Blended Engineering Curriculum for Better Employability of Students

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***Abstract*—The economic situation of today is so challenging that it is no longer sufficient for a new graduate to have knowledge of an academic subject alone; increasingly it is necessary for students to gain those skills which will enhance their prospects of employment. Professional education needs to prepare students as engineers of the future with the required skills and knowhow which they will need to manage rapid change, uncertainty and complexity. Engineering higher education needs to constantly strive to keep pace with these advances and challenges. This paper is aