

## **AC 2010-2064: A WORKSHOP FOR INDIAN ENGINEERING FACULTY UNDER THE INDO-US COLLABORATION IN ENGINEERING EDUCATION**

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Vinod K Lohani is an associate professor in the Engineering Education Department (EngE) and an adjunct faculty in the Civil and Environmental Engineering at Virginia Tech. He received a PhD in civil engineering from Virginia Tech in 1995. His research interests are in the areas of knowledge modeling, water and energy sustainability, engineering learning modules for freshmen, and international collaboration. He led a major curriculum reform project (2004-09), funded under the department-level reform program of the NSF, at Virginia Tech. A spiral curriculum approach is adopted to reformulate engineering curriculum in bioprocess engineering in this project. He co-authored an award winning paper with his student Dr. Jennifer Mullin, first PhD graduate in EngE, and others at the 2007 annual conference of ASEE. He received the College of Engineering (CoE) Faculty Fellow award in 2008 and is selected to receive the W.S. 'Pete' White Innovation in Engineering Education Award in 2010 from the CoE.

### **Ricky Castles, Virginia Tech**

Ricky Castles holds a BS (2003), MS(2006), and Ph.D.(2010) in computer engineering and an MS in Industrial and Systems Engineering(2008, Human Factors Option) all from Virginia Tech, Blacksburg, VA, USA. He served as a Graduate Teaching and Research Assistant in the Virginia Tech departments of Engineering Education and Electrical and Computer Engineering. He currently also serves as a contractor for Imaging Science Research, Inc., Burke, VA. His research interests are in the area of human-computer interaction, knowledge modeling, and educational technology. Dr. Castles is a student member of the ASEE and the IEEE.

### **Gary Riggins, Virginia Tech**

Gary Riggins is a 4th year civil engineering student at Virginia Tech with a double major in French. He has focused his academic career on learning about civil engineering (transportation systems) in different environments. He spent the summer of 2009 conducting a self-designed project including job-shadowing engineers at the Indian Railways and attending the Indo-US Faculty Leadership Institute at Infosys in Mysore, India. Gary studied at the French engineering school INSA-Lyon for a year, and is currently studying in Rio de Janeiro, Brazil.

# **A Workshop for Indian Engineering Faculty under the Indo-US Collaboration for Engineering Education**

## **Introduction**

A one-week workshop titled “Modern Approach to Introduction to Engineering” was conducted in Mysore, India in July 2009 under the auspices of the Indo-US Collaboration for Engineering Education (IUC EE). The vision of the IUC EE is to improve the quality and global relevance of engineering education in India and the United States by fostering collaborations ([www.IUC EE.org](http://www.IUC EE.org)). Twenty-two engineering faculty members representing disciplines such as mechanical, electrical, civil, and computer science from different engineering colleges in India participated. The key objective of the workshop was to train participants to introduce or enhance hands-on learning experiences in the first year curriculum of engineering programs in participating Indian schools. Hands-on engineering learning activities, supported by two NSF projects, implemented at Virginia Tech’s first-year program are introduced to Indian faculty for meeting this objective. The main topics discussed during the workshop are: (i) how to introduce design experiences in first-year engineering curriculum, (ii) need to incorporate ethics instruction in Indian engineering programs, (iii) need to introduce hands-on learning to enhance early learning experiences of Indian engineering students, and (iv) how engineering curriculum development issues can be translated into PhD level engineering education research projects. The workshop was held on the campus of Infosys, Inc., a software giant in India. Two American students (Castles and Riggins), co-authors of the paper, accompanied the lead author and assisted in implementing the workshop activities. As one of the lead graduate students, Castle was deeply involved in developing and implementing the hands-on learning activities into the first-year year program. Riggins had participated in these activities as a freshman at Virginia Tech. This paper summarizes: (i) workshop content, (ii) feedback from workshop participants, and (iii) reflections of two American students (one PhD student and another undergraduate student) who travelled to India for the first time.

## **Workshop Schedule and Activities**

The activities presented at the workshop have been developed and implemented at Virginia Tech’s freshman engineering program and are supported by two NSF projects. These activities have been reported in various conference and journal publications. A brief description of the NSF projects along with the activities follow.

