Efficient Lighting Management Curricula for ASEAN: Lesson Learned from Its Development and Testing Processes

Acharawan CHUTARAT and Pramoht UNHAVAITHAYA
(King Mongkut's University of Technology Thonburi and Chulalongkorn University, Thailand)

ABSTRACT
Lighting education in Southeast Asia has been questioned if its contents and processes are appropriate for today's changes toward globalization. This paper was written to share approach to curriculum design and development by selected EU universities and Southeast Asian Universities. The project Efficient Lighting Management Curricula for ASEAN (ELMCA) has been awarded a grant by the Asia-Link Programme of European Commission. ELMCA is a co-operation project between lighting efficiency academics from EU members (Germany and Finland) and selected Southeast Asian countries (Thailand, The Philippines, and Vietnam) for the development of efficient lighting technology and energy management curricula. The project duration is 2007-2009. The outcome of the process is not to come up with some vague recommendation but to prepare new practical and advanced efficient lighting higher education curricula specifically adapted to the need of the stakeholders in the three ASEAN countries. This paper describes development process, observation and results from its process and testing. Expected results are client response as common factors, market needed and processes of education that are correlated to perceptions of students that corresponds to globalization period in a local context.

Keywords : lighting education, energy-efficient lighting management, development and implementation of lighting curricula

1. INTRODUCTION:

Challenges in the Creation and Development of the Efficient Lighting management Curricula

There has been some progress on the status of efficient lighting in the three countries. In the past, considerable efforts have been made by the government of these countries to promote the energy conservation. These efforts resulted in the creation of initiatives to promote energy conservation. In lighting, the efforts focused mainly to the involvement of domestic production and usage of energy efficient lighting equipment such as fluorescent thin tube T8, low loss magnetic ballast and efficient lighting luminaire for T8 fluorescent lamp. There was some promotions to replace incandescent lamps with compact fluorescent lamps to increase energy-efficiency. Although there was continuous development in energy efficient lighting, the development is still limited especially when considering modern lighting technology and implementation. These limitations reflect the lack of lighting experts as well as inadequate lighting education in all three ASEAN countries. ELMCA provides a great opportunity for the ASEAN countries to increase the energy-efficiency in lighting through the implementation of organized educational courses on energy-efficient lighting technology and management.

Working team for ELMCA is a group of professors and researchers in fields of electrical engineering and architecture who have similar interest in energy efficient in lighting. Aims of this project are to improve energy efficiency in lighting among Southeast Asian countries through efficiently educate various key human resources by the development of the integrated light and efficient lighting technology and energy management curricula for the three countries. Additional goals are the creation of technical networks among universities, lighting industries, standard institutions and government policy makers and planners with the hope for the creation of the research and development to more advance knowledge and specialization in lighting technology and energy efficiency management.

Challenges took place when different people from different disciplines with different view point with similar interests worked together. At the beginning, it was difficult to learn from each other's experience due to the differences in background and boundaries. Dialog and discussion among the local team has been set to meet once a week to share knowledge. Communication was a key that everyone listened with an open-mined attitude in order to understand each other. This multidisciplinary team approach created a unique learning experience to develop and to agree upon lighting course content. Next sections describe details and results from development process as well as suggestions.

2. METHODS

The process of the efficient lighting management curricula development is divided into six phases: 1)assessing needs in various professions and

industrial sectors in the target countries; 2) brainstorming ideas for integrated higher education concept in the field of energy efficiency; 3) developing lighting engineering/architecture and energy efficiency management modules and curricula; 4) testing modules and curricula developed and used in various universities; 5) refining and enhance the modules and curricula based on the test results; and 6) promoting and planning for wide application of the improved modules and curricula. The following sections portray the above process.

