THE HONG KONG
POLYTECHNIC UNIVERSITY

Working Group on Outcome-Based Education

| Ref. No. |
|---|
| For official use only |

# Projects on Promoting Outcome-Based Approaches in Student Learning 2007-08
# Application for OBA Funding

## PART I: General Information

### 1. Title

Nurturing creativity in outcome-based learning: Competitions and physical modeling in selected Civil Engineering subjects

### 2. Name(s) of Applicant(s)

Project Leader

| Name | Dept | Post | Groupwise | Ext. |
|---|---|---|---|---|
| Chau, Kam Tim | CSE | Chair Professor | cektchau@inet.polyu.edu.hk | 6015 |

Team Member(s)

| Name | Dept | Post | Groupwise | Ext. |
|---|---|---|---|---|
| Wong, Hoi Chu | CSE | Associate Professor | cerwong@inet.polyu.edu.hk | 6057 |
| Lam, Ka Se | CSE | Associate Professor | cekslam@inet.polyu.edu.hk | 6071 |
| Xia, Yong | CSE | Assistant Professor | cexyxia@inet.polyu.edu.hk | 6066 |
| Kwan, Chung Lim | CSE | Instructor | ceclkwan@polyu.edu.hk | 3967 |

### 3. Total funding requested

### 4. Expected duration of project: 24 months

Proposed commencement date: 01/07/2008

Expected completion date: 30/06/2010

## PART II: DETAILS OF PROPOSAL

### 1. Project objectives and significance

*(What are your objectives in initiating this project? How does it align with institutional goals and targets in implementing outcome-based approaches in student learning?)*

**Introduction**

One of the most important issues in out-come based education lies on the implementation of outcome-based learning and teaching. In the last 8 years, PolyU's strategic objective number one is to train students with generic competence as well as technical competence in professional context. It is recently recognized that our students need to be highly innovative and creative in solving technical problems in the workplace. This kind of creativity can be considered as both generic and professional attributes that we intended for our graduates. Nurturing creativity is important in preparing our students to cope with the ever-changing dynamic world and job requirements. The main challenge is how we can adopt teaching methodology and assessment that align with learning outcomes (i.e. creativity in professional context). This is the main focus of this proposal.

The main objective of this project is to propose new teaching methodologies and activities through the use of competitions, and physical modelling in our technical subjects. Four subjects would be included in this proposal (i.e. *Structural Mechanics, Structural Analysis, Rock Engineering and Soil Mechanics*), but the philosophy behind our initiatives can easily be extended to other technical subjects within Civil Engineering or even other engineering disciplines.

**Objectives**

The objectives are promoted learning and teaching through games, competitions and building physical modelling. The main objectives are:

1. Structural Mechanics: Inspiring Creative Thinking and Critical Thinking in the subject "*Structural Mechanics*" through the use of physical modelling in simple structures.
2. Structural Analysis: Development of creativity and teamwork in education of "*Structural Analysis*" through physical model experiment
3. Rock Engineering: Motivating students' interest in rock joint mapping in "*Rock Engineering*" through the use of 3-D physical modelling and 3-D animation of stereographic projection.
4. Soil Mechanics: Development of creativity in "Soil Mechanics" through competition in minimizing settlement of model structures on soft clays.

**Significance**

This project targets to propose new outcome-based teaching methodologies and their implementation in nurturing creativity, hence addressing the most grass-root-based and fundamental problems that we face in the new revolution of outcome based learning and teaching. Nurturing creativity is of profound importance in preparing our students to cope with the ever-changing dynamic world and job requirements.

## 2. Target users

*(Who are the intended users of the 'deliverables' of the project – faculties / departments management or programme/subject teams or students?)*

The users of this proposal are 31069 BEng(Hons) in Civil Engineering, full time year one, year two and year three students, whoever taking Subject Structural Mechanics II, Structural Analysis, Rock Engineering and Soil Mechanics.

The class size for each year is about 100.

