Gujarat Technological University

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GTU POST-GRADUATE RESEARCH CENTERS

Centre for Industrial Design

OPEN DESIGN SCHOOL

Gujarat Technological University

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Introduction:

The old method of using a blackboard for conveying knowledge from a teacher to students is being replaced with an LCD projector. However this change, unless used with care, may increase the pace of presentation by the teacher, making it more difficult for a student to grasp the lecture fully [1].

Traditional methodologies of learning and models of professional education may fall short in the changing economic context, said Ellen Yi-Luen Do (GeorgiaTech) and Mark D. Gross (Carnegie-Mellon) in their paper on ,'Environments for Creativity – A Lab for Making Things'. New technologies may not usher in the desired change, if the technologies are not coupled with new and carefully worked out processes of learning.

The Do-Gross paper says that engineering curricula are strong on teaching analysis and principles and light on the actual practice of making things. Learning to make things is learning to design and learning to be creative. They say that everyone can be creative, because everyone has the ability to create or to make things. But "Engineering and computer science students tend to be less well prepared for open-ended investigation than those who have studied design. Engineering and computer science students with whom we have worked are happiest when we present them with a specification of work to be accomplished," say Do and Gross.

As engineering education have become mature, as empirical and analytical processes have become well-defined, the strait-jacket of working out a 'design', using the complete specifications, has become the norm. When one does not look at new materials and at alternative solutions, when one does not consider different ways of solving the same problem, when solving a design problems requires plugging in some values in certain empirical or analytical formulae or into a software package, one does not learn design even though in the class-room an illusion of teaching design may be created [2].

In reality, a student does not learn creativity or design or the art of making new things, if she forgets to look at new materials, contexts of usage and the possibilities of modulating the specifications to obtain a better product. If a student focuses on only the manipulation of the given data to obtain a solution, she may earn an engineering degree but she may remain innocent of the art of engineering design. "Exploring the alternatives — is what distinguishes routine acts of making, that is to say production, from more creative acts of making that may result in innovative ideas," say Do and Gross. They say that if creativity is crucial in the new economy, then perhaps we can foster creativity by putting making back into education. According to them, there is nothing new about that idea, but for a variety of reasons, learning to make things has become conspicuously absent in most courses of higher education.

It is true that analysis is an important part of engineering studies but learning of analytical procedures can degenerate into study of manipulation of mathematical equations which are devoid of any reference to practical applications of these mathematical formulations. The net result is that engineering education can become boring and purposeless where the four years are used not for

learning engineering but for building a transcript, semester by semester and then for acquiring a parchment which certifies that the young person has spent four years at an engineering college.

Gujarat Technological University (GTU) has started the process of bringing excitement of learning into the laboratories, classrooms and workshops. Besides other initiatives, one strand in the process is to imbue the whole of the learning process, during the under-graduate studies, with design orientation.

Other Related Work:

The work in the rest of the world on making engineering studies more interesting has involved the following experiments [3]:

1. **Project Oriented Problem Based Learning (POPBL)** has been used in the open and distance learning mode by an international consortium of universities called the Global Engineering Team (GET). GET has been working to take projects from the industry and to have them implemented in different cultural environments at universities located in Europe and South America and Africa.
2. **Problem Oriented Project Organized Learning (POPOL)** can be divided into two main themes – design oriented which solves practical problems by synthesizing knowledge form many disciplines (know-how), and problem oriented which solves theoretical problem by use of any relevant knowledge (know-why). At Aalborg University in Sweden, experiments in both the methodologies of POPOL have been tried.
3. **Project Based Learning (PBL)** leads to active learning processes which encourages student to think critically and to solve problems through a focus on practical task. Students can work in a group and learn from each other through group discussions. PBL leads to motivated students. It creates student centered environment where the instructor is not supposed to have the initiative in the learning process but he is supposed to act as a mentor and a guide. The challenge in PBL process is to select projects which can be managed by the young students and which emphasize the application of theory, use engineering design processes, and meet the standards and safety criteria.

