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INNOVATIVE TEACHING OF BUILDING TECHNOLOGY TO ARCHITECTURE STUDENTS IN THE UNIVERSITY OF MALAYA

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Summary

The built environment is an integral part of the infrastructure necessary for human survival. Current concerns over the environmental sustainability of our biosphere for future generations are being scrutinised on the fringes of the higher education. The focus of this paper is on the teaching approaches of academicians of a public university in Malaysia, specifically on the integration of building technology and sustainability issues into the subjects offered. Architecture teaching involves not only the teaching of art and aesthetics but also the science of building. With the increased use of high-rise construction, intelligent building features as well as the use of building services to make the buildings habitable, it becomes imperative that the students of architecture understand and appreciate the complexities of the engineering systems to make the buildings sustainable and energy efficient, so that their carbon footprint is minimal. The process of architectural design starts with the sketch design as well as a statement of design intent including sustainability and targets by the architectural student. At this point several major decisions are being made with respect to the orientation, fenestration, service cores, environmental control systems etc. These preliminary design decisions would affect the overall energy efficiency of the building as such. It is thus necessary for the architectural student to comprehend and assimilate advanced building technologies. This paper presents a novel approach adopted in the Department of Architecture at the University of Malaya for the teaching of Building Analysis to year 3 students as well as Advanced Building Technology to Year 4 students in a five year Architectural programme.

1. Introduction

Buildings are increasingly becoming more complex and more sophisticated due to advances in building technology, construction and engineering (Gyula Sebestyen 2003). Thus the Architect needs to depend upon a team of specialists who can handle the different aspects of the design and construction of the buildings. Unlike in the earlier days the architect and hence the architecture student should be aware of the latest technological developments and their adaptation for the successful design as well as running of the buildings

2. Architecture through the ages and the building envelope

The "Pre-Industrial" architecture was characterized by abundant resources and limited technology. During that period the architects necessarily had to use the building envelope as the modulator and filter for the harsh outdoor climatic conditions. The building envelope was the PRINCIPAL means of controlling the visual and indoor thermal environment in the buildings. The luminous environment in the buildings was by day lighting in most instances.[1] The "Industrial revolution" markedly changed the above parameters. The advent of new materials coupled with advances in mathematics, structural engineering, building services engineering etc., has immensely contributed to the growth of the modern day skyscrapers and intelligent buildings. The exterior wall now simply becomes a member supported by structural framework at each floor. The exterior wall thus becomes a skin to exclude wind and rain water penetrations into the buildings. The concurrent developments in air-conditioning, lighting, lifts and escalators allowed the buildings to become deeper and deeper in plan as well as to be designed to greater heights (Fuller Moore, 1993, Gyula Sebestyen 2003)

The "Modern movement"[2] used the freedom thus gained by the technical and engineering developments to explore new building forms. Economy of structure, space, labour and construction became the characteristics of the new International style. The concurrent developments in the horizontal and vertical transportations in buildings allowed the buildings to be designed to greater heights. Hence the new buildings are designed to be heavily dependent on electrical energy for their sustenance. This can be construed as "energy dependent" architectural style (Fuller Moore, 1993, Gyula Sebestyen 2003)

3. Architecture studio teaching

In the Architecture Studio, Design projects are the main vehicle by which all the subjects taught in the lectures, seminars as well as from fieldwork are integrated to enhance the learning and creative design skills. (Esa 2002).Figure1 is a simplified illustration of the architecture educational process. The project becomes the central objective for students. (Tony Brown 2001)

Project based learning as a subset of Problem-Based-Learning techniques are often used in teaching as a method of achieving deep learning and simultaneous mature participation within the education process. Project-based techniques may range from the search for an optimal solution to precisely framed problems through to scenarios more akin to complex real life situations where the principal difficulty is one of identifying and framing the appropriate parameters (Peter Skinner 2002).