2.1 Need Assessment and Brainstorming

Kick-off Regional Need Assessment was held in Thailand, as the lead partner, and Awareness Building seminars were carried out in Bangkok, Hanoi, and Manila in November 2007. Current status of energy efficient lighting (EEL) has been compiled as information to construct questionnaire for need assessment and for discussion during the kick-off meeting. The following are the stakeholder list: government agencies, academic staffs such as professors, lecturers, teachers and researchers, industries, state enterprises / authorities, lighting related private sectors, social and academic associations as well as end users. A series of presentation by Thai and EU experts highlighted the current education system on lighting and energy efficient lighting in Thailand, its strength, current gaps and opportunity for enhancement through the project. Q&A and a panel discussion helped clarified the interest of stakeholders in the audience. A questionnaire on interest in advanced lighting in building was distributed to the participants and collected at the end of the workshop. Discussions were about the respective interest of each partner as well as to listen to feedback from partners and stakeholders. Findings made through the need assessment of efficient lighting education reveal that several barriers in EEL education must be overcome in order for EEL to be fully implemented in all three ASEAN countries.

2.2 Content Development

In order to share knowledge and work together from different places and time zones, a web site has been created. The internal web page has a partner specific area for exchange of communication and experience sharing for the team to upload and download course materials. The public pages display the project progress, outcome, and materials from trainings and events during the project implementation.

Results from need assessment has been evaluated and taken into consideration for further steps. Face to face meeting has been set weekly for the lead partner for the first year and twice a month for the second year to ensure that strategies and contents are well organized toward the right direction. In addition to local meetings, conceptual workshop and strategy development meetings were held in Germany. All key experts from the five partners attended the brainstorming workshop in Karlsruhe and visited its lighting laboratory in both University Karlsruhe and Helsinki University of Technology.

When all four courses have been developed and compiled, each Asian partner still needed to refine course materials to balance between the content and knowledge level of learners as well as to organize for the sequence of all the contents to be ready for the implementation phase. It was decided not to proceed with the translation of the course material in Thai and Philippines languages, because course materials in English language can also be approved and taught at several universities in Thailand and Philippines. However, at the time of writing this article, Vietnam partner has been working on the translation of ELMCA course materials, starting with the modules which requires for the lectures on the Basics of Lighting.

2.3 Implementation and Evaluation

Thai and Vietnam partners initiated the procedure for the approval of the developed courses. There is no need for a special approval for Philippines partner because the new course material developed under ELMCA will be incorporated to existing course. Chulalongkorn University finished a testing program of the courses II, III and IV for the academic staff, graduate students and lighting professionals. Course II had been tested with 25 participants. Course III and Course IV had been tested with 40 participants and 25 participants respectively. ELMCA modules of the course I (Light and Lighting Fundamentals) had been tested at School of Architecture and Design, King Mongkut's University of Technology Thonburi (KMUTT), Bangkok. 18 students were exposed to the course materials. 3 ELMCA modules of the course I and 4 modules of the course IV were applied with 10 undergraduate students at School of Architecture, Kasembundit University (KBU), Bangkok.

For Philippines partner, tests of the course modules were completed by 45 architectural students. For Vietnam partner, courses are now being tested with electrical engineering students and lighting engineering students. Results from evaluation and lesson learned from Vietnam partner will be available in May 2009.

Each course module used was tested for (i) correct sequence and/or flow and (ii) its value as a knowledge-base for Lighting Design. Regarding (i) the actual offering of the curricula modules to attendee was instituted to test its effectiveness, then

a general assessment of the offering was done where problems encountered and their solutions were observed and noted by professors. Regarding (ii) the students were tested through quiz, homework in addition to direct experience through workshop and discussion.

Finally, at the end of the semester, all of the students were surveyed using the ELMCA Assessment Tool with questions grouped according to the following criteria; 1) Student Information, 2) Course Design, 3) Course Results, 4) Instructor Characteristics, and 5) Additional comments.