*If the target users are students, complete the table below:*

| Programme/ subject code | Programme/subject title | Credit units | Mode of study | Student intake quota per year |
|---|---|---|---|---|
| 31069 CSE 204 | BEng(Hons) in Civil Engineering/ Structural Mechanics II | 3 | Full-time | 100 |
| 31069 CSE 301 | BEng(Hons) in Civil Engineering/ Structural Analysis | 3 | Full-time | 100 |
| 31069 CSE 411 | BEng(Hons) in Civil Engineering/ Rock Engineering (Optional subject) | 3 | Full-time | About 50 |
| 31069 CSE 307 | BEng(Hons) in Civil Engineering/ Soil Mechanics | 3 | Full-time | 100 |

*Please insert rows in the table if more space is required for additional information.*

## 3. Outcomes and deliverables

### (a) Major outcomes and deliverables

*(What will be the major outcomes and deliverables of the project?)*

| | Major outcomes and deliverables with descriptions |
|---|---|
| (a) | Students will learn the concept of critical thinking and creative thinking. |
| (b) | Students will be assessed on critical thinking and creative thinking. |
| (c) | Survey the student feedback on the effectiveness of using competitions and physical modelling in teaching and learning. |

*Please insert rows in the table if more space is required for additional information.*

### (b) Plan for developing and piloting / implementing the deliverables

*(Detail the plan and procedures that you will adopt to develop and pilot/ implement the outcomes and deliverables. Also specify the dates of the pilot / implementation period)*

**Subject: <u>Structural Mechanics II</u> (Critical and creative thinking through competition)**

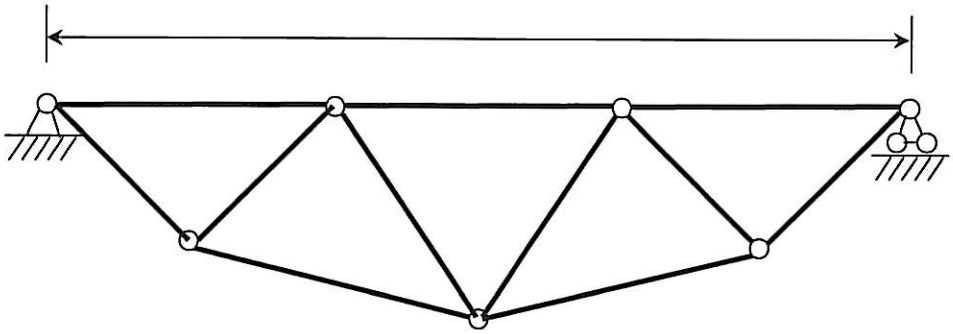
(I) Plan for development of critical thinking

The plan is to use two laboratory sessions for training of critical thinking. In both the "shear center" and unsymmetric bending experiments, students are asked to test two beams with different cross-sections. Usually four students work on one beam and the other group of four worked on the other beam. The two groups then swap after

completion of the first beam. In the critical training exercise, a fault or more than one faults were created in the first round so both groups will find out that their experiments are not successful. The students are then asked to criticize the setup of the experiment. They need to make modifications to achieve the objectives of the experiment. A certain percentage of the score (say 20% to 30%) of the laboratory reports is aligned to this critical thinking ability. The concept of critical thinking are then delivered to the class in lectures or tutorials after laboratory reports are returned to students.

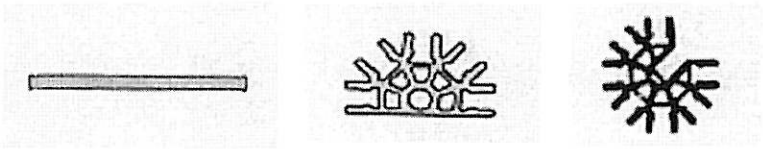
(II) Plan for development of creative thinking

The plan is to conduct a structure design competition. The competition will be conducted as an assignment. The class is divided into twenty groups. Students are then asked to design a bridge using a frame structure. Only the span of the bridge is fixed, all other parameters are free. Each group is given one box of joints and rods so that the total number of joints and rods are identical for each group. Students have to construct their own designed bridge using only the materials provided. Before the end of the semester, all bridges have to be tested for the deflection at mid span using a standard weight. The score of this assignment is inversely proportional to the deflection of a bridge. The concepts of creative thinking are then delivered to the class in the last lecture.

