Innovative Teaching of Building Technology to Architecture Students in Malaysia

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Abstract

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. The process of Architecture design starts with the sketch design by the architect. At this point, many 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 architecture 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, commencing from the academic session 2005-2006 for the teaching of Advanced Building Technology to Year 4 students.

Keywords: *Building Technology, Energy conservation, Intelligent buildings, Building Service*

Introduction

Buildings are increasingly becoming more complex and more sophisticated due to advances in building technology, construction and engineering. 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

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

[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).

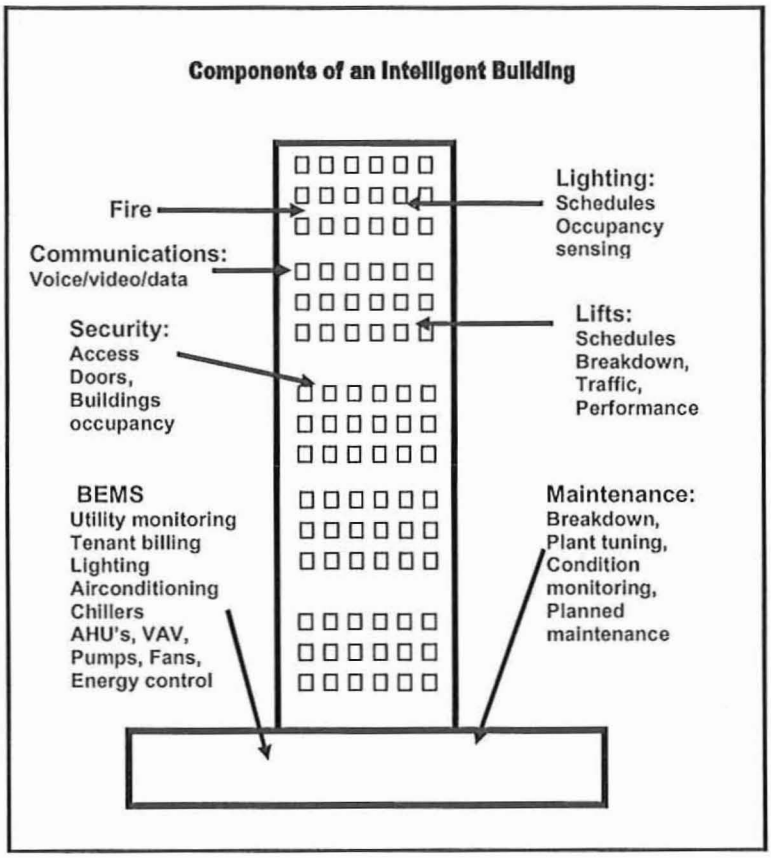

Figure 1. Components of an Intelligent Building

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.

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)

Building services

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".

[1] 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 shows some of the major components of the Building services for an Intelligent Building.

The Mechanical and Electrical services involved are,

1. Air-conditioning equipment viz., Chillers, AHU's, FCU's, filters, cooling towers etc.,
2. Transformer and associated switchgear rooms
3. Lift motor rooms and associated equipment rooms
4. Active and Passive fire protection equipment
5. Cold and Hot water supply
6. Sewerage disposal etc.,

The scope, complexity, value, use and installation of these specialized building services machinery are increasing rapidly with the advent of the intelligent buildings. An architect is expected to have a basic understanding of the above 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. This can be observed during the recent SARS outbreaks in several countries as well as to the occurrence of Legionnaires disease in the past decade.

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) .

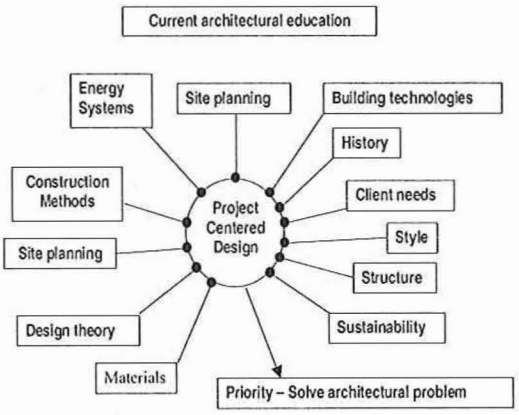

Figure 2: Architecture Studio Teaching Process (Tony Brown 2001)

Figure 2 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).

