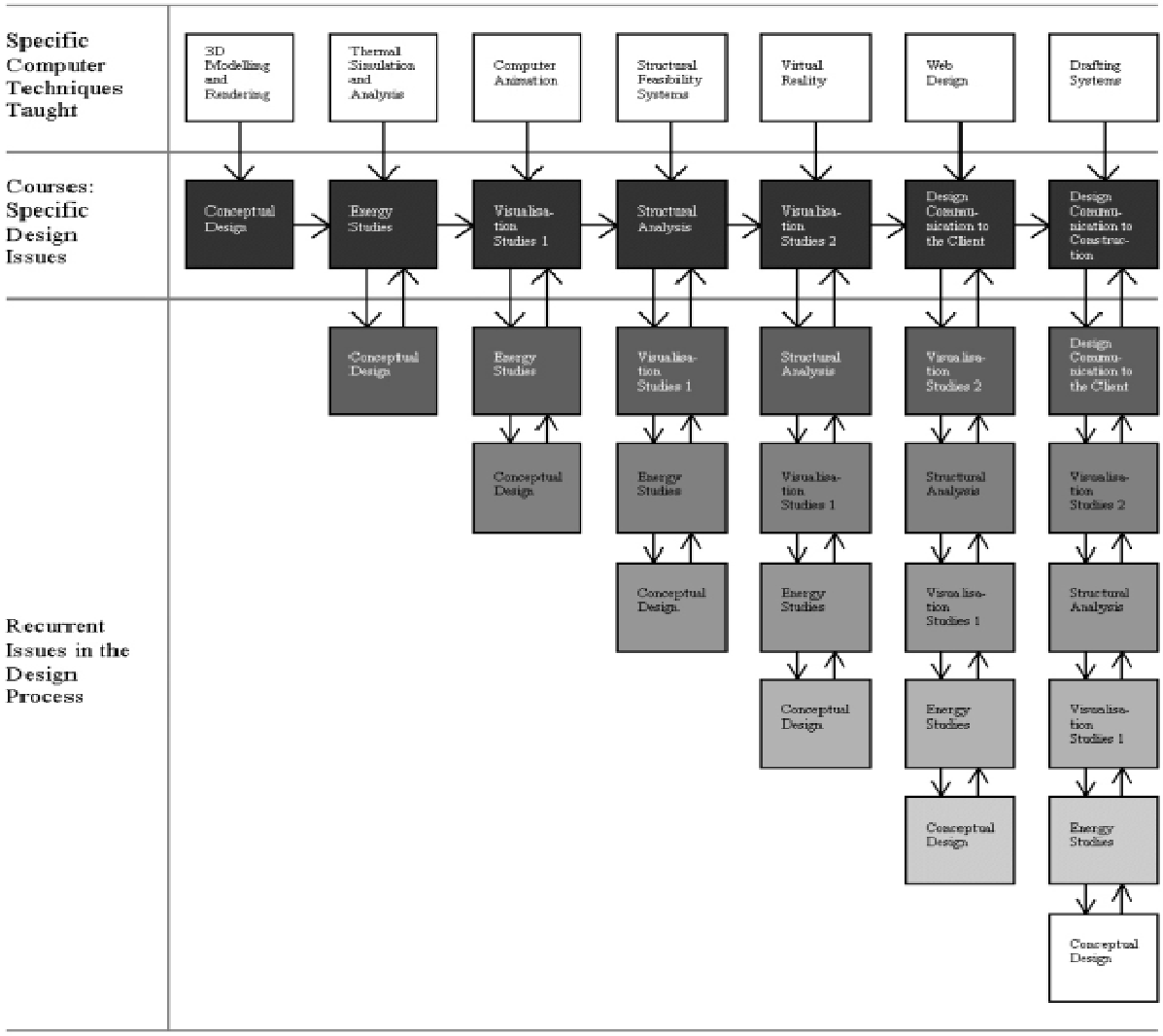


Figure 1. CAAD Program structure developed by Silva (2000) for the University of Brasillia

 

A brief description of these programs is discussed below:

i. Theoretical introduction and development of skills

- Introduction to Computing: Introduction to computing concepts and technology. Introduction to hardware and software, interfaces, computer networks and the Internet.
- Introduction to Computer-Aided Design: Introduction to computer-aided design concepts and techniques. Bi-dimensional, tri-dimensional and multi-dimensional media. Future perspectives of computer-aided design.
- Introduction to Conceptual design: A discussion and practice about the perception of architectural objects. Concepts of object representation and document representation. Introduction to 3D modelling as design experimentation media.
- Design Theory and Computer-Aided Design: Introduction to the application of computer methods in architecture and building design. A discussion of design methods using computers, its implications, advantages and limitations. Development of a series of design exercises.

ii. Common Theme Unit (Design Project)