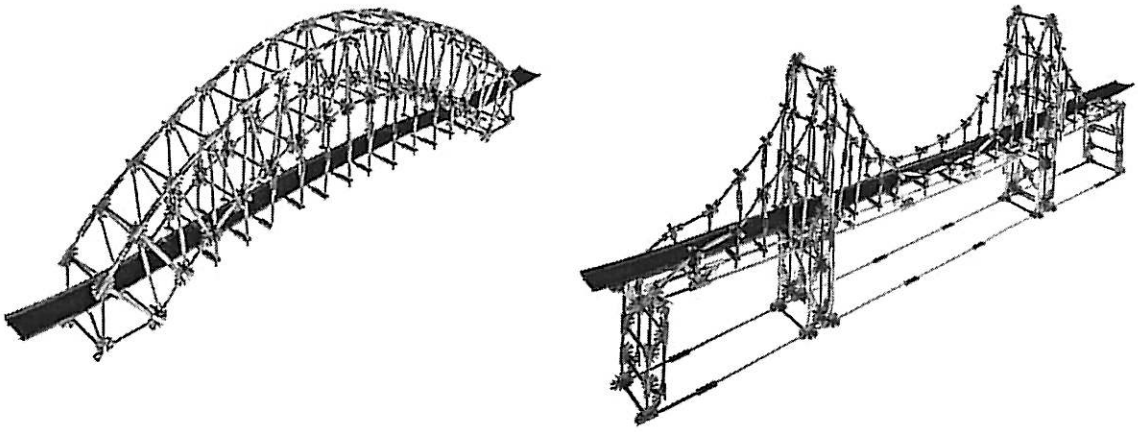


**Subject: <u>Structural Analysis</u> (Nurturing creativity through competition)**

This educational project aims to enhance the learning outcomes of students, particularly creativity and teamwork, through construction of physical models, by utilizing a plastic toy K'NEX in the laboratory test. Within the small project, students, in group form, are required to try different ways to build one small structure until some criteria are achieved. During the process, testing and computer analysis are integrated to check the results.



Some pieces of toy



Bridges built with K'NEX

**Background**

Creativity is the ability to make something new, whether a thought or idea, an object, a product or a process, a work of art or performance, or an interpretation. Creativity is crucial to structural engineering. It promotes new technologies and progress of the whole society. For example, new structural forms, new materials and new analytical methods have appeared.

It is suggested that the classroom environment plays a crucial role in promoting creativity. That is, creativity can be encouraged by establishing a creative climate. Concerning the current situation of the University, progressive approach should be provided in the curriculum design. The applicant proposes the innovative activity starting from the laboratory work of subject *Structural Analysis (CSE301)* in the Department of CSE.

Teamwork is another important attribute for structural engineers. Nowadays, nearly all practical structures, from the design stage to the management after completion, require teamwork and cooperation from different disciplines. It is our mission to motivate the students work together. The group project will foster interdependence as each group member not only has to contribute their own section, but also to ensure the completion of sections from other members to make the whole project complete.

**Advantages**

1. Students have much more fun and interests in developing their own structural model, than the traditional laboratory test in which the structure has been specified and provided by the lectures/Department. Consequently it motivates their creativity and participation.
2. Students have great freedom to build different types of structures. This can cultivate their innovation.
3. The entire process requires students integrate different knowledge together, for example, material testing, measurement of strain and deflection, computer modelling, and so forth. Through the small project, students can learn the physical behaviors of structures, testing methods and computer analysis.
4. The entire process requires group members work together closely to achieve best results. This allow them develop the teamwork during the project.
5. The toy, K'NEX is suitable for the project because it is composed of several sizes of bars, joints, as shown in the figure. Examples of bridges built by the toy components can be found as well. The flexibility allows one build different types of structures and therefore understand different structural characteristics.
6. The budget of the project can be low as the components of the toy are affordable and reusable.
7. CALSB, an educational software developed by one CSE colleague can be used to analyze the model. More advanced software package (SAP2000, for example) is available in the Department.
8. The activity can be developed and incorporated with other subjects, such as structural mechanics, structural design, and so on.