Teaching technology to architecture students

The aims of teaching technology to the architecture student can be itemized as follows,

- To explore and understand technological possibilities and limitations,
- To learn various aspects of building design and construction
- To integrate technology into design
- 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 Guan Tiong 1999 & Gyula Sebestyen 2003). Specialist technology tutors are brought into the studio to understand and aid in 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, University of Malaya, Advanced Building Technology had 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.

Innovative teaching of Advanced Building Technology at the University of Malaya

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.

Thus, starting from academic year 2004-2005 onwards, it was decided to bring all the technology lectures 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. The first building used for this purpose is the "Telecom Tower. (Menara Telekom) " as shown in Appendix 1. It is one of the notable intelligent buildings near the University of Malaya campus. This is a very unique tall building with intelligent building design features. The technology aspects of the building were itemized and introduced to the students in the inaugural session. The students had to 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 organize their study methods and site visits. They had to liaise with the various consultants and specialist contractors. All this had to occur within a period of eight weeks. The students regularly met-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 had milestones and targets to meet during the semester. The examination schedule is set out in Appendix 2. The whole process is perceived to be a student-led educational adventure and learning experience.

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.

Acknowledgements

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References

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APPENDIX 1

BAES 4229 ADVANCED BUILDING TECHNOLOGY II
Semester 2 2005/2006

Menara Telekom, Kuala Lumpur, Malaysia

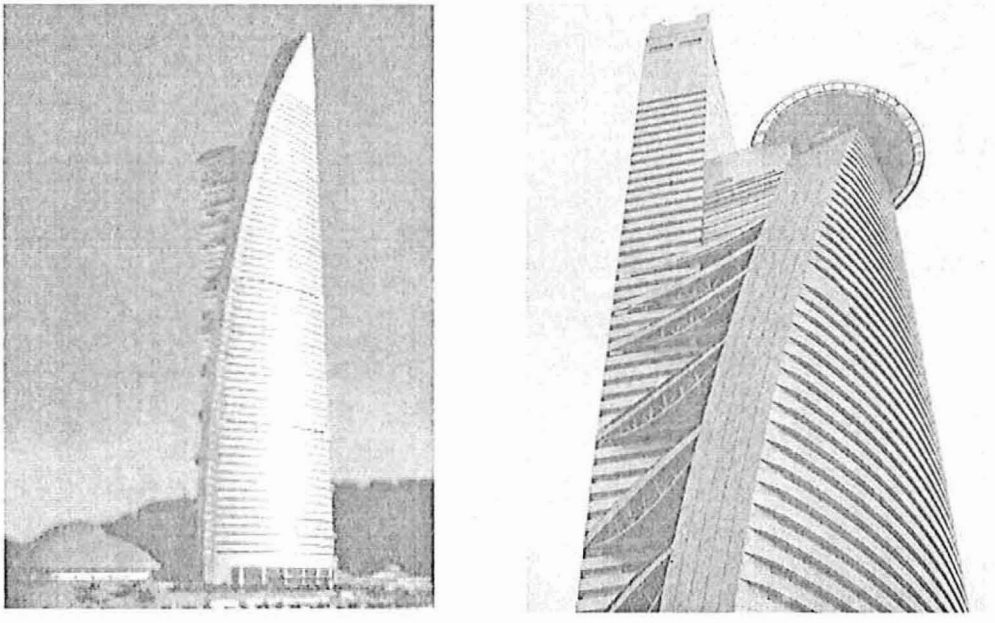

Figure 3: Telecom Tower (Menara Telekom)

The design has been influenced by the bamboo shoot, which has a symbolic meaning in the Malaysian culture. The bamboo shoot represents strength, rapid growth and fertility.

It was completed in 2001 at a cost of RM600 million. Towering at a height of 310 metres, the 77 storey building in Jalan Pantai Bahru is Telecom Malaysia's new corporate headquarters. The Telecom Tower is the world's 20th tallest building.

Its unique curvilinear structure is based on renowned Malaysian sculptor and artist Latiff Mohidin's award-winning masterpiece - the *Pucuk Rebung* - which depicts a young bamboo shoot with strong foundations at its root and little leaves sprouting. The building is designed by Hijjas Kasturi Associates.