4. Teaching of sustainability issues to students of Architecture in the University of Malaya

The ambience in and around buildings is the result of the built environment. The responsibility for this falls squarely on the architect (Flynn et al, 1992). The extent and contents of the requirements has grown more complex in recent times as shown in Figure 2 ((Gyula Sebestyen 2003)

The architectural curriculum in the University is based on Design as a vehicle for integration of all the taught subjects. During the first three years of their course the students are given inputs on environmental physics, building structures, building materials, and construction as well as building services. As part of this exercise,

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[1] We require from buildings, as from men, two kinds of goodness: first the doing of their practical duty well: then they be graceful in doing it. (John Ruskin: The stones of Venice,1851).

[2] This is expressed, perhaps, as the new spirit of the 20th century in the claim by Gropius that the designer was released at last from the "tyranny of the wall", which had become merely a boundary between the outside and inside of the buildings.

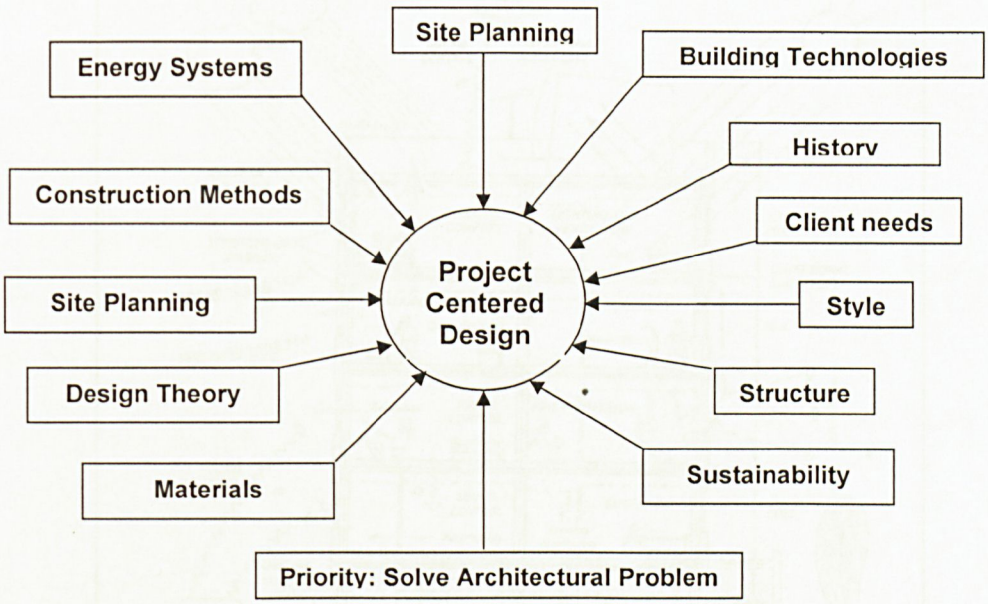


Figure 1 Architecture Studio Teaching Process (Tony Brown 2001)

students are set to solve practical problems, which would involve environmental sustainability issues. The students are encouraged to be proactive in their research and presentations. The students are taken on field trips as well as practising architects are invited to the studios to show how they tackle sustainability issues. The Faculty is fortunate to have eminent architects assisting the students to understand and design environmentally sustainable buildings.

The University's research facility on renewable energy is to be used as a test bed to test new ideas in the future. The facility is being used at present to monitor the performance of some of the building integrated photovoltaics. The students are encouraged to have meaningful discourses in the studio setting for achieving an environmentally sustainable building.

In year 3 studio one of the assignments encourages the student to include the passive and active architecture aspects in their design showing the cause and effect of the sustainable features chosen to the occupant by doing virtual studies of their proposal. They are also exposed to site visits to the internationally known Low Energy Buildings.

5. Innovative teaching of Building Technology at the University of Malaya

The modern day skyscraper is dependent on energy resources and engineering services systems for its daily operations. These services are commonly grouped under the generic heading of "Building Services". Figure 3 shows some of the major components of the Building services for an Intelligent Building.

The scope, complexity, value, use and installation of the specialised building services machinery are increasing rapidly with the advent of the intelligent buildings. An architect is expected to have a basic understanding of the building services so that proper space allocations for plant rooms, ducting, cooling towers and other equipment are made during the initial design phase. Any miscalculations at the sketch design stage are detrimental to the servicing and maintenance of the buildings, leading to Indoor Air Quality (IAQ) problems in the buildings.

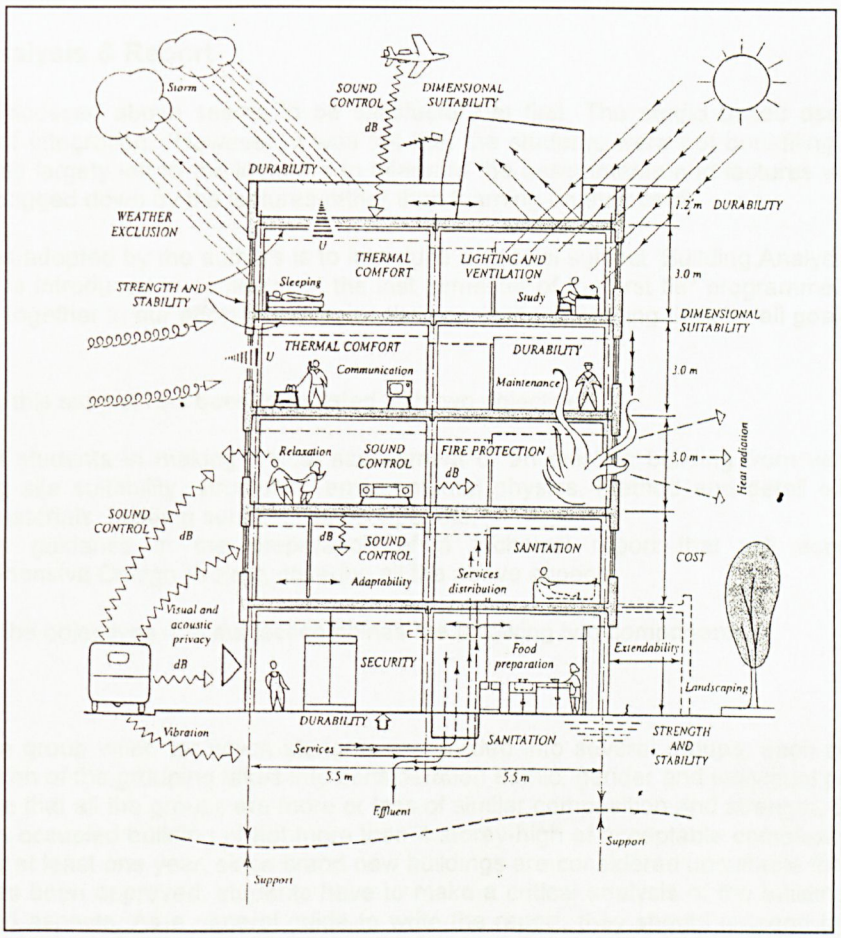


Figure 2 Performance requirements for buildings (Gyula Sebestyen 2003)