**Implementation**

Currently the students in structural engineering discipline have 6 hours laboratory and 3 hours computer analysis. Within 9 hours (without increase their study load), the students are required to build a structure with components of K'NEX, test the structure with loadings, and analyze the model with computer software package for comparison. The process is repeated to achieve the optimum structure.

## Subject: Rock Engineering: (Demonstrating Creativity)

Stereographic projection simplifies graphical solutions to problems involving the relative orientations of lines and planes in space. In rock mechanics contents, stereographic projection is appealing for analyzing the stability of excavations including slopes, tunnels and foundations.

The principle of the projection considers a reference sphere. Line or plan passes through the center of the reference sphere from the upper hemisphere to the lower hemisphere (Fig. 1). A horizontal plan through 0 is termed the projection plane. The stereographic projection is the line or plan in the lower hemisphere pierces horizontal projection plan to the top of the reference sphere at F (Focus). Figure 1 shows a line and plan projection in 3-D space. A stereonet (Fig. 2a) and polar net (Fig. 2b) are created by the stereographic projection of a set of reference planes and lines with in one hemisphere. The relationship between the stereonet and polar net is shown in Fig. 2c. The most convenient way for the student to project the plane or line is by tracing it form the stereonet or polar net (Fig. 2).

However, students are always confused when carrying out the projection in particular for analyzing the stability of excavation. This project proposes an innovative and creative ways of teaching Stereographic projection through the use of 3-D animations and 3-D physical models. The creativity is introduced to students in this subject through our creative use of 3-D animations and 3-D physical models. This will set a role model for students to appreciate the usefulness and power of creativity.

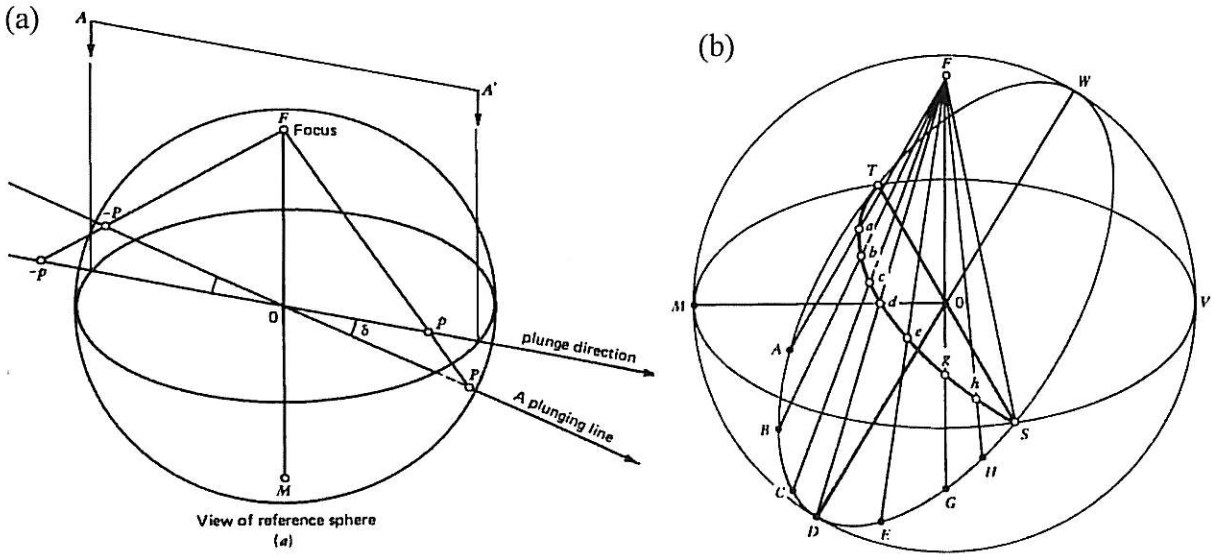



Fig. 1 line projection (a) and plan projection (b) of stereographic projection.