The Work at GTU:

GTU has been working so that the learning processes in engineering move towards design of systems rather than being oriented to synthesis and analysis of individual components. For this purpose GTU has conducted many workshops for faculty members to sensitize them towards using examples of design in their respective courses, so that learning processes can challenge a student to design a small product, system or process.

DESIGN WORKSHOPS:

When the students projects were reaching completion, we organized two Design Workshops.

GTU organized a 4-day workshop on 27th & 28th April 2013, 4th & 5th May 2013. (The Call for the 4-day Workshop is at http://www.gtu.ac.in/circulars/13Jul/3072013.pdf. Its report is available at http://www.gtu.ac.in/circulars/13Apr/22042013_GTU.pdf.)
Another one-day workshop was organized on 19th July 2013. (Its report was published at http://www.gtu.ac.in/circulars/13Jul/29072013.pdf.)
It was followed by a two-day workshop on 29th -30th July 2013 for creating a framework for Final Year Engineering projects. (The report is available at http://www.gtu.ac.in/circulars/13Aug/26082013.pdf.)
28th September, 2013: Efforts to introduce Design orientation into different subjects of engineering were initiated.
(Please see http://www.gtu.ac.in/circulars/13Sept/DDA_Workshop.pdf.)

Earlier in November-December 2011, two sessions of 2-hours each had been taken by Dr Vikram Parmar for the Final Year students, who were working on their projects.

BUILDING DESIGN-ORIENTATION INTO THE SYLLABI:

GTU is in the process of updating its syllabi after its first cohort of 4-year degree engineering students have graduated out. In the new syllabus, we want to put into every course a module which asks the students to complete assignments on design relating to the course that they are studying. When such a process is followed right from the beginning of engineering education, a young person will start thinking creatively and the processes of rote learning will progressively be de-emphasized.

Since such projects have to be found for a large number of courses in different branches, GTU proposes to organize meetings of faculty members along with the resource persons for each course so that a set of example projects can be worked out for every course. The syllabus may include a module where the faculty member is supposed to give practical projects, which require a student to design some product, system or process, as assignments. The projects may be taken from an industry or these may be specified by the faculty members or the students may come up with appropriate proposals.

The progressive assessment system at GTU has 30 marks for continuous assessment by the faculty members, 50 marks for term work, assignment and laboratory work and 70 marks for end semester exams. The objective is that in every engineering subject, a part of the 80 marks of progressive assessment may be used to assess the design based assignments.

The faculty member in each and every college may assess the design-projects and while submitting the assessment of the 80 marks to the university he or she may also upload the best three such assignments / projects.

While framing the syllabus, the experts may have given only a couple of example assignments. However at the end of the semester, the university may have a few hundred examples of projects which have been found to improve learning process in the colleges. The experts may meet again to have a look at the new projects and redefine the example projects to be made available for the next year. In this way

hundreds of teachers and thousands of students will be able to progressively improve the project/ design based learning and make the system of engineering education more interesting.

The German Development Agency (DAAD) has supported, jointly with many industries, GET projects for the last few years [3]. A similar effort through international collaboration among Latin American and Caribbean Consortium of Engineering Institutions (LACCEI) has been reported in [4]. These projects have been the final year projects of engineering students. When GTU students start going through project based learning in various courses from first year to fourth year, it will become possible for GTU to join such international consortia for further improvements in the quality of engineering education.

GTU Center for Industrial Design:

GTU proposes to establish a Center for Industrial Design to lead and manage the design-oriented learning processes at all its Colleges. The Center will also help the industries improve its design processes and it may accept consultancy assignments for design. While the Consultancy projects may help the industry, the objectives during the initial years would be to build and improve capacities among the faculty members. Secondly such projects would provide opportunities to the students to work on real-life projects.

GTU has set up 25 GTU Innovation Sankuls to bring all the 167 industrial estates into active collaboration with GTU's affiliated Colleges.