### **A. NSF Project under the Department-Level Reform (DLR) Program (2004-09)**

In 2004, a group of engineering and education faculty at Virginia Tech received a 5-year curriculum reform and engineering education research grant under the department-level reform program (DLR) of the NSF. This grant resulted in development of a framework for reformulating the curriculum of bioprocess engineering within the Biological Systems Engineering (BSE) department using a spiral theory approach. The twentieth century psychologist, Jerome Bruner, proposed the concept of the spiral curriculum in his classic work *The Process of Education and*

*The culture of education* [0] [1]. Bruner proposed that a learning curriculum could be arranged so that the central questions, or themes in a discipline, would be returned to again and again as learners advance in their knowledge and intellectual capacity. A 7-step process is developed to implement the spiral curriculum in the bioprocess engineering and details are presented in [2] and [3]. All workshop participants were introduced to the spiral curriculum process adopted by the DLR project investigators in reformulating the curriculum of the bioprocess engineering. The DLR project investigators have conducted spiral curriculum workshops at national and international sites [2]. In addition, a number of hands-on engineering learning activities were developed and implemented into the freshman engineering program at Virginia Tech as a result of this NSF project. A brief description of activities follows.

**Mechatronics Hands-on:** In order to give meaningful hands-on learning experiences related to Electrical, Computer Science/ Engineering and Mechanical Engineering to engineering freshmen at Virginia Tech a “mechatronics” hands-on was piloted in spring 2006 with approximately 180 students. Since then, approximately 5,000 engineering freshmen have participated in this 90-min hands-on activity. Students build a 2-wheel robot using several mechanical (gears, wheels, shafts, etc.) and electrical (resistors, capacitors, motor driver integrated circuits, breadboard, battery, diodes, micro switches, etc.) parts. A detailed PowerPoint presentation is developed that explains the entire hands-on activity. All instruction materials were shared with the workshop participants. The authors carried all mechanical and electrical parts from the US to India for conducting this hands-on activity. In fact, they had to pay custom duty at the airport for taking these parts into India. All faculty participants built the 2-wheel robot (see Figure 1) and appreciated the potential of hands-on learning. Details of this mechatronics activity are presented in [4] and [5].



Figure 1: Faculty Participants Building a 2-wheel Robot

**Sustainable Energy Design Project (SEDP):** Engineering freshmen at Virginia Tech participate in early design experiences in their freshman engineering courses. Since fall 2006, a Sustainable Energy Design Project (SEDP) has been successfully implemented in one of the freshman engineering courses. Student teams are asked to design and construct a “promotional invention” that promotes awareness of a renewable energy source. Each team of 3-5 students selects one of five renewable energy sources, i.e., hydropower, geothermal, solar, wind, and biomass, based on the team’s interest and research. Teams are instructed to assume that the audience is the general public, who may have limited knowledge of renewable energy sources. Student teams are

instructed to consider the following parameters in creating design solutions: (i) *It should be functional, safe, and interesting*; (ii) *It must highlight one or more key components of a renewable energy source*; (iii) *It should strive to educate and entertain as well as generate further inquiry and interest in renewable energy sources*; and (iv) *It should aim to have broad appeal across gender, age, race, and nationality*. Students are coached to follow various steps of engineering design process in this 8-week long design project. The project includes both individual (e.g., research questions on potential of renewable energy sources, design sketches, etc.) and team (e.g., brainstorming activity, design report, class presentation, etc.) assignments. Students are allowed a budget of \$20 per team for completing their designs. Results of exit surveys done at the end of the semester clearly show that a majority of students benefited from their experiences with SEDP and appreciated the relevance of sustainability as part of their early design experiences. At the workshop in Mysore, the entire process of implementing the SEDP was demonstrated to all participants. In addition, they were shown examples of design sketches, team logs, peer evaluations, design project reports, and final designs. A paper [6] based on SEDP work won the best paper award at 2007 Annual conference of the ASEE. Further details on SEDP implementation including assessment data are given in [7].