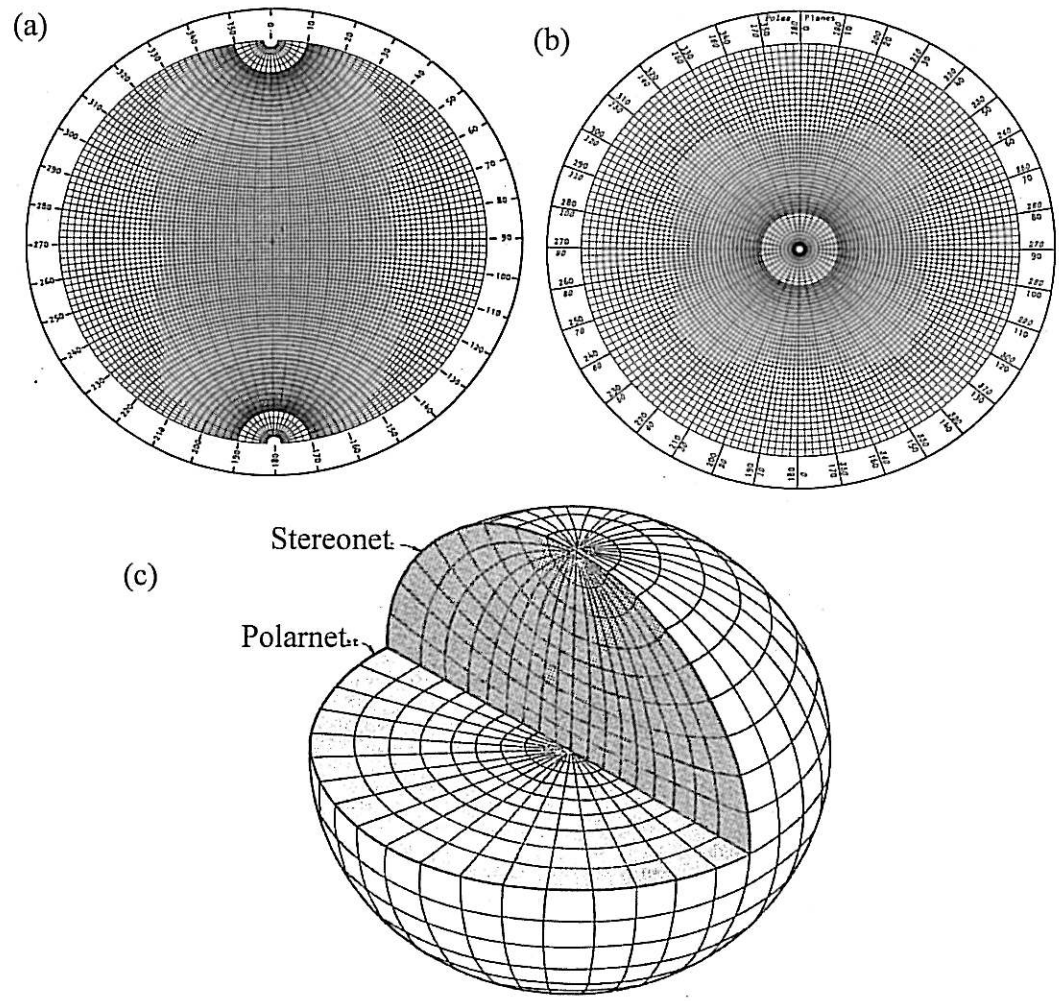



Figure 2 Stereonet (a), Polar net (b) and the relationship between the stereonet and polar net

**Methodology:** It is proposed to create a set of 3-D animations showing the process of stereographic projection including lines and plane projection. This 3-D animations can upload on the website, so that the students can repeat the projection process when they carrying the assignment. This 3-D animation can strengthen the concept of stereographic projection. Furthermore, a 3-D physical model for demonstration is required. The sphere model is made by transparent material and the upper and lower hemisphere can separated (Fig. 3). The planes are made by carton paper and the lines are made by 2mm diameter iron bar for projection. The lower hemisphere is filled by transparent ball with 10mm diameter. The carton paper plane or iron ban can be inserted into the transparent ball for fixing purpose. A laser pointer is needed to show the projection process of a plane or line on the horizontal plane.