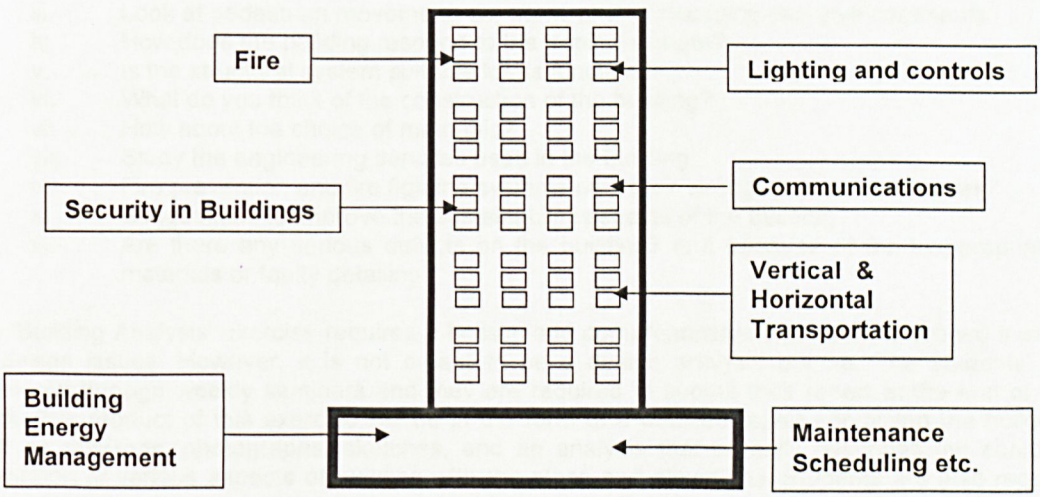


Figure 3 Components of an intelligent building

5.1 Building Analysis & Report

The arrangement discussed above seems to be satisfactory at first. The studio based assignment does achieve the object of integration. However, it was felt that the students were not benefiting fully from the programme, as it was largely left to the lecturers to integrate the assignments and lectures with the studio. The students were bogged down by the lectures rather than learning on their own.

One of the strategies adopted by the authors is to introduce a special subject 'Building Analysis & Report' in year 3. The subject is introduced in semester 6, the last semester of the first tier programme. It consists of two parts combined together in our effort to maximize the possibility of fulfilling the overall goal of integrating the various subjects.

To achieve the goal, this subject has been formulated with two objectives:

i) To train students in making critical assessment of an existing building from various aspects, covering site suitability, structures, environmental physics, method and detail of construction, use of materials, building services, landscape, etc.

ii) To give guidance in the preparation of a technical report that will accompany their Comprehensive Design Project, covering all the above aspects.

In consonance with the objectives, the subject combines the following two components,

Component 1

This component is a group work, for which students are divided into several groups, each comprising 4-6 persons. The formation of the grouping takes into consideration ethnic, gender and individual performance of the student to ensure that all the groups are more or less of similar composition and strength. Every group is required to select an occupied building of not more than 4 storey-high of acceptable complexity, which must have been in use for at least one year, since brand new buildings are considered unsuitable for this exercise. After their choice has been approved, students have to make a critical analysis of the building, covering all the above mentioned aspects. As a general guide to write the report, they should respond to the following questions and instructions, which by no means are exhaustive.

i. Explain briefly the function of the chosen building.
ii. Is it appropriately located on site in terms of orientation and context?
iii. Look at pedestrian movement, car parks and landscaping and give comments.
iv. How does the building respond to the tropical climate?
v. Is the structural system suitable for its function?
vi. What do you think of the construction of the building?
vii. How about the choice of materials?
viii. Study the engineering services used in the building
ix. Fire prevention and fire fighting systems etc., their strengths and weaknesses?
x. Suggestions to improve the sustainability aspects of the building?
xi. Are there any serious defects on the building? Is it because of the inappropriate choice of materials or faulty detailing?

The 'Building Analysis' exercise requires a holistic and comprehensive approach, which will inevitably touch on design issues. However, it is not meant to be a design analysis per se. The students' progress is monitored through weekly seminars and they are required to submit their report at the end of the seventh week. The product of this exercise will be in the form of a detailed report containing the building records, such as drawings, photographs, sketches, and an analysis that critically describes the coordination and integration of various aspects of building with the plans and elevations. Students are also required to give suggestions for the improvement of construction details that they consider to have caused problems or undesirable effects to the building performance and users. The analysis should contain not less than 5000 words, complimented with pictures and sketches with proper annotations. The power point version of the report will be used by each group in presenting their work in a series of seminar conducted during the second half of the semester.

5.1.2 Component 2

This is an individual work in the form of 'Technical Report' that every student shall prepare during the second half of the final semester and hand in at the end of the 15th week. Having gained experience from the preparation of 'Building Analysis' previously, he/she is expected to be able to write the report that will complement his/her Comprehensive Design Project (BAEA 3276) which is meant to be the culmination of his/her project solving ability at the end of the first tier programme (Part 1 level of the Malaysian Board of Architects as well as Part 1 RIBA)