- Conceptual Design: 3D Modelling as a design medium. Design Project. Exploration of design alternatives regarding form, sun lighting, artificial lighting and materials through 3D modelling and rendering.
- Energy Studies: Introduction to the environmental simulation, analysis and appraisal in architectural design.
- Visualisation Studies 1: Introduction to computer animation techniques as a means of design study and presentation. Design Project.
- Structural Analysis: Introduction to computer-aided structural pre-dimensioning as a means of facilitating the interaction of architects with structural engineers. Design Project.
- Visualisation Studies 2: Introduction to virtual reality as a design medium. Introduction to VRML. Design Project.
- Design Communication to the Client: Introduction to Web composing and editing for publishing portfolios. Principles of Web design. Design Project.
- Design Communication to the Construction Site: Introduction to the documentation of designs in computers. Principles of design documentation in computers. Design Project.
- Project Presentation: Presentation and exhibition of design projects.

iii. Advanced Topics

- Introduction to Software Engineering and Programming: Software specification and design. Practice, techniques and programming environments. Software validation and management.
- Knowledge Management Systems in Architecture: Introduction to knowledge representation in architecture. Knowledge representation models. Rule-based systems and expert systems. Domain implementation.
- Dissertation: Development of research topic in the area of computer-aided architectural design

Arising from Silva (2000) CAAD teaching model developed for the University of Brasillia, Table 3 therefore shows the proposed new framework for integration and teaching of CAAD in Nigeria schools of architecture.

 

Table 3. Proposed New Framework for Integration and Teaching of CAAD in Nigeria Schools of Architecture

| Year of Study | Semester | Course Title | Synopsis |
|---|---|---|---|
| **200** | 1st | Introduction to Design Computing | The course introduces the students to computing concepts and technology. It provides the students with the basics of computer hardware and software, interfaces and computer networks. It also teaches the students the techniques for basic drawing and editing using computer technology |
| | 2nd | Design Computing Workshop Practice-1 | The course introduces the students to computer aided design concepts and techniques in a design project based environment. It brings the students to a new level of sophistication in terms of automation and interfacing with other drawings and data. |
| **300** | 1st | Design Computing Workshop Practice-2 | The course introduces the students to conceptual design. It provides the students with the techniques of using 3D modeling as a design medium. It also teaches the students to create photorealistic views of 3D models as a means of design study and presentation. |
| | 2nd | Design Computing Workshop Practice-3 | The course introduces the student to design theory and computer aided design. It introduces the student to the application of computer methods in architecture and building design in a design project based environment. It brings the students to a new level of sophistication in terms of exploration of design alternatives regarding form, sun lighting, artificial lighting and materials through 3D modeling and rendering. |
| **400** | 1st | Building Information Modelling -1 | The course introduces the students to using the BIM technology in parametric modelling. It provides the students with the techniques of using computer technology in database management and conceptual design. It also covers the basics of presenting the Building Model and working in teams on a project using BIM technology. |
| | 2nd | Building Information Modeling -2 | The course builds on the concepts introduced in the Building Information Modelling-I. The students learn about using the BIM technology for exploration of design alternatives regarding form, sun lighting, artificial lighting and materials through 3D modeling and rendering.It brings the students to a level of sophistication in terms of using the BIM technology for exploring sustainable design concepts. |
| **500** | 1st | Theory and Practice of Design Computing 1 | The course introduces the student to the application of design computing in energy and visualisation studies. The students learn about the concept of environmental simulation, analysis and appraisal in architectural design. It also teaches the student computer animation techniques as a means of design study and presentation of the Design Project. |
| | 2nd | Theory and Practice of Design Computing 2 | The course introduces the student to a new level of performative architecture using digital technology. The student learns the application of design computing in structural analysis and advanced visualisation studies. The students learn about the concept of computer-aided structural pre-dimensioning as a means of facilitating the interaction of architects with structural engineers. It also teaches the student virtual reality as a design medium. Introduction to VRML |
| **600** | 1st | Theory and Practice of Design Computing 3 | The course introduces the student to the application of design computing in architectural practice and construction. The students learn about the concept of seamless transition between design computing and digital fabrication. It also teaches the student the practice, techniques and programming environments in architecture. |
| | 2nd | | Application of teaching of CAAD on Architectural Design Thesis |

## 6. Conclusion

This study set out to develop a new framework for teaching of CAAD in schools of architecture in Nigeria. The

 

paper recognized the complexity and dynamic process involved in architectural design particularly in a globalized world. The study observed that architectural education curricula must reflect the needs and aspiration of professional practice in the globalized market. Teaching of CAAD in curricula of schools of architecture in Nigeria is not new but the teaching approach is piecemeal instead of holistic. The piecemeal approach adopted was as a result of the already overloaded curricula which make it almost impossible to integrate other courses. The study noted that the piecemeal approach of teaching CAAD does not favour the future professionals in terms of competitiveness with their counterparts in a globalized market. Thus, the paper took a cue from existing CAAD teaching model to develop a new framework for the teaching of CAAD in schools of architecture in Nigeria. The paper concluded by advocating for an integration of this developed model of teaching CAAD as a way of enhancing the knowledge base of future professionals and improving their competitiveness globally.

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