



Progress Report

Activities Conducted July 15 – October 31, 2005

Report Submitted by:

Executive Committee, GCEC:
Tomasz Arciszewski, Ian Smith, Hani Melhem

1. Organization of Conference Sessions

The Center has organized two sessions under the title “Globalization and Computing in Civil Engineering” during the Joint International Conference on Computing and Decision Making in Civil and Building Engineering in Montreal, Canada, June 14-16, 2006. The first session is focused on education with four presentations while the second one is on professional practice and includes a panel discussion with nine participants from academia and industry. For more details, see Appendix 1.

2. Cooperation with the ASCE senior executive officers

2.1. Meeting with Walter Malrowe

In August, 2005, a meeting with Walter Marlowe (ASCE, Director, Professional Practice) has been organized and attended by Tomasz Arciszewski and Rafal Kicingier. The discussion was focused on:

- Development of the ASCE Certificate in Computing
- Body of knowledge in computing (definitions, topics, taxonomy of topics, ontology, etc.)
- Development of a business plan

- ISO guidelines

Walter Marlowe expressed enthusiastic support for our initiative and promised to provide his assistance in the implementation of our plans. The next meeting with him is scheduled for November 28, 2005.

2.2. Organization of Meetings at the ASCE on November 28, 2005

A sequence of working meetings with senior ASCE officers has been organized to advance our activities in the area of education. Appointments have been secured with:

- Patrick Natale, Executive Director
- John Casazza, Director, Continuing Education
- Walter Marlowe, Director, Professional Practice
- Marissa Sherard, Director, International Programs
- Johanna Reinhard, Director, Publications
- Michael Goode (tentative), Vice President, CERF

The GCEC delegation will include:

- Tomasz Arciszewski (Chair, Executive Committee, GCEC)
Professor and Chair
Civil, Environmental and Infrastructure Engineering Department
School of Information Technology & Engineering
George Mason University, Fairfax, VA
- Raymond Issa (member, Executive Committee, TCCIT)
Director of Graduate and Distance Education Programs,
Professor
School of Building Construction
University of Florida, Gainesville, FL
- Rafal Kicingier
Assistant Research Professor
Civil, Environmental and Infrastructure Engineering Department
School of Information Technology & Engineering

- George Mason University, Fairfax, VA
- Hani G. Melhem (Vice-Chair, International Organizations, GCEC)
Martin K. Eby Professor of Structural Engineering
Department of Civil Engineering
Kansas State University
 - John Miles (Co-Chair, Working Group for Education, GCEC)
Professor, Head of Institute of Machines and Structures
Cardiff School of Engineering
Cardiff University, UK
 - W. M. Kim Roddis (member, ExCom, ASCE)
Professor and Chair
Department of Civil & Environmental Engineering
The George Washington University, Washington, DC
 - Guillermo Salazar (Education Committee Chair)
Assistant Professor
Civil Engineering Department
Worcester Institute of Technology
Worcester, MA
 - Ian Smith (Vice-Chair, Education)
Professor of Structural Engineering
Director, Institute of Structural Engineering
EPFL Lausanne,
Switzerland

3. Education

3.1. Development of a course “Fundamentals of Computing in Civil Engineering” (Ian Smith and John Miles)

A detailed one-week course proposal for practicing civil engineers has been developed (see Appendix 2). Also, a business plan has been prepared. The course will be initially offered in the United Kingdom, and later, after initial experience is available, in other

countries. It will be a pilot course for purposes of course feasibility study and further development.

3.2. Organization of a meeting at the NSF, November 28, 2005

A meeting has been organized with representatives of the NSF International Division to discuss our global educational and research plans. The meeting will be attended by several program directors from the International Division and by Dr. Chema De LaGarza, Director, Program "IT and Infrastructure Systems." Our delegation will be the same as for our meetings at the ASCE Headquarters (see above).

3.3. Organization of a visit to NEW Laboratory at George Mason University, November 28, 2005

Our delegation visiting the ASCE Headquarters and the NSF will visit in the evening on the same day the NEW Laboratory in the Volgenau School of Information Technology and Engineering at GMU. The laboratory is directed by Dr. Mark Pullman of the Computer Science Department and specializes in the development of advanced software for distant learning. The purpose of the visit is to explore new state-of-the-art facilities and distant learning technologies that may be helpful to the Center's mission.

4. Development of the ASCE Certificate in Computing

4.1. Identification of Topics and their Taxonomy (Ian Smith, Tomasz Arciszewski)

Extensive discussions took place regarding the timing of this activity. Finally, it has been agreed that rapid prototyping should be used and the initial sets of definitions and topics have been developed. They are neither final nor exhaustive and they will be further developed (See Appendix 3).

4.2. Teaching Modules Development Guidelines (Ian Smith, Tomasz Arciszewski)

A set of guidelines and a proposed teaching module development process has been developed. (See Appendix 4)

4.3. Development of Business Plan (Rafal Kicinger, Raymond Issa)

After the meeting with Walter Marlowe, Rafal Kicinger began working on our business plan following Marlowe's and ISO guidelines. The first draft of the document (approximately 15 pages) has already been developed by Rafal and sent to Raymond Issa to continue the work. A more advanced draft will be given to Walter Marlowe on November 28, 2005.

5. Logistics

5.1. Building Global Network

5.1.1. African Network (Joseph Ugwu)

Initial contacts were established by Joseph Ugwu followed by formal invitations from Tomasz Arciszewski sent to:

- Dr. S N Odai
Kwame Nkrumah University of Science and Technology
Kumasi.
GHANA

- Professor A. B. Ngowi
Head, Department of Civil Engineering
University of Botswana
Private Bag 0061
Gaborone
Botswana

- Dr Theo C. Haupt,
Coordinator - Southern African Built Environment Research
Center (SABERC)
P.O. Box 1906
BELLVILLE 7535
South Africa

- Prof. M.H.H. Nkunya
Chief Academic Officer
University of Dar es Salaam
P.O.BOX 35091 - DAR ES SALAAM- TANZANIA
- Professor N. N. Osadebe
Dept of Civil Engineering
School of Engineering
University of Nigeria
Nsukka
Anambra State
Nigeria

As of now, the first four universities have already formally responded to our invitations and became members of our Center. We expect the University of Nigeria to respond soon.

5.1.2. *Asian Network* (C.K. Soh)

A dialog was initiated involving Tomasz Arciszewski, C.K. Soh (Singapore), Bimal Kumar (UK/India) and Mohan Kuramaswamy (Hong Kong). A decision was made to establish a working group for the Asian Network with C.K. Soh being the Chair. As recently as yesterday, (November 7, 2005) Tomasz Arciszewski exchanged messages with the group members about our objectives and plans of action. The Group is expected to produce an initial plan of action and a proposal for an Asian network, including its organization, before the end of November, 2005.

5.1.3. *East European Network* (W. Sosnowski)

The activities began only recently, but progress is expected soon. Most likely, Ukraine will be the first member.

5.2. **Homepage**

A prototype of our homepage has been created. For the time being it is available at <http://www.websitefororg.com/GlobalCenter/index.htm>,

but very soon it will be available at the ASCE server with the domain name ASCEGlobalCenter.

5.3. Logo

A logo for our Center has been designed by a professional graphics designer (see above) at no cost for the ASCE.

5.4. Database (Rafal Kicingier)

A contact management database ACT! has been established with 25 records of the Center's members.

APPENDIX 1

Contributed sessions

“Globalization and Computing in Civil Engineering”

Two Sessions

Joint International Conference on Computing and Decision Making in Civil and Building Engineering in Montreal, Canada, June 14-16, 2006.

Sessions Organizer and Chair: Tomasz Arciszewski

Session No. 1

“Globalization and Computing in Civil Engineering: Education”

1. “A Course in Computer- Aided Engineering Fundamentals,” Ian Smith, EPFL Lausanne, Switzerland, and John Miles, University of Cardiff, United Kingdom.
2. “Global Collaboration in Construction IT Education,” Danijel Reblj, University of Maribor, Slovenia.
3. “An Experience in Large Class Teaching with Online Learning,” C.K. Soh, Nanyang Technology University, Singapore.
4. “Defining Innovative Architectural – Construction Integrated Curriculum for Sustainable Global Practice,” Rahinah Ibrahim, Putra University, Malaysia, Renate Fruchter, Stanford University, USA

Session No. 2

“Globalization and Computing in Civil Engineering:
International Cooperation”

1. “Explicit Choices and Emergent Work Practices in Global Teamwork,” Renate Fruchter, Stanford University, USA.
2. “ICT Applications in Construction: A Comparative Study of Benchmarks, Benefits, Costs & Risks between Hong Kong & Australian Construction Firms,” Joseph Ugwu’ Mohan Kumaraswamy’ Thomas Ng, University of Hong Kong, Hong Kong.

Panel Discussion

Panelists:

1. Tomasz Arciszewski (Facilitator)
2. Dietrich Hartman, Ruhr University in Bochum, Germany
3. John Matusik, Engineering Groupe, USA
4. John Miles, University of Cardiff, United Kingdom
5. Renate Fruchter, Stanford University, USA
6. Joseph Ugwu’ University of Hong Kong, Hong Kong
7. Danijel Reblj, University of Maribor, Slovenia
8. Ian Smith, ETH Lausanne, Switzerland
9. C.K. Soh, Nanyang Technology University, Singapore

APPENDIX 2

Educational Activities

Pilot Project in Great Britain

Course Title: Fundamentals of Computer-Aided Engineering

Course Justification

Although civil engineers were the first engineers to use computers in 1956, they have been slow to adopt new methods and technologies. One explanation is the paradox of being first. Early use has led to complacency regarding the importance of advances in information technology and this has subsequently led to inappropriate use and unnecessary costs. Such bad experience has hurt the image of computing in civil engineering and this has resulted in insufficient allocations of appropriate teaching time within undergraduate curricula. Our young engineers have become ill prepared to recognize opportunities and benefit from new technologies. In practice, use of computing for high value-added activities in civil engineering is now the lowest of all engineering domains. Having been the first engineers to apply computing, we are now last.

Over the past decade, attempts to remedy this situation have met with mixed results. For example, arguing that civil engineers rarely program computers in their professional lives, some universities have eliminated programming courses from their study programs. In their place, courses in specialized areas, such as construction, have been given more time to introduce special purpose software tools for use in project courses. While such training may make engineering students more immediately useful, uncontrollable events may make these efforts futile. For example, new software versions may be released, software companies could go bankrupt and employers may adopt other software for their work. Finally from a long-term perspective, such education is a weak preparation for future developments in information technologies.

How can civil engineers benefit the most from current and future information technologies? This course provides a solution. Civil engineers need to have a better knowledge of those fundamental aspects of computer science that are relevant to civil engineering. Such aspects are the basis of advances downstream when new information technologies are developed. In this way engineers become better prepared to judge current and future proposals. Furthermore, while most engineers may not program, many will be asked to participate in teams with computer specialists for tasks such as project support, knowledge management and purchase of computer infrastructure. Since teamwork is most effective when players have close technological cultures, this course will help build trust between team members and thus avoid costly mistakes.

The course is organized into modules that are derived from fundamental topics in computer science. Taught by civil engineers with much practical experience, examples are drawn from civil engineering cases and practical experience. At the end of teaching parts of modules are exercises where students apply what they have learned to civil engineering situations. Since the emphasis is to “think before you type” and to maintain generality for universal application, no contact with specific hardware or software is included.

Teaching Plan

Authors: Ian F.C. Smith F.ASCE and John C. Miles M.ASCE

One-week course in 2006 given to engineers working in practice

Total time: 32 hours over 4.5 days (Monday morning to Friday noon)

1. Identifying the type of problem (3 hours)

- Fundamental logic in open and closed worlds
- Importance of abductive tasks and their difference with respect to simulation and analysis tasks
- Engineering tasks – identification of deductive, inductive and abductive tasks in engineering
- Setting the scope for computer-aided engineering challenges of the future

Exercises: Matching engineering tasks to types of logic

2. The limits of computing - dealing with complexity, who / what makes the decisions **(4 hours)**

- Why computers cannot do everything: estimating trends in execution time, why computers can do some things very well
- O Notation
- Why bigger computers will sometimes not help: classification of functions
- Tractability and algorithm optimality
- Determining the complexity of tasks
- P, NP and NP completeness
- What do engineers do?

Exercises: Using O-Notation to estimate the effect of task size

3. Representing information (5 hours)

- Garbage in → garbage out
- Data structures – lists, graphs, trees, stacks, queues
- Knowledge structures
- OOP – classes, encapsulation, abstract, polymorphism, message passing, decomposition hierarchies, agents
- Ontologies – creation, incremental growth, maintenance

Exercises: Cycles in message passing, ontology creation

4. Designing relational data bases (4 hours)

- Relational model
- Functional dependencies
- Normal forms
- Up-date anomalies

Exercises: Design of a robust database from functional dependencies

5. Optimization, search and exploration (6 hours)

- Although engineers can rarely optimize in an open world, some mathematical techniques help the search for good solutions
- Types of optimization problems

- Objective functions, goals and constraints
- Gradient methods
- Stochastic search – evolutionary algorithms, simulated annealing, probabilistic methods
- Multi-criteria optimization: Pareto and other approaches
Exercises: Gradient optimization, solution space creation, stochastic search

6. Learning from experience (4 hours)

- Company experience is valuable
- Case based reasoning – five stages – difference between CBR and information retrieval
- Statistical learning - ANN
- Inductive learning – ID3, Entropy
- Data mining
Exercises: Case based reasoning, ANN, Entropy

7. Decision support (2 hours)

- Why keep knowledge?
- Types of knowledge
- Rule bases – chaining
- Linking to analysis software
- Appropriate presentation of information
- Agents
- Challenges and risks
Exercises: Rule chaining, updating, agent information cycling

8. Graphics and geometrical modeling (2 hours)

- Why bad graphics leads to higher costs
- Geometrical representation: Parametric CAD, sweep, Bézier, boundary representations, winged edge representations, geometric solid modeling
- Displaying information: projections, shading, lighting, textures

9. Distributed systems (2 hours)

- What is wrong with mainframes?

- Why link computers together?
- Client-server architectures
- World Wide Web,
- Grid computing
- Peer-to-peer networks
- Computer Supported Collaborative Work
- Agents

Business Plan

Authors: Ian F.C. Smith F.ASCE and John C. Miles M.ASCE

Date: October 31, 2005

Pilot Project in Great Britain

One-week course in 2006 given to engineers working in practice

Revenue

Cost of course \$4,500 (£2,500) per student

Number of students: 15 (course will not be given below 8 students)

Expected revenue: \$ 67,500 upper and \$ 36,000 lower bound

Costs

Preparation of course materials	\$4000
Rental of room	\$8000
Cost of instructors	\$5000
Expenses	\$3000
 Total costs	 \$20,000

Earnings

Upper bound	\$47,500
Lower bound	\$16,000

Projected Earnings

The Pilot Course will be given in 2006. Subsequent courses will be offered from 2007. Revenue will depend on location of course. It is expected that 2 courses per year will be offered in high-income countries. Since development costs are only needed once, upper bound profits could rise to \$51,000 per course (preparation of course materials would drop to \$500).

From 2009, one course per year will be offered in middle-income countries. In middle-income countries, fees will have to be reduced. Revenue for middle-income countries for 15 students would be \$30,000 (\$2000 fee). Costs would be \$12,000 since room rental would drop to \$3000 and travel expenses would increase by \$1000. The table below gives an approximate summary of upper-bound projected earnings for six years.

2006	2007	2008	2009	2010	2011
\$47,500	\$102,000	\$102,000	\$120,000	\$120,000	\$120,000

APPENDIX 3

Computing in Civil Engineering: Definitions and Initial Topics.

Computing in civil engineering is interdisciplinary. It is focused on the multistage process of knowledge creation. Such creation involves the following stages:

1. Representation
2. Acquisition
3. Storage,
4. Information Processing,
5. Knowledge Utilization
6. Visualization and task support

The body of knowledge related to computing in civil engineering thus includes the following components:

1. Theoretical foundations
2. Building knowledge representations
3. Acquiring data and knowledge
4. Information storage
5. Information processing
6. Knowledge utilization
7. Engineer-computer interaction

Components and potential teaching modules are provided in the table below (non exhaustive).

Computing Body of Knowledge: Initial Draft

Knowledge Components	Topics			
1. Theoretical foundations	Formal Logic	Computational Complexity	Engineering Task Classification	Terminology schemas
2. Building knowledge representations	Data Structures	Object-oriented representations	Geometric Modeling	Ontologies
3. Acquiring data and knowledge	Machine Learning	Data Mining	Case-based Reasoning	Interpretation of measurements
4. Information Storage	Data Base design	Ontologies	Semantic Networks	Product modelling
5. Information Processing	Computational Mechanics	Optimization, search and exploration	Case adaptation	Object-oriented computing
6. Knowledge Utilization	Knowledge Systems	Distributed Systems	Agents	Collaborative work (CSCW)
7. Engineer-Computer Interaction	Computer Graphics	Data Visualization	Knowledge Visualization	Passive and active support

APPENDIX 4

Teaching module preparation guidelines

Teaching modules may vary in length from one to four hours

All transparencies are to be prepared using MS PowerPoint. Approximately 40 transparencies are necessary for each hour. The use of non-textual information is strongly recommended.

Each module should contain:

1. A list of key words (major concepts)
2. A list of definitions
3. 3-4 major sections focused on concepts and examples
4. Recommended readings
5. Exercises for home assignments, quizzes, and tests

Preparation Process:

1. The author develops a draft of a module
2. The draft is sent to The Chair of the Education Working Group
3. This group approves the draft and/or recommends improvements
4. The final version is developed
5. The final version is sent to The Chair of the Education Working Group
6. The Education Working Group approves the final version and/or recommends improvements
7. Final improvements are made