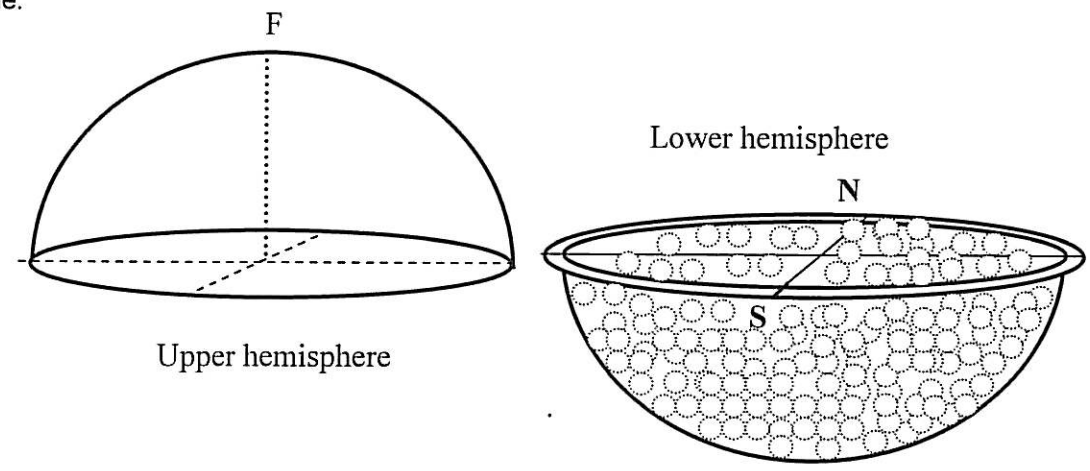


Figure 3 The physical model of stereographic projection

For this subject, no assessment on creativity will be made. But the students will be surveyed on the effectiveness of these tools (animation and physical models) in teaching the subject area. Actually, both of these tools are completely new ideas, and to the best of our knowledge such ideas have never been used in teaching this difficult subject. Therefore, creativity is taught by setting an example (i.e. we show our creativity in learning to students).

## Subject: Soil Mechanics (Nurturing creativity through competition)

### Introduction

A "fun" competition is proposed in the learning and teaching of "Soil Mechanics". The students will learn the basics of "Soil Mechanics" before participating in this competition. Students will asked to form group of 7 students. The main objective of the competition is to minimize the settlement of a structure model resting on a soft clay layer. Limited amount of specific materials (like, toothpicks, plastic straws, and cardboard papers etc) will be supplied to students and they are required to come up with the most creative ways to minimize the settlement of building model with the limited materials provided. The constraints and rules of how to use the provided materials will be kept to minimum in order to arouse the creativity thinking and innovation of the students.

The type and locations of the loading on the structure model, and the stabilizing materials provided will only be announced at the spot of competition. The students will only be given 15 minutes to work out their solutions, so that the students need not to spend a lot of time preparing for the competition and cannot copy from other sources. This also makes the competition fun. The team come up with the smallest settlement wins. The results will count toward the coursework marks and certificates will be awarded to the winning team.

### Methodology

Container of soft clay will be given to students, and a building model will be placed on the clay. The student can use the provided materials (they will be small, weak, soft and highly deformable) to put into the clay to minimize the settlement. There is no model answer. The chosen materials for competition will be selected in a way that the traditional thinking will not work. That is, innovation is a must for the winner.

Planned pilot / implementation period of the deliverables:
Start Date (dd/mm/yyyy): .....1 July 2008.....
End Date (dd/mm/yyyy): .....30 June 2010.....