In every field, GTU is creating strong networks among Colleges, so that they can work together to improve the quality through boot-strapping. GTU works to build capacities in Colleges and it works to coordinates collaborative efforts among Colleges. This model of a hub at GTU and spokes networking and strengthening the Colleges is being used widely by GTU. We propose to follow the same model at the School of Industrial Design by setting up an Open School of Design for building capacities all over the State. The School will work as the Hub, with spokes going through the twenty five Sankuls towards all the 167 industrial estates.

***References**: 1. Plenary Lecture on "Design for Effective Teaching and Learning in Technical Education" by Dr. S.K.Saha, IITD at the National Conference on Design for Product Life Cycle, Feb 17-18, 2006, available at http://web.iitd.ac.in/~saha/public_html-old/dplc06-cdproc.pdf as of 2nd November 2013*

2. Ellen Yi-Luen Do (GeorgiaTech) and Mark D. Gross (Carnegie-Mellon) ,'Environments for Creativity – A Lab for Making Things', C&c 2007, ACM 978-1-59593-712-4/07/0006

3. International Team Approach to Project Oriented Problem Based Learning in Design by Global Engineering Team 2008, available at http://stbweb02.stb.sun.ac.za/sol/Finlo/PROJECTS/Engineering/Completed/Scheffer%20Cornie%20and%20A%20Basson%20Mechanical%20Engineering/Publications/International%20Budapest,%20Oct%202009.pdf as of 2nd November 2011

4. Ivan E. Esparragoza et al,' Building International Collaboration Experiences among LACCEI Institutions through Global Design Projects', Latin American and Caribbean Journal of Engineering Education, Vol. 1(1), 2007 20

Appendix:

GTU's Project on

Active Learning & Creating Excitement

in ***Laboratories, Workshops*** *and* ***Classes (ALCE)***

ALCE aims at bringing excitement of learning into the laboratories, classrooms and workshops of Colleges, affiliated with GTU. This may be done by using ICT more effectively, by sensitizing the faculty members and by preparing courseware, which is interesting and which provokes one to think. This project on the delivery of GTU's academic programs is designed to generate a system, which nurtures creativity among the young and fosters the environment for research.

The first deliverable, under the project, is the best of courseware for the GTU syllabi. The courseware must not be power-point slides, which have text or equations only. The slides should include content with animations, pictures, videos, applications of concepts, under discussion etc.

Learning processes of education in technology must be made more interesting, if the nation is to develop. For making his classes interesting, a Professor at IITKh has taken his students out of the classroom to study a machine or a system or a process. They have been asked to sketch the mechanism or the process and they have been asked to suggest improvements in the product or process. He has used games like Antakshari to check whether the students remember technical words. He has used jig-saw puzzle to see whether the students understand a process and whether they understand common formulae, used in the subject, under discussion.

The methods of the nineteenth and the earlier part of the twentieth century were good when we wanted to train only a small number of engineers and when we only wanted to produce efficiently goods, which had already been designed and produced in the developed world . When the nation is developing at a fast rate, it requires a large number of well-trained engineers, who can develop innovative products, which can remove drudgery from the work of an ordinary Indian and which can improve the quality of life in India and the world.

Active learning requires that the academic processes become student-centric. A student can learn better when learning processes bring the real world into the class-room. When the real word cannot be brought in, the learning spaces, outside the classroom, may be chosen.

Today when Internet can be used to convey information efficiently, the classroom should be used for exercises, coaching and discussion. This is called 'flipping the classroom'. Listening to the video-lectures and using other resource material may be a pre-class-room activity. The classroom may be for understanding the applications, for discussing the philosophy and history of development of the concepts and for estimating the trends of new developments and research.

Assessment processes may also use as much of technology as possible. Technology can track a student's progress and obtain useful data about a student's successes and shortcomings in learning. The classroom or individual time with the teacher may be used for a joint analysis of the data and for devising new challenges for the student.