The report shall contain,

i. Site analysis and site studies
ii. Project brief/Client brief
iii. Compilation of initial sketches, concept/intention, massing and photos of initial models
iv. Summary of relevant clauses in Uniform Building Bye Laws related to the building needs
v. Building purpose group, travel distance, fire fighting appliances, etc.,
vi. Local Authority's guideline concerning planning, plot ratio, plinth areas, parking
vii. Calculation of plot ratio, plinth areas and parking requirement of your project
viii. Land use diagram, site planning and landscape
ix. Building services: water, electricity,& electronic, sanitary, telephone, lift & escalator, solid waste disposal system, etc.(Drawings must be in ACAD).
x. Structure and Elevation studies
xi. Interior design
xii. Photos of final model in context

5.2 Advanced Building Technology

The aims of teaching technology to the architecture students in the upper years can be itemised as follows,

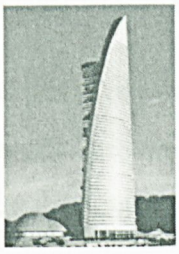
- To explore and understand technological possibilities and limitations,
- To learn various aspects of building design and construction
- To integrate technology into design and
- To understand the roles of consultants amongst others.

There has been a conscious effort to integrate technology subjects into architecture design in recent years (Lim 1999, Rao et al 2003). Specialist technology tutors have been traditionally invited into the studio to understand and aid the design process. The mathematical content of the technology subjects are kept to a minimum and integration and exploration of technology subjects are encouraged. At the Department of Architecture, Advanced Building Technology has been traditionally taught over two semesters at the Year 4 level. During both the semesters, the students are given eight lectures on specialist topics by in-house lecturers as well as by visiting experts and from the trade. The students are also taken on site visits and are required to complete two assignments during the semester, to show their understanding of the design and operation of tall buildings under the Malaysian climate. One of the assignments is set in the context of studio design.

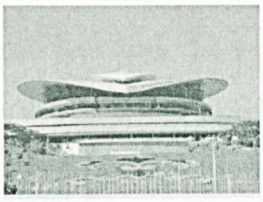
Starting from academic year 2004-2005 onwards, it was decided to bring all the lectures for the building technology to semester one. Thus, the students will get concentrated inputs on building services, structures and construction technology. Various specialist lecturers were invited to talk about their specialities and its application to the high-rise building with special reference to Malaysia. A simple 2-week assignment was set to understand the concept of service cores and their utilization. A second assignment was set in the context of Putra Jaya, the new administrative capital of Malaysia, to give a feel for technological developments.

In the Second semester, the students were introduced the innovative teaching of technology subjects. Figure 4 shows the buildings that have been utilised for the study since 2004, they are: the Securities commission building, the Telecom Tower, the Putrajaya Convention center and the Low energy office building in PutraJaya.

The Securities Commission Building Kuala Lumpur, Malaysia



The Telecoms Building Kuala Lumpur, Malaysia



Putra Jaya Convention Center, Putra Jaya, Malaysia

Low Energy Office Building Putra Jaya, Malaysia

Figure 4 Buildings chosen for study for Advanced building technology since 2004.

These are very unique buildings both for their architecture as well as for their innovative technological features. Three of the buildings have won international awards for energy conservation and for innovative design features. The technology aspects of the buildings were itemised and introduced to the students in the inaugural session. The students do a study of the overall building and its design as well as to individually do a deeper study of their chosen topic. The students had to organise their study methods and site visits. They have to liaise with the various consultants and specialist contractors. All this has to occur within a period of eight weeks. The students regularly meet-up in a discussion session with the coordinators once every two weeks to discuss the materials collected, analyse their utility and share the knowledge across the class. The coordinators acted as facilitators and gave directions for further work as well as explained any new concepts and ideas the students encountered. The students have milestones and targets to meet during the semester. The whole process is perceived to be a student-led educational adventure and learning experience.

6. Conclusions

A new and innovative concept of teaching advanced building technology is described. The students are required to do an in-depth study of a building with reasonably complex structures, services as well as construction features. They have learned fast and seemed to find the teaching process more exciting and useful. The teaching process has met its intended objective of creating enthusiasm and excitement for learning of technology amongst the students. The students appreciate the building technology aspects of design as it is based on a real building ably assisted by the consultants and experts involved in its design as well as in the operation of the building.

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