**LabVIEW Modules:** LabVIEW (**L**aboratory **V**irtual **I**nstrumentation **E**ngineering **W**orkbench) is a graphical programming language from National Instruments. This software uses a dataflow programming model in which the output of each computation node is calculated when all the inputs are determined for that node. The calculations take place concurrently for nodes that do not have a data dependency. Since fall 2007, LabVIEW has been successfully used to cover basic programming concepts in a freshman engineering course at Virginia Tech. All participants had access to the LabVIEW software at the workshop. The authors conducted various LabVIEW activities that have been successfully implemented at Virginia Tech's freshman engineering program. Additionally, all participants received LabVIEW lecture notes and hands-on exercises. Details of LabVIEW instruction and assessment data are given in [8].

**Engineering Ethics Module:** It is not common to formally include engineering ethics instruction into engineering programs in India. The authors shared their experiences of covering engineering ethics into freshman engineering program at Virginia Tech with the faculty participants. Engineering freshmen at Virginia Tech are expected to demonstrate an understanding of professional ethics and application to real-life situations upon successful completion of a freshman engineering course. Students are assigned textbook readings on ethical theories, ethics case studies and videos (*Incident at Morales and Gilbane Gold*) and are engaged in in-class discussion of ethics scenarios published in various professional publications. Ethics skits and discussion of contemporary issues like Hurricane Katrina have also been included in ethics instruction at Virginia Tech [9] and [10]. More details on engineering ethics instruction at Virginia Tech are given in [11]. All faculty participants watched an ethics video *Gilbane Gold* and participated in discussion of various ethical issues showcased in the video.

**Tablet PC Initiative:** Engineering freshmen at Virginia Tech are required to own a Tablet PC since fall 2006. A technology-enhanced pedagogy has been successfully implemented into freshman engineering at Virginia Tech to improve the quality of classroom instruction. Examples of instructional activities included electronic note taking, use of inking features to review

homework solutions and completing skeleton PowerPoint slides designed to increase the engagement level of students in a large classroom, and setting up online collaboration sessions to do group design project and problem solving activities. In fall 2007, DyKnow, a Tablet PC friendly software, was implemented to enhance student-faculty interactions in classroom. In fall 2008, an electronic grading system facilitated by the Tablet PCs was successfully implemented into freshman engineering program [12]. Further details on Tablet PC and DyKnow implementation are provided in [13] and [14]. These experiences were shared with Indian participants to emphasize the role of modern technologies to introduce the concept of feedback based learning in the classroom.

Engineering Education Research Projects: One of the co-authors (Castles) shared his PhD research with the workshop participants. In this research, education is modeled as a closed loop feedback controller and the principles of feedback control theory are extended to "Teaching and Learning" process. An XML (Extensible Markup Language) based software is developed to couple concept inventories with concept maps in order to generate knowledge maps representing students' understanding of a discipline based upon their responses to a custom-designed concept inventory. The ultimate goal is to develop a knowledge representation and assessment paradigm that will facilitate better student learning. A poster based on this research received the 3<sup>rd</sup> place award under "learning and computation" category at the NAE Grand Challenges conference held at Duke University in March 2009. This research is applied to the mechatronics initiative, discussed above, and faculty participants were demonstrated how innovative curriculum development activities can be turned into PhD level research projects. More details are given in [15] and [16].

The authors also presented another PhD research project that involves research extension of the LabVIEW curriculum discussed above. Demonstration of a LabVIEW Enabled Watershed Assessment System (LEWAS) was made by lead author's graduate students from Virginia Tech campus to Indian faculty participants (see Figure 2 (right)). This system has capability for remotely assessing real-time water quality and quantity data from a water quality impaired creek that flows through the campus of Virginia Tech. LEWAS provides LabVIEW based programmability to a remote user who has access to the internet. The system has capability to sense temperature, conductivity, dissolved oxygen, and pH of water and the data is shared with a remote client via Wireless LAN. The field implementation of LEWAS employs an industrial computer (a compactRIO from the National Instruments) as the server which can run remotely and continuously without user intervention. Again, faculty participants had an opportunity to observe how a curriculum development experience can be expanded into a PhD level research project. More details on LEWAS are given in [17]. In addition, details on analysis of assessment data for evaluating effectiveness of various activities in DLR project are presented in [18].