The state-of-the-art building is rated as a six-star intelligent building by City Hall, which provides infrastructure for multimedia services with high speed connectivity and features an energy-efficient facilities management system. The building is equipped with an Integrated Building Management System (IBMS) concept created by Telekom Malaysia's research and development division to provide a productive and cost-effective environment. The IBMS has the ability to integrate 11 key mechanical and engineering sub-systems within the tower - ranging from the air-conditioning and ventilation system, to the lighting control system, and the security management and lift and escalator systems.

Another key feature in the building is the document conveyor system, which

transports documents and parcels within the building - from three floors underground to the 55th floor, the highest office floor in the tower.

Menara Telekom can house 6,000 occupants and has 22 "sky gardens" (one on every third floor) to provide a conducive working environment. The landscaped terraces are tranquil, private retreats for rest and relaxation.Among the facilities are a professional performance theatre for an audience of 2,500 and exhibition halls. Occupants of the building can also enjoy sporting and recreational activities at the Menara Telekom Sports Complex. An indoor gymnasium is also available for exercise enthusiasts.

Telekom Malaysia employees with young children can send them to "Tiaratots", a fully-equipped childcare centre with an indoor play centre. More than 100 children spend time at "Tiaratots" under the care of 15 guardians while their parents are working.

Task

Students are required to carry out an in-depth analysis on the above building to create an understanding of how the Architecture design solutions, structures, environmental control systems, building services, building cost etc., are utilised and integrated to produce a creative response for practical & aesthetics purposes. They are also required to study how complex and conflicting requirements are resolved.

Learning Outcomes:

- An awareness of the environmental and constructional factors that affect architecture design decisions necessary for the proper function of buildings.
- An understanding of the relationship between structures, services and architecture form..

Working Method:

- Students are to visit the building to view and understand the spatial layout and facilities.
- Attend a series of discussions with the building's designers / consultant team to learn and understand the principle ideas involved, the various factors taken into consideration in the design process, and the integration of various technical aspects within the building.
- Initially students are to work as a group to analyse the possible topics for the building.
- Subsequently each student is to select at least one topic for an in-depth study. The topics that are to be discussed and covered may encompass the following aspects :
- Integration of design, services and structures,
- Research into methods of construction and their effects on the design.
- Foundations,
- Structures and materials.
- Cladding,
- Fire protection and its application in design.
- Energy use and energy conservation,
- Air conditioning system,
- Building automation system,
- Intelligent building design features,
- Building Security,
- Building external envelope and maintenance and
- Landscape

Requirements:

- Discussions and power point presentation in a seminar session
- Final report : all the individual sections to be bound together as one final report
- Submission of the entire document as a CD ROM.
- Report submission : To be announced later in consultation with the class
- Discussion and presentation : To be announced later in consultation with the class

APPENDIX 2

BAES 4229 ADVANCED BUILDING TECHNOLOGY II
Semester 2 2005/2006

Please note the following schedules

Particulars	Date and Time
Submission of Integrated Reports	9:45 am Tuesday 28th March 2006 This portion of the Assignment wil carry 50% Marks for the Final Examination.
INDIVIDUAL PRESENTATIONS-1 *All the students should be present for the entire session* Too Kean Kong Hu Siau Ping Chan Chung Meng Lee Ren Ying Mohd Hazwandy Bin Mohd Zin Lina Teoh Yee Chin	 This portion of the Assignment will carry 30% Marks for the Final Examination. 9:30 am to 12:30 pm MONDAY 24th April 2006
INDIVIDUAL PRESENTATIONS-2 *All the students should be present for the entire session* Yap Boon Kean Jessica Loo Li Quen Siti Aisyah Binti Mahayuddin Nor Farihah Wahidah Yaakub@ Md Isa Loh Yung Hui Azri Bin Aziz	 This portion of the Assignment will carry 30% Marks for the Final Examination. 9:30 am to 12:30 pm Tuesday 25th April 2006
Submission of the CORRECTED Final submission. The final submission will include 2 Copies of the BOUND report + 2 CD Rom's of the complete work. [The CD should include the PowerPoint Presentations + photographs + the reports.]	This portion of the Assignment will carry 20% Marks for the Final Examination 11 am Friday 28th April 2006.

Posting of the Draft Grades on the Door of Assoc. Prof. S P Rao's office (UC 18)	3 pm Monday 8 May 2006
Grievance Procedure: Any Appeals should be in WRITING addressed to Assoc. Prof. S P Rao and to Prof. Ezrin. Reasons for the appeal must be clearly stated.	12 Noon Tuesday 9 May 2006