Section 1. Project Description

Nature of the Innovation

The proposed innovation, Case-Based E-Learning Module for Solving Real-World Engineering Problems, will give all engineering students the opportunity to experience an ill-defined, real-world, global engineering problem, an opportunity available only to a select, small group of students historically. Over the last two years, a group of four engineering students enrolled in the Senior Design Capstone course were given the opportunity to work on an ill-structured problem within the context of Costa Rica. We will build on foundational work from the last two years and strive to design a virtual experience in which all students can have a similar learning experience without the necessity of travelling abroad.

Foundational work has been completed over the past two Spring semesters (2007-2008) in which eight students (a team of four students per semester) were given an open-ended, ill-defined community context in which to conduct seven weeks of preliminary research into the issue followed by one week of on-the-ground work in the community and culminating in seven weeks of synthesis and integration of a final design concept that would improve the current conditions in the community. Student efforts have included research of geographic, governmental, cultural, and environmental aspects of the area tightly connected with information received from community surveys and discussions with community leaders to understand local needs within the context of larger Costa Rican issues. These two years have provided critical exploratory insight as to logistics and community partners for creating a more efficient and productive experience for future student and faculty experiences. In particular, the previous two years have indicated the value of student reflection, both individually and collectively, within the engineering education experience, which stereotypically is perceived as predominantly technical in nature. Moreover, they have indicated the need to focus on including local Hispanic students in the dialogue between U.S. students and the local citizenry in order to improve both the design outcome as well as the student experience.

Preliminary Interface

Based on the design framework, the preliminary interface of the case-based e-learning module has been developed (see figure 4). This module consists of four major stages: Exploring Situation, Constructing Reality, Creating Solutions, and Reflecting on the Process and the Product.

Case development: Costa Rica project

The case is developed based on a current need in a rural community in the Limon province of Costa Rica and will involve engineering students who are completing the design requirements for their engineering degrees. The content of this innovation will be driven by UGA faculty with expertise in natural resources engineering, engineering education, and watershed management with the primary

Figure 4. Prototype Interface

objectives being to provide students with the opportunity to:

- Experience the complexity, tension and conflict of democratic processes, particularly within poverty-level communities, that are inherent to the sustainable management of local resources;
- Understand and experience the application of critical and complex thinking within the domain of an open-ended, poorly understood issue constituted by societal, environmental, cultural, economic and technological constraints within an international context.

Need/rationale

This education and research project will have broad societal impacts as it is attempting to not only create a learning innovation, but to simultaneously assess the impact of this learning innovation on students' ill-defined problem solving skills and on their epistemic growth. The Case-Based E-Learning Module will be easily integrated into other engineering and non-engineering courses because of its portable nature. Currently, many students do not have the opportunity to participate in programs such as Engineers without Borders (EWB) or Engineering Projects in Community Service (EPICS) in which the students experience real-world problem solving. This project will provide a learning experience for all students that will emulate some of the epistemological gains that occur after participation in a program such as EWB or EPICS. The goal of this innovative Case-Based E-Learning Module is to increase students' ability to solve ill-defined problems and to increase the students' epistemic level. Today's students are increasingly going to be faced with complex human and environmental issues, and this educational innovation, Case-Based E-Learning Module, is attempting to better prepare engineering students to face these complex, large-scale issues such as the energy crisis and global warming.

Relevance of the project to unit and University priorities

This project is critical to the priorities of the Faculty of Engineering and to the University. The Faculty of Engineering is attempting to educate engineers to be excellent not only in their analytical skills, but also in their abilities to be humanistic and innovative. This project attempts to provide all engineers at UGA and potentially beyond to experience an ill-structured design problem within a developing country, an opportunity that is typically only afforded to a small subset of students (typically no more than eight students per year in UGA's engineering program). This project also aligns with the mission and vision of the University, as can be seen in the University's motto, "to teach, to serve, and to inquire into the nature of things." A result of engagement in this case-based e-learning technology is to empower the students with the understanding of their role in teaching members of their community, serving members of their community, and better understanding the nature of the problems inherent in communities. While the context of this case-based e-learning technology is a rural village in Costa Rica, it can easily be transferred to local communities within Georgia. Future iterations of this case-based e-learning technology can also contain modules related to local Georgia issues, including issues of poverty, energy shortages, and landfill shortages.

Specific courses or student groups benefiting from the project

The following courses will immediately benefit from this project:

ENGR 2920, Engineering Design Methodology
ENGR 1140, Computational Engineering Methods
ENGR 1120, Engineering Graphics and Design
ENGR 1920, Introduction to Engineering

Number of students served including undergraduate, graduate/professional or both

Throughout a year, roughly 180 undergraduate students will be served with this case-based e-learning technology. Hopefully as it is developed, future iterations (contexts) will be available so that even more students can be impacted at the University of Georgia including upperclassmen in the engineering program and students in peripheral departments such as Technology Education, Instructional Technology, and Art. This case study will be easily integrated to other engineering and non-engineering courses because of its portable nature. Therefore, this innovation has the potential of reaching audiences at a national and potentially international level.

Section II. Budget

Proposed Budget: Year 1

Item	Quantity	Total Cost	Requested from LTG	Provided by Other Sources
Video Editing, Computers, Software and Web Space		$10,000		In-kind by OIT & EPIT
External Hard Disk (1 TB)	3	$2,200	$2,200	
External Hard Disk (2 TB)	2	$1,000	$1,000	
Supplies (100 CDs, 100 DVDs, 100 Video Tapes, 4G Memory Cards)		$1,000	$1,000	
SDLR (Single Lens Digital Camera)	1	$1,500	$1,500	
High Quality Digital Video Camcorder	3	$3,000		In-Kind by OIT, EPIT & FOE
Design & Production (173 hours)		$9,300 (207 h)	$9,300 (207 h)	
Research Lab -- Rm 621 Aderhold	1	--	--	In-Kind By EPIT
Research Lab – Rm 219 Drifmier	1	--	--	In-Kind By FOE
Content Collection at Costa Rica (travel of David Gattie & 4 students, collect video and still images)		$6,600		International Scholarship of Engagement Grant
Total		**$34,600**	**$15,000**	**$19,600**

Budget Justification Narration: Year 1

Video Editing Computers, Software, Web Space	The Office of Instructional Technology (OIT) and the Department of Psychology and Instructional Technology (EPIT) will provide necessary equipment, software, and Web space for digitizing, editing, developing, and implementing the innovation for this project
External Hard Disks	1 TB high speed external hard disks (3) will be used for video editing by three video editors hired under Design & Production. 2 TB hard disks (2) will be used to save the back-up files.
Supplies	Digital storage such as CDs (audio/image), DVDs (video/image), digital videotapes, and Memory Cards are necessary to save and manage digital content and data, and backup files.
SDLR & High Quality Digital Video Camcorder	High quality digital still images and video images are necessary to collect and develop engineering contents (cases, situations, materials, etc) at Costa Rica and Athens. In order to obtain professional images during trip to Costa Rica (the travel will be supported by other

	resources), two SDLRs will be needed. However, no high quality digital cameras are available through OIT, Faculty of Engineering (FOE) and EPIT. Three high quality Camcorders will be provided as in-kind support.
Design & Production	Approximately 207 hours of design and development service will be necessary for developing engineering cases, videotaping expert interviews, editing video clips, developing content, programming database and developing the Web site. This is budgeted based on $45 per hour.
Research Lab—Rm 621 Aderhold	Room 621 in Aderhold hall allocated by EPIT department will be used for conducting this project (Design and Research).
Computer Lab—Rm 219 Driftmier	Room 219 in Driftmier Engineering Center allocated by FOE will be used for conducting this project (Implementation).
Content Collection at Costa Rica	The Office of the Vice President for Public Service & Outreach has provided funding of $6,600 through a Scholarship of Engagement Grant. The funding will be used to help David Gattie and 4 undergraduate students travel to Costa Rica for one week during March of 2008.

Timeline (Year 1)

Date	Objective	Person(s) Responsible
Oct. – Dec. 08	• Previous curriculum analysis • Learning environment model development	Kellam, Choi, Gattie Choi
Jan. – June 09	• Case collection and selection • Static Website development • Case data collection at Costa Rica • Content/Case Development	Kellam & Gattie Choi Gattie, Kellam, & Choi Kellam & Choi

Proposed Budget: Year 2

Item	Quantity	Total Cost	Requested from LTG	Provided by Other Sources
Video Editing Computers & Software and Web Space		$10,000		In-kind by OIT & EPIT
Supplies (2 External Hard Disks, 100 CDs, 100 DVDs, 100 Video Tapes)		$2,000	$1,000	
Apple Computer	1	$3,000	$3,000	
Content Development (244 hours) -- 244 hours from LTG		$11,000 (244 h)	$11,000 (244h)	
High Quality Digital Video Camcorder	3	$3,000		In-Kind by OIT, EPIT, & FOE
Research Lab -- Rm 621 Aderhold	1	--	--	In-Kind By EPIT
Research Lab – Rm 219 Drifmier	1	--	--	In-Kind By FOE
Total		**$29,000**	**$15,000**	**$14,000**

Budget Justification Narration: Year 2

Apple Computer	Part of video editing and most video review should be conducted in Engineering side while most editing work will be conducted by Apple computers in Education side. Since no apple computer is available to the PIs in engineering, one Apple computer need to be purchased.
Supplies	Digital storage such as had disks (editing), CDs (audio/image), DVDs (video/image), digital videotapes, and memory cards are necessary to save and manage digital content and data, and backup files.
Design & Production	Approximately 244 hours of design and development service will be necessary for developing engineering cases, videotaping expert interviews, editing video clips, developing content, programming database and developing the Web site. This is budgeted based on $45 per hour.

Timeline (Year 2)

Date	Objective	Person(s) Responsible
Aug – Dec. 09	• Further content collection (expert interview) • Content/Case development • Content digitization and production • Dynamic Website Development	Choi, Kellam, Gattie Kellam, Choi, & Gattie Choi, Kellam, Gattie Choi, Kellam, Gattie
Jan. – June 10	• Evaluation Rubric development • Implementation • Learning Outcome Evaluation	Choi, Kellam, & Gattie Kellam, Gattie, & Choi Choi, Kellam, Gattie

Section III. Learning Outcomes

Learning Outcomes

This educational innovation aims to meet the following learning outcomes:

1) increase students' ability to understand, approach, and solve ill-defined, societal problems within a larger, global landscape.

2) increase students ability to solve complex design issues with analytical, economic, environmental, social, and cultural aspects.

The case-based e-learning technology must meet the above learning outcomes in order to be deemed a success. This innovation will give students first-hand experience solving an ill-defined problem without the necessity to travel to another continent. This learning experience will result in students that are not only better prepared to deal with complex design issues, but to begin to understand the fuzziness of these problems and the importance of a cross-disciplinary team of experts with multiple perspectives in order to propose a possible solution for such a complex, real-world issue. These are skills that are not easily taught, but through experiential learning can be learned. We propose that this technology will afford all students' experiences necessary to be successful and contribute to today's society as engineers.

Methods for Evaluating the Project and Learning Outcomes

The formative evaluation will be held after the initial version of the Case-Based E-Learning Module is developed. The usability of the interface will be tested by a sample of first and second year engineering students. The instructional aspect of the environment will be reviewed by Dr. Thomas Reeves, a Professor of Instructional Technology and leading scholar in the area of e-learning evaluation. The contents of the learning environments will be reviewed by a panel of engineering professors who will implement this learning environment into their

classroom. Finally, a think-aloud protocol will be used by a subset of students that have used the technology in a class and a group that have not to find out whether the problem-solving approach of students that used the case-based e-learning technology differs from those that did not use the case-based e-learning technology.

Evaluation	*Method*
Usability	Interview/ Focus Group, Questionnaire, and/or Observation of students using the innovation
Instructional Aspects	Review by expert in e-learning evaluation
Content	Interview/ Focus Group, Questionnaire, and/or Observation of faculty using the innovation in their classes
Learning Outcome	Think-aloud protocol, pre-post test of a subset of students using this innovation

Potential Applications in other Academic Areas

This project has the potential to impact programs campus-wide that have a strong design component, including but not limited to Technology Education, Landscape Design, and Studio Art. The context of Costa Rica was selected because it has not only a strong analytical component, but critical environmental, economic, social, cultural, and global aspects. This very complex issue will be appealing to students across a larger subset of students campus wide. Additionally, this case-based e-learning module is ready to be expanded easily to other contexts and these contexts should be carefully selected so that they have a broad applicability across campus. Possible contexts include issues local to Georgia and that fit into the land-grant mission including poverty, energy shortages, and landfill shortages. While these will not be implemented within the next few years, the project will easily be expanded when it demonstrates success in the initial stages.

Section IV. Support Plan

Staffing and resources to be used to continue the initiative following LTG funding.

The lead investigators of this project have already applied for external funding through the National Science Foundation's Course, Curriculum, and Laboratory Improvement, Phase I grant for $150,000. If this first attempt to secure external funding is not successful, we will revise and resubmit next May. There are also additional possibilities for funding internally through the new Faculty of Engineering, and the recent STEM initiative. We are devoted to carrying out this project and will explore all possible avenues of funding.

This project is staffed with Dr. Nadia Kellam, an Assistant Professor with expertise in Engineering Education and Complex Systems, Dr. Ikseon Choi, an Associate Professor with expertise in Instructional Technology, and Dr. David Gattie, an Associate Professor with expertise in Systems and Engineering Ecology. Dr. Kellam is devoted to improving the education of engineers so that they are prepared to be productive citizens in today's constantly changing, global landscape. Dr. Choi has been instrumental in the development and deployment of case-based e-learning technologies in other contexts including medicine. Dr. Gattie has been the instructor for the Senior Design course in which the context for this technology is based and therefore is committed to this project. We are all very devoted to this project and intend to find funding for this project in the near future and over the longer term to ensure the sustainability of this project.