Thus classroom ceases to be a place for teaching. It becomes a place for learning and the faculty member becomes a mentor.

PRACTICAL WORK: Practical work is of great importance for technology education. The objectives of the work in the laboratories and workshops are as follows[1,2,3,4]:

1. Cognitive Learning: The practical work leads to a better comprehension of the theoretical concepts

2. Discovery Learning: It begins with formation of hypothesis, design of an experiment for proving the hypothesis, interpretation of results

3. Vocational Training: For learning current practices and learning professional ethical behaviour

4. Development of Personal Skills: Learning the art of Report Writing, Team Working, Communication and interpersonal relations, safety precautions, about maintenance of clean environment, proper attitudes and values.

It is not only the students, who have become examination-oriented, the syllabus designers have also started sacrificing learning for ease of conducting examinations. A normal practice today is that the syllabus for a course contains a set of experiments, which every student is supposed to perform and the practical examination is supposed to ask a student to perform one of the set. The practical work, then leads to meter-reading and graph-reading exercises, which may lead to satisfaction of some of the skills, mentioned in item 4 above. But such processes lead to a complete elimination of the other three objectives.

A better practice would be to gradually progress through Herron's Four Levels of Control[5] for a Lab/ workshop work after specifying a general theoretical area on which the practical work is to be done:

Level 1: Pre-set elements and students follow instructions
Level 2: Leave the answer open.
Level 3: Leave the answer and the methodology open.
Level 4: Leave the answer, the methodology and the specific aims open.

The progression from level 1 to 4 may be used at first year, as one moves from the first week of studies towards the last. However the Level 1 should be avoided in higher classes.

The Syllabi are designed by senior teachers. They feel that if they leave it to the College or the faculty to decide about the practical work, the young and inexperienced teachers may not be able to get the right

kind of practical work done. But the solution should not be a tight straight-jacket of pre-specified set of experiments. The right solutions are as follows:

- to give a sample set and then ask every faculty member to apply his own mind: Thus Dr L. N. Mittal [2] has given the following examples:
    - In Concrete Laboratory, practical work may be to 'Design Concrete Mixes' of different grades by conducting relevant tests. By including such experiments, all students will be busy in designing the mixes and develop professional competencies.
    - In estimating & costing, practical exercise may be to 'Prepare Tender Documents'
    - Providing dissemble/assemble experiences of machines/equipment etc.
- to organize a large number of FDPs on how to get the lab work done well.

Dr. L. N. Mittal [2] has suggested four useful practices:

i. Each teacher should be asked to write 4 to 5 questions as to what students will be able to do after the completion of the practical work of a session.

ii. After finishing a practical assignment, teacher should emphasize that the students are able to draw conclusions of the practical work done by them by administering viva-voce questions.

iii. Record of attendance and practical done by individual students should be maintained. A student not attending practical classes regularly should be warned and defaulters may not allowed sitting in the semester examination.

iv. While conducting final practical examination, the external examiner may
    a. ensure that a student has attended practical classes regularly,
    b. ensure conduct of practical work,
    c. check the record of observations and
    d. administer viva- voce questions based on all experiments for each individual student.

WORK DONE BY GTU's ALCE UNIT:

1. GTU has organized workshops for sensitizing teachers.
2. Initially eight courses (four for Diploma Engg and four for Degree Engg) were selected and meetings of teachers for each of the eight courses were organized. Through workshops, teachers were encouraged to develop new kind of courseware.
3. Three workshops of NPTEL leaders have also been organized. The IIT Madras unit professors have promised to help tailor the NPTEL videos to GTU syllabi.
4. Under the ALVCOM (Active Learning Video Lecture Communication) program, regular telecast of lectures was initially started for the eight first year courses of BE and DE on Saturday, 1st September 2012. During the second semester of the academic year 2012-13, nine courses (five for Diploma Engg and four for Degree Engg) were selected.