Figure 2: Faculty participants in a hands-on design activity (left); Remote demo of LEWAS (right)

B: NSF Project under Nanotechnology in Undergraduate Education in Engineering (NUE) Program (2008-10)

Nanotechnology Learning Module: A group of investigators at Virginia Tech are working on a NSF project that is targeted at developing and implementing a nanotechnology option within the Engineering Science Mechanics department. A spiral curriculum approach is used in designing nanotechnology learning modules at various learning levels (i.e., freshman, sophomore, etc.). A nanotechnology learning module has already been developed and approximately 3,000 freshmen have already participated in this module. The module includes a prior knowledge survey, a 55-min video presentation on nanotechnology, a 7-video to showcase nanotechnology related experimental equipment, a hands-on module, and a post-module survey. The 55-min video presentation included a brief history of nanotechnology including size comparisons of an atom, DNA molecule, carbon nanotube, human hair, sand grain, etc., discussion on the interdisciplinary nature of nanotechnology, discussion of forces at macro- and atomic scales, and typical applications of nanotechnology. The courses/topics chosen for developing similar modules at upper levels include societal and ethical implications of nanotechnology, material response and behavior, computational mechanics, and undergraduate research experiences. Complete details of the nanotechnology module are given in [19] and [20]. A presentation to discuss development and implementation of the freshman engineering module was given to approximately 200 Indian faculty members (see Figure 3) including the participants of the workshop at a common session that is organized for all attendees. It may be noted that the workshop discussed in this paper was one of the 8 workshops organized by the IUCEE during July 06-10, 2009.



Figure 3: Nanotechnology Presentation at a Common Session

In addition to above, the authors also shared their experiences regarding latest developments in engineering education research in the US. Also, a presentation was made to discuss lead author's experiences of co-directing an NSF/REU site on watershed sciences and engineering at Virginia Tech [21]. This presentation emphasized the importance of engaging undergraduates into research experiences. Appendix A gives the schedule of the week-long workshop.

### Workshop Evaluation

In order to evaluate workshop activities, all workshop participants responded to a survey at the end. This survey was designed and analyzed by the IUCEE administrators. The lead author got in touch with an IUCEE official in fall 2009 and obtained the evaluation data (see Table 2). Each row summarizes feedback for each participant.

Table 2: Workshop Evaluation

| What was the best part of the course?   | What was different or unique about this course....?  | What could have been improved in the course?   |
|---|--|--|
| Spiral curriculum concept, a video clip on ethics, hands-on session on Mechatronics and LabVIEW | Some of the case studies were very original<br>Research in Engg Education is unique itself | The case studies were relevant to USA, a few case studies of other parts of the world would have been beneficial   |
| Inspiring   | Hands on experience  | More programs on LabVIEW should be taken   |
| Concepts on spiral curriculum and concept maps  | Ambience and course instructors  | More ways of introduction to engineering or modern engineering   |
| Open sharing of experiences, about students behaviors, responses                                | Hands on training<br>Live demonstration of teaching methods                                | Course curriculum split into number of hours spent on each topic for the engg exploration course at Virginia Tech. |

|   |   |   |
|---|---|---|
| <p>Experimenting with LabVIEW<br/> Bringing interdisciplinary concepts together<br/> Documenting and analyzing every piece of work we do<br/> Engineering and education collaboration</p> | <p>Instructor stressed on documenting and analyzing everything we do. This adds value to whatever we do.</p>  | <p>Best teaching practices in US were covered. I would have been very happy if best practices here in India were discussed if possible.</p> |
| <p>The handouts given and the practical sessions on LabVIEW and projects like Robot</p>   | <p>In this program, mainly we were able to get and compare various schemes and share the experiences with the speakers who came all the way from USA. We got to know a lot of things which in India probably years will take to implement</p> | <p>The course could provide some solutions to problems and difficulties in India</p>  |
| <p>The online session from VT was interesting and kind of support and encouragement we got was amazing</p>  | <p>Highly motivating<br/> Hands on practice sessions<br/> Online sessions from USA</p>  | <p>Faculties of same interest may be selected</p>   |
| <p>Sharing the experience and guiding us for the better teaching and guided research work</p>   | <p>The faculty put all his efforts along with able team members and shared his knowledge and experience with enthusiasm.<br/> Well done job in 5 days</p>   | <p>Nothing</p>  |
| <p>Spiral model of curriculum development</p>   | <p>Content</p>  | <p>Maybe more newer approaches</p>  |
| <p>Hands on design activity (which was the focus of the course)<br/> Use of Engg Education<br/> Engg ethics</p>   | <p>No comment</p>   | <p>No comment</p>   |
| <p>Hands on practice and sharing the views</p>  | <p>Faculty from other countries along with their students</p>   | <p>The course must be for 15 days as per AICTE<br/> Addition of live demo from other institutes</p>   |
| <p>Using spiral curriculum approach to design the curriculum</p>  | <p>Relevant</p>   | <p>Nothing</p>  |
| <p>Use of hands on training</p>   | <p>More hands on training<br/> Systematic survey in the field of engg education in US</p>   | <p>Engg education in Indian context could have been added</p>   |



|  |   |   |
|--|---|---|
| Presenters untiring attitude and convincing ability  | Global approach, faculty members<br>Topic relevant to the current scenarios   | More hands on software applications   |
| Introducing course topics with examples and case studies   | New area or new topics. This course addresses new multidisciplinary nature topics. Such a course may improve the teaching style to make the course content more interesting and understandable            | New techniques and methods to improve teaching. Better ways to teach the course content |
| The concept of spiral curriculum<br>Demonstration of LabVIEW experiments through remote control<br>Processing knowledge maps scientifically  | It is not subject specific and applicable to all branches of engineering. In my opinion all faculty must attend this course   | More number of hands on kits  |
| Experimentation skills on Mechatronics   | Importance to laboratory, experiments, projects<br>Using technology in teaching   | Study of syllabus of some of the world class engg colleges                              |
| LabVIEW classes with real time activity  | Online teaching methodology and leadership activities   | More presenters   |
| The use of modern technology as teaching aids in the teaching-learning process. The pre and post assessment by students about the course deliberation and to use it for the betterment of the students is one of the best part | This course has a special global goal unlike other FD courses. The course is about how to collaborate the US and Indian experiences in the teaching-learning process and use them for the benefit of both | Nothing   |
| Knowledge map<br>Research in engineering education   | This is not about a single branch of engineering but about whole engg education   | Nothing   |
| Hands on exercise on robot and LabVIEW   | More emphasis on practical problems and situations<br>Practical work we did in workshop   | Focus on practical situation<br>Step wise solution of practical problems                |
| The spiral way of developing curriculum and introduction to hands on learning experience   | Authorities on the subject were delivering it and it gave us a learning experience that what is going on other side of the globe  | The duration  |

## Reflections of Two Students Who Visited India for the First Time

Gary Riggins', a junior in the civil and environmental engineering program at Virginia Tech, India trip was organized by the lead author. His reflections follow.

*"At the workshop, I assisted the lead authors with the freshman engineering design activities. In a daily opening plenary session, faculty from various US engineering colleges presented a keynote lecture to share their academic experiences with Indian participants. Through these lectures, I learned about interesting research areas of other professors, such as Connexions, an open courseware project at Rice University.*

*Before attending the workshop, I spent several weeks traveling by train to different cities in 9 of India's 28 provinces. Part of my summer project was a job shadow experience with the Indian Railways. In that capacity, I visited construction sites of both the Mumbai and New Delhi metro projects as well as the recently built Konkan Railway through the hilly, rural coastline south of Mumbai.*

*After the week-long workshop at Infosys, I visited two engineering schools near Hyderabad. At BVRIT College of Engineering, I attended classes with students and toured various laboratories. One of the student projects, as at my own engineering school, was to develop a hybrid auto-rickshaw (see Figure 4), a 3-wheeled taxi which is ubiquitous on India's streets. The BVRIT campus recruits nearly 500 undergraduate and graduate students each year in five disciplines: biomedical engineering, chemical engineering, computer science, electronics and communications engineering, and electrical engineering.*

*I also attended a middle school physics class. The teacher reviewed the electron energy shells as the students answered enthusiastically in unison. After the bell rang, I stood up and answered some of the students' questions about school in the United States. Through the experience of attending a workshop with Indian faculty at Infosys, the visits to various schools, and the job-shadow at the Indian Railways, I gained unique insight into India's family, business, and educational culture."*



Figure 4: Auto-rickshaw hybrid vehicle project at BVRIT (left), BVRIT, Narsapur Campus (right)

Dr. Ricky Castles is a Ph.D. co-advisee of the lead author and his reflections follow.

*“I have had many Indian colleagues and professors, but I had not previously had an opportunity to see Indian culture first-hand. When my advisor presented me with the opportunity to go with him to lead a workshop for the IUCEE I thought it was a great opportunity, but I was a bit nervous and did not know quite what to expect. Traveling to India was certainly an adventure I will never forget. After two long plane rides my advisor and I arrived at the Bangalore airport around midnight and were greeted by immigration officers demanding to see the contents of a suitcase I brought containing electronics kits for our workshop. After some heated discussion we finally agreed to pay the duty they demanded and were on our way to the Infosys campus in Mysore. After a lengthy trip by car my advisor and I finally arrived in the wee hours of the morning at the Infosys campus where we would then lead a week-long workshop as part of the IUCEE activities.*

*Several faculty members and students from other United States universities also traveled to Infosys to put on various workshops from different technical disciplines during the week. The Infosys campus was an incredible place and every need we had for the entire week was met. We were provided with excellent accommodations, three meals a day, and a pleasant tea break twice a day. The buildings at Infosys were immaculate and the architecture blended stately Greek and Roman structures with the technological state of the art. A diverse group of engineering educators participated in our workshop ranging from young new professors to department heads and deans. I felt a bit intimidated to be presenting to those with significantly more impressive credentials than my own, but I was very pleasantly welcomed and treated like a colleague and a respected guest throughout the week. I had a chance to demonstrate many of the hands-on activities that we use in the workshops for our first-semester freshman course at Virginia Tech and showed how more hands-on activities could be incorporated within the curriculum. I learned that most Indian engineering education is based on formal lecture and mathematical problem solving and hands-on education seemed more like a game to many of the educators at the workshop rather than legitimate tools for teaching. By the end of the week I believe most workshop participants saw the merits of hands-on learning and were eager to try some new initiatives in their own curriculum. I also presented some of my research work involving the modeling of student learning and was able to get feedback from workshop participants on my methodology and the implementation of the work.*

*During the week at Infosys I had the opportunity to experience local culture. Several members of our contingent visited the Mysore palace and toured some of the local downtown shops. We also visited a Hindu temple and observed some of the worship activities that were happening there. This was quite a contrast to the environment on the Infosys campus as we experienced local beggars, snake charmers, and haggling merchants. Following the IUCEE, I continued my stay in India for another week traveling back to Bangalore with a fellow student from Virginia Tech and later on to New Delhi, Agra, and Jaipur with a Ph.D. candidate from Iowa State whom I met during the week at Infosys. I toured beautiful botanical gardens, several nice museums, a national park, the Taj Mahal, and several forts.*

*In reflection upon my time spent in India I observed a very strong contrast between rich and poor. At almost every place I visited panhandlers would try to get me to give them money or buy trinkets. There seemed to be an automatic association that because I was white, I must have money. Children often followed me for significant periods of time as I would walk around the*

*streets and they would pantomime that they were hungry and needed money for food. Upon giving one child some money suddenly another would appear. I am a student of modest means, but in India, I was rich, or at least that's how I was perceived. At times I certainly felt that way, especially when I could get a full meal at a nice restaurant for under \$5US. Most of the major tourist attractions had two different prices for admission, one for Indian citizens and another for foreigners, with the rate for foreigners usually 2-10 times as costly, but even the inflated foreigner admission price seemed inexpensive.*