3. RESULTS AND DISCUSSION

3.1 Need Assessment

Although the surveys reported a higher-than average mean value for familiarity with design guides, knowledge of major topics toward EEL understanding is lacking. The curricula on energy-efficient lighting technology and management will increase the understanding of these topics. The design of EEL courses bared in mind the needs and goals of each ASEAN nations. This section focuses on results from two sources: 1) initial brainstorming during the Kick-off Regional Need Assessment and Awareness Building in Thailand, Vietnam, and Philippines and 2) questionnaires.

The following conclusions on "curricula" outline were achieved:

1) Target groups: all partners agreed that the main target groups should essentially be students from electrical engineering and architecture wishing to specialize at the BSc level (3rd year) or MSc. level in energy efficient lighting (EEL). Some courses should address the needs of undergraduate students; for example: introduction to efficient lighting, and/or other groups of students such as mechanical engineers or civil engineers. In addition, some courses, repackaged by the respective Asia partners as short compact courses could be useful for vocational education at the college level or continuing education for working professionals. Figure 1 presents percent of preferred type of curricular.

2) Nature of "curricula": all partners agreed that the best way forward could be to develop a series of courses that do not represent a single syllabus for one type of graduate but rather represent courses in a variety of topics that could be used by Asian partners as add-on to already existing curricula to strengthen the efficient lighting dimension of existing diploma or degrees.

3) The volume of course material to be developed jointly by all the partners. Effort will be done not to reinvent the wheel, but rather to repackage and adapt existing material available by each partner or existing in other publicly available curricula and courses. Suggestion of innovative themes and course structure will be proposed by the European partners. However, initial requirements and draft curricula structure outline option are given by ASEAN partners. This will include innovative thinking that will be attractive for targeted students and future's needs. (1)

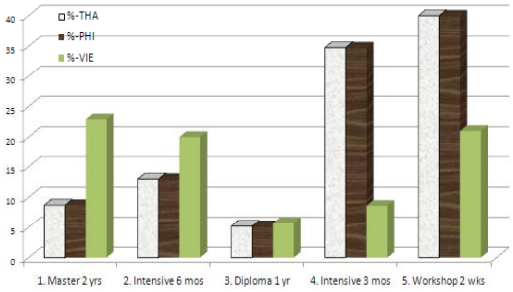

Figure 1 Percent of preferred type of curricular

The important factors found from questionnaire that influence the decision to design or to implement EEL in buildings were owner/client's request and the increasing of electricity cost. This indicates that demand in efficient lighting has been derived by owners or clients and electricity costs. Other factors influencing decisions are company's policy, global warming issues, health and well-being of occupants and building codes. (2)

Moreover, subjects were asked to select three most barriers to the use of EEL in buildings. For Thailand (and Philippines), the top three barriers found were the higher cost of equipment (60.9%), the lack of government supports and incentives (58.7%), and the lack of practical design guides / design tools or available knowledge center (39.1%). Other minor barriers found from this study were lack of qualified experts (32.6%). See Figure 2.

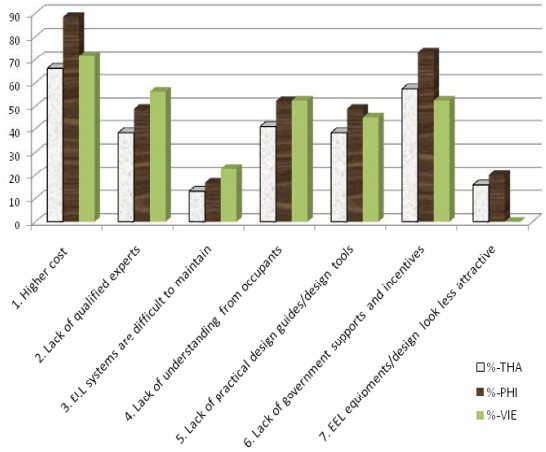

Figure 2 Percent of people who selected three most important barriers to the use of EEL

This implies that roles of government and its policies to support on cost or incentives are crucial

to be taken into consideration. Furthermore, information and communication center for knowledge in design guides or tool is critical to better understanding, supporting, and implementing efficient lighting in buildings. (2)

In summary, Thailand and Vietnam has similar need, which is to develop both 1.) shorter courses ranging from a 2-week workshop to 3 and 6 months intensive courses as well as 2.) longer courses that will be set up as a minor. The Philippines has a different need where an addition of a newer short course as well as improvement on existing courses is required. The next section explains detail of course content development.

3.2 Content Selection

Lighting education content has been developed from EU countries and ASEAN countries with the aim to promote energy efficient in lighting for future. The outcome of the brainstorming workshop was an agreement of the five partners to structure the architecture of the curricula along 4 main courses comprising each around 14 topics to be refined and developed. The main outcome of the task was the agreement to structure the curricula flexibly through a series of modules embedded in four courses that could allow each partner university to integrate these modules in existing engineering or architecture curricula. The titles of the four main courses were agreed as follows: (i) Light and Lighting Fundamentals, (ii) Energy Efficient Lighting Technologies, (iii) Lighting System Design and Simulation and (iv) Energy Efficient Lighting Management. Each course are composed of 14 modules of 2 training units (50 minutes per unit) and provide around 3 credits (2 credits for participating to the course lecture and 1 credit for the exercises, homework and assignment) for an engineering or architecture diploma. The development of the four courses was made jointly with a spread of the development of the material to be balanced among the 5 partners based on a detail list of topics to be refined and the core competence and interest of each partner. Curricula material included course text, list of reference material, presentation slides and a number of exercises per topic treated in the course.

3.3 Implementation Results

Evaluation form developed by ELMCA team was given to students at the end of semester. From the result collected from the evaluation form, in general for both Thailand and Philippines, students who attended the course regularly, were well-informed about course objectives and were aware of the course prerequisites.

With respect to the course design, students found all course topics interesting. Course content and material for all courses except course 4 (Energy Efficient Lighting Management) were found to be highly appropriate. Course 4 which is a new course, requires further development, especially detail of best practice or case studies. There is a need to compile for more information on best practice as a database for further learning.

Regarding course design strategies, all courses still lack of interactions, activities, assignments and quizzes. Those are major concerns from attendee for more direct experience and exercise.

According to the course result, students accomplished most course objectives and results met their expectation, except course 3 (Lighting Design and Simulation). Course 3 required basic skills in computer simulation where some attendee had limitations. For example, they were not familiar with the application of photometric data and modeling systems in computer simulation. Student to lecturer ratio was about 20 to 1 where lecturers could not respond to requests in a timely manner. Ratio of about 10 to 1 could have been appropriate. There were four three-hour sessions for both interior and exterior lighting simulation. However, students requested longer hours for computer simulation and more examples for practicing.

The last subject about instructor characteristics, respond from attendee was acceptable. Concerns from attendee for improvement were “accessible to answer questions or provided clarification outside class hours”, “respond to questions clearly and constructively”, “guide and inspire students to take interest in the subject” and “encouraged participation and questions”.

Overall observation and results from evaluation form, most students preferred less content but more interactive, case studies and direct experience. They could have had more time for deep listening to digest content and to think for further application. Work-based learning could be a good strategy to share and exchange idea among attendee who have different background to understand value of lighting application. This allows students to be able to investigate, to research on their own interest and to work as a team as a multidisciplinary approach for future energy efficient lighting application and management.

4. ACKNOWLEDGEMENTS

The authors would like to express deepest appreciation to the people who helped make this work possible. We would like to express appreciation to European Commission for the funding as well as to people within the academic community in the fields of architectural lighting and illuminating engineering at Chulalongkorn University and King Mongkut’s University of

Technology Thonburi. Finally, the author would like to express special thanks to all the partners: 1) Chulalongkorn University (CU), Faculty of Engineering, Center of Excellence in Electrical Power Technology, Bangkok, Thailand; 2) Helsinki University of Technology (TKK), Helsinki, Finland; 3) Lichttechnisches Institut (LTI), University Karlsruhe, Germany; 4) National Engineering Center (NEC), University of the Philippines Diliman, Manila, the Philippines; and 5) Institute of Engineering Physics (IEP), Hanoi University of Technology, Hanoi, Vietnam.

REFERENCES

1) Chulalongkorn University, Faculty of Engineering, Centre of Excellence in Electrical Power Technology (CEPT): First Quarterly Update, Asia Link Program: Efficient Lighting Management Curricula for ASEAN, Bangkok, (2007)

2) Chulalongkorn University, Faculty of Engineering, Centre of Excellence in Electrical Power Technology (CEPT): Preliminary Data Analysis: ELMCA survey from Awareness Building Seminar, Attachment to ELMCA's Minute of the Meeting No.1/2008, (2008)

APPENDIX

The followings are details of the four courses developed under ELMCA.

Acharawan CHUTARAT
King Mongkut's University of Technology Thonburi (KMUTT),
School of Architecture and Design (SoA+D), Bangkhuntien-Chaitalay Road, Takham, Bangkok 10150, Thailand
Phone : +66-(2)-470-7887
Fax : +66-2-452-3792
E-mail : iacharat@kmutt.ac.th

Pramoht UNHAVAITHAYA
Chulalongkorn University
Faculty of Engineering, Centre of Excellence in Electrical Power Technology (CEPT)
Bangkok, Thailand
E-mail : pramoht@meridiantechs.com

1	Light and Lighting Fundamentals
1.1	Light, eyes, vision, health and productivity
1.2	Light in nonvisual process
1.3	Definition and terminology
1.4	Photometry & colorimetry
1.5	Principles of light generation
1.6	Daylight, light sources and control gears
1.7	Light sources and control gears
1.8	Optical properties of material
1.9	Luminaries
1.10	Luminaries
1.11	Principles of lighting calculation
1.12	Lighting application (indoor)
1.13	Lighting application (outdoor)
1.14	Project discuss-Lighting quality, efficiency

2	Energy Efficient Lighting Technologies
2.1	Components of lighting systems
2.2	Daylight and daylighting
2.3	Artificial light sources
2.4	Artificial light sources
2.5	Artificial light sources
2.6	Control gears
2.7	Control gears
2.8	Luminaries (indoor and outdoor)
2.9	Luminaries (indoor and outdoor)
2.10	Luminaries (indoor and outdoor)
2.11	Lighting system control and management
2.12	Lighting system control and management
2.13	Lighting product standards
2.14	Lighting product standards

3	Lighting System Design and Simulation
3.1	Lighting design process and code+standard
3.2	Lamp and luminaire application
3.3	Lighting design principles for interior I
3.4	Lighting design principles for interior II
3.5	Daylighting model simulation
3.6	Computer simulation for interior space
3.7	Computer simulation for interior space
3.8	Daylighting design and consideration for energy efficient
3.9	Lighting system, installation and maintenance
3.10	Lighting design principles for exterior I
3.11	Lighting design principles for exterior II
3.12	Full scale mock up
3.13	Computer simulation for exterior space
3.14	Workshop in decision making-energy-economic

4	Energy-Efficient Lighting Management
4.1	Energy and building
4.2	Codes, standards & recommendation 1
4.3	Codes, standards & recommendation 2
4.4	Energy efficient lighting systems in action
4.5	Energy efficient lighting policy and management 1-principles
4.6	Energy efficient lighting policy and management 2
4.7	Energy efficient lighting policy and management 3
4.8	Lighting economics 1-introduction and LCC
4.9	Lighting economics 2-LCC for buildings
4.10	Lighting economics 3-LCC for outdoor lighting
4.11	Energy-efficient lighting best practices 1-commercial
4.12	Energy-efficient lighting best practices 2-office
4.13	Energy-efficient lighting best practices 3-industrial
4.14	Energy-efficient lighting best practices 4-exterior