   This venture of GTU is supported with the help of technical facility through **Bhaskaracharya Institute for Space Applications and Geo-Informatics** (BISAG). ALVCOM **e**nables students of GTU affiliated colleges to have an access to video lectures from eminent faculties from all over Gujarat. Thus ALVCOM is creating a platform of knowledge sharing.

The video-recordings of the lectures, which are telecast, are available at the GTU web-site.

5. Involving all faculty and students in preparation of courseware: Active Learning Assignments for students in the new syllabi (available at http://www.gtu.ac.in/syllabus/NEW%20BE/Teaching%20Scheme%20of%202013-14_Group%20I%20for%201st%20year.pdf) of 2110014, 2110002, 2110005, 2110006, 2110013, 2110007, 2110015, 2110003, 2110011, 2110001, 2110004 have been prescribed. Preparation of the courseware, under ALCE by students, can be a good way for creating an environment, wherein both the 17,000 faculty members and 400,000 students are engaged in making the learning process an exciting experience. This can also provide the professors get real data as to what material just isn't clicking for their students.

PROJECT-BASED (or Problem-based) learning processes can hold a student's interest much better. The learning systems will become more student-centric, if project-based or problem solving or design-based methodologies are used in as many courses as possible.

GTU has organized a number of faculty development workshops for preparing a framework for design-based learning processes.

WORK BEING DONE BY GTU's SYLLABUS COMMITTEE for DEGREE ENGINEERING PROGRAMS: Dr. L. N. Mittal [2] laments the fact that , curriculum of Mechanical Engineering does not have a subject on CNC machines and the curriculum of Civil Engineering does not have a subject on 'Estimating and Costing/Tendering.

At GTU under its Vishwakarma Yojana (VY), during the academic year 2012-13, Final Year Engineering students have prepared Detailed Project Reports for 71 villages by working with the village leadership for about 10 months. During 2013-14, 192 villages have been selected for a similar study.

An innovative course called Contributor Personality Development Program, which inculcates values among the young citizens of India, has been designed and is required to be taken by every student, who graduates from GTU.

After the first cohort of students passed out last year, a Committee was set up under the leadership of Dr Nilesh Bhatt to redesign the syllabus. The Committee has already designed the syllabi for the first year. For the three courses - 2110005 (Elements of Electrical Engineering), 2110006 (Elements of Mechanical Engineering), 2110004 (Elements of Civil Engineering)- (available at http://www.gtu.ac.in/syllabus/NEW%20BE/Teaching%20Scheme%20of%202013-14_Group%20I%20for%201st%20year.pdf)-, a case study of systems is required to be prepared by every student, who goes through the course. For the course # 2110017 on Eletrical and Electronic

Workshop, a small design item has been given in the 5th Workshop Practice.(available at http://gtu.ac.in/syllabus/NEW%20BE/Year-I/2110017.pdf)

However a great deal of work remains to be done by the Syllabus Committee and it is engaged in the process of designing an innovative syllabus.

References:

1. *Norrie S. Edward,' The Role of laboratory work in engineering education: student and staff perceptions', International Journal of Electrical Engineering Education, 39/1*
2. *Dr.L.N. Mittal (Cognifront)," Laboratory Experiences - Suggestions For Improvement", 5th June 2013*
3. *G. Posner and A. Rudnitsky,"Course Design", (Book), Loingman, NY, 1982*
4. *O.P. Anderson,""The Experience of Science: A New Perspective on Laboratory Teaching", (Book), The Teachers College Press, NY, 1976*
5. *M.D. Herron, "The nature of scientific enquiry", School Rev., **79** (1971), 171-212*

GUJARAT TECHNOLOGICAL UNIVERSITY

AWARDS:

1. ASSOCHAM Best University of the Year Award, February 2014
2. Dainik Bhaskar National Educational leadership Award, October 2013
3. CCI Technology Education Excellence Awards 2013 for being the Best University in Internationalization of its faculty and students at Ahmedabad
4. CMAI's ICT World Communication Award 2013 for being Pioneer in ICT Education; the Award presented by Kapil Sibal, the Union Minister for Communication & IT, Dr. S.S. Mantha, Chairman AICTE, Hamadoun Toure, General General ITU and others at Delhi
5. World Education Award 2013 for GTU's project on Active Learning at Delhi
6. ASSOCHAM (Associated Chambers of Commerce and Industry of India) National Excellence Award 2013 for Best Government University for Promoting Industry-Academic Interface, delivered by Dr. M.M.Pallam Raju, the Union HRD Minister at Delhi
7. DNA & Star Group Award for the Best Education in Business Studies 2013 at Mumbai
8. AIMS International Innovative University Award 2013, at IIM Bangalore
9. The Best Jury Award in the category of Best Interface between Academia – Industry at the World Education Summit 2011
10. GESIA Award – 2011
11. Sherdil Gujarat Award -2011
12. Thalassemia Awareness & Testing Program Award -2011
13. Thalassemia Awareness & Testing Program Award -2010
14. ICT Enabled University Award E-India 2009
15. Manthan Award South Asia – 2009

POST-GRADUATE RESEARCH CENTERS:

1. Center for Environmental and Green Technologies
2. Center for Mobile Computing and Wireless Technologies
3. Center for Cyber Security
4. Center for Environment & Energy Efficiency Tools (CE3T)
5. Center for Infrastructure, Transportation and Water Management (CITWM)
6. Center for Technology Education, Public Policy and Universities of the 21st Century
7. Center/ School for Global Business Studies: Indo- German Study Center, Indo-Canadian Study Center, a Global Country Study Report program, International Student program
8. Center for Business Ethics and CSR
9. Center for Financial Services
10. Center for Marketing Excellence
11. Center for Governance Systems in Businesses, Industries, Universities, Hospitals, NGOs and Governments
12. Center for Pharmaceutical Studies and Drug Delivery Technologies: Besides its work in research in various areas of pharmaceutical studies, the Center proposes to develop a Center for nano Applications.
13. Center/ School for Industrial Design
14. Center for Project Management in Chemical Engineering

GUJARAT TECHNOLOGICAL UNIVERSITY

Ahmedabad Campus: Board for Wireless and Mobile Technologies; Open Source Technology Clubs unit and Mobile Monday Clubs unit; Active Learning and Creating Excitement in the Laboratories, Workshops and Classrooms (ALCE) and Active Learning Video Lecture Communication (ALVCOM) Unit; GTU Innovation Council (http://www.gtuinnovationcouncil.ac.in); Student Start-up Support System (S4); S4 Co-Creation Center (S4-C3); S4's Student Startup Showcase Stage (S4-S4); Young Entrepreneurs for S4 (YES4); S4 Extension Center Unit; Research & Consultancy Services Cell (RCSC); Sports Council, Youth Festival Council, Social Work Council (Blood Donation Camps and Thalassemia Testiing)

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Gandhinagar Campus : Post-Graduate Research Center for Pharmaceutical Studies and Drug Delivery Technologies; Intellectual Property Rights Cell and Patent Clinic

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Chandkheda Campus : Academic Unit including Course Development Cell; Board for Green and Environment Technologies; Twelve Post-Graduate Research Centers; Research Projects Unit; Indo-German Studies Center; Faculty Development Program Unit; Indo-Canadian Studies Center; Global Countries Studies Report (GCSR); International Students Cell; International Experience Program (IEP) unit; International Adjunct Professors Unit; Vishwakarma Yojana Cell; e-Library Unit; Financial Services Skills Council (GTU-FSSC); Council for Human Resource Studies and Organizational Structures (GTU-CHRSOS); Skills Council for Marketing (GTU-SCM); GTU Alumni Association (GTU-AA); Centers of Excellence and CCI Awards Unit; Conferences Unit; Integrated Training And Placement unit (I-TAP); Accounts Unit; Human Resource Department; RTI unit; Examination Unit