## 4. Dissemination and sharing plan

*(How are you going to disseminate and share the outcomes and deliverables of your project?)*

| Where to disseminate/share outcomes/deliverables of project? | How to disseminate/share outcomes/deliverables of project? |
|---|---|
| Within CSE | – Share through informal exchange among project teams members<br>– Results of the project will upload to website |
| Other PolyU departments | – Share in seminars/workshops organized by EDC etc departments |
| Other universities, local and overseas | – Participate and submit papers to conferences held locally and overseas |

## 5. Evaluation plan

*(How do you plan to evaluate the effectiveness of the project, particularly its impact on the implementation of outcome-based approaches in student learning in the PolyU?)*

To evaluate the effectiveness of the project, questionaire will be designed to solicit views of students and student performance will be analyzed. In particular, we will

a) Collect subjective views of students will be solicited through questionnaires specifically designed to examine the impact of the teaching methodology on them.

b) Compile the statistics of student performance in these activities and gauge them against the final examination. Correlation will be established (i.e. whether students perform better in competition are the same ones perform better in traditional examination).

## 6. Impact

*(How will the project contribute to the success of the implementation of outcome-based approaches in student learning in the PolyU/ department/ programme/ subject?)*

The effectiveness of the proposed teaching methodology through competition and models in nurturing creativity will be assessed. The results of the project (no matter positive or negative) will be contributing to the implementation of outcome-based approached in student learning in CSE in PolyU. If the students do not learn creativity through these activities, it can provide a useful example of what goes wrong. Others need not to fall into the same trap again. If the results are positive, we can share this to other subject lecturers in CSE as well as other departments within PolyU.

Since this project proposes down to earth implementation of outcome-based approaches in student learning, no matter what is the outcome it is contributing to our learning process of the outcome-based learning and teaching in PolyU.

**7. Target date(s) for submission of progress and completion reports**

| | Planned submission date (mm/yyyy) |
|---|---|
| 1. Progress report<br>*(for projects whose duration lasts more than 1 year; to be submitted mid-way through the proposed project period)* | 6/2009 |
| 2. Completion report<br>*(to be submitted within 3 months after the project completion date)* | 9/2010 |

## PART III: BUDGET OF PROPOSAL

***Important Notes**

1. Funding requests for equipment and/ or software will be considered only if:
   a. the equipment / software is essential to the successful implementation of the project, AND
   b. it is not available in the department concerned. The Project Leader has the responsibility to check this out.
2. The purchasing policies and procedures of FO must be followed for the procurement of approved items.
3. Funding request for conference attendance will not be considered.

## PART IV: DEPARTMENTAL ENDORSEMENT

### Endorsement by Chair of ~~ELTC~~/ DLTC:

Comments on the proposal:

Name: K.T. CHAU (in block letters) Signature: Tai Chau Date: Jan 31, 08

---

**Project Leader**

Name: K.T. CHAU (in block letters) Signature: Tai Chau

Dept: CSE Date: Jan 31, 08

## Endorsement by Dean/ HoD:

Comments on the proposal:

The proposal is strongly supported.

***By endorsing this proposal, I agree that:***

1. **The proposal suitably addresses the School/Department's needs in promoting and implementing outcome-based approaches in student learning and will be considered as part of the School's/Department's Business Plan.**

2. **The School/Department will receive a funding as calculated for item (e) in the Budget section which I will use for providing the time release recommended by the project proposers, based on the Total Workload Model, to support them to work effectively on the project.**

Name: Y L XU (in block letters) Signature: _____ Date: Feb. 1, 2008

---

Please return this form to Miss Miranda Fung, Secretary of Working Group on Outcome-based Education, c/o Educational Development Centre by **31January 2008**

Ref. no. 11

# Supplementary Note

*Converted from email received on 14 April 2008*

| | |
|---|---|
| **Proposed Project:** | Nurturing creativity in outcome-based learning: competitions and physical modeling in selected Civil Engineering subjects |
| **Chief Proposer(s):** | Prof. K.T. Chau (CSE) |

Please delete the budget of the software in this case. I think the department should be able to top-up this if our project is funded. Thanks.

KT Chau