*I observed that one of the major dividing factors that separates the rich from the poor in India is education. I saw many children of school-age working or begging on the streets during times I would expect children to be in school. I distinctly remember a little girl of no more than four or five years old who worked at a bus depot selling small bags of popcorn. Unlike the US, school is not compulsory for children in India and the poor often do not have access to even the most basic of education. The literacy rate amongst the poor is particularly low and this severely limits their ability to advance. Many pharmacies have to color-code pills because patients often cannot read the directions for their medication. As someone who intends to pursue a career in academia the notion of how empowering education is resounded in my mind after seeing what a difference a good education can make in people's lives in India. The Infosys training campus where we gave our workshops provides training for thousands new Infosys employees each year who will go on to emerge as leaders in the top rated information technology company in all of India. They will have the means to support themselves and their families comfortably while so many others are destined to live a life of poverty. The difference in these two life paths is high quality education."*

## **Summary**

The paper presents a model for engaging U.S. students in global education by involving them in dissemination of innovative engineering learning activities at the international level. The IUCEE took a unique step in this direction in 2009 and is extending a great help in enhancing quality of engineering curricula in India. These efforts will lead to evaluation of various models for: (i) transferring expertise from developed world to developing world for improving the quality of engineering education, and (ii) providing global education to U.S. students. Curriculum development and reform are time consuming processes and younger faculty members should be rewarded for getting involved in curriculum reform activities. The lead author contacted all workshop participants in fall 2009 to seek feedback about their activities at their respective schools after the workshop. Below are two responses:

*Participant#1: "Based on the IUCEE workshop, I have done the following: 1. Delivered a lecture on "Modern Approaches To Engg. Education" at an AICTE sponsored STTP on "Effective Teaching..... and Outcomes based Education" today (17th Dec.) at NIT Surat. 2. Earlier I wrote an article for our college magazine "Renesa" on Object oriented curriculum using some key concept learnt in that workshop."*

*Participant#2: "Yes in my Department I have made a presentation about the course and new things which can be used to enhance students' interest in courses. Personally i am introducing more hands on activities in my class of surveying. Also I have frequently made students to think in groups about questions asked during the class and results encouraging. Students are more involved in classes and become attentive. I have also touched upon about ethics issues in my class. However, I am not able to start other activities till now."*

Both Ricky and Gary had a first-hand experience of technical education, corporate culture, social and cultural traditions, public sector engineering projects (Railways) and infrastructure in India. In fall '09, Gary shared his experiences in India with approximately 150 engineering freshmen at Virginia Tech and is currently studying for a semester in Brazil under a department of education project led by the lead author.

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## Appendix A: Workshop Schedule

| Date    | Session 1<br>9:30-11:00  | Session 2<br>11:30-1:00  | Session 3<br>2:00-3:30   | Session 4<br>4:00-5:30   |
|---------|--|--|--|--|
| July 6  | -Course Overview<br>- Introduction to Freshman Engineering Program at Virginia Tech, USA | -US National Science Foundation (NSF) Project on Spiral Curriculum<br>-Introduction to Design - Hands-on Design Activity 1 | -TabletPC/DyKnow Initiative at Virginia Tech<br><br>- Tablet-PC Based Electronic Grading System in a Large First Year Engineering Course | - Hands-on Design Activity 2   |
| July 7  | Sustainability in Freshman Engineering   | Examples of students' design project work  | Ethics in Engineering Education  | Engineering Ethics Videos  |
| July 8  | Introduction to LabVIEW  | LabVIEW Hands-on Activity 1  | -LabVIEW (Looping and Case Structures)   | LabVIEW Hands-on Activities 2  |
| July 9  | LabVIEW Applications   | Mechatronics I   | Mechatronics I   | LabVIEW assessment data and presentation from a remote site                              |
| July 10 | Mechatronics II  | Ph.D. research work- Engineering Education   | -Participants' presentations (10-12 min/group)   | Nanotechnology Education for Engineering Freshmen at Virginia Tech<br>-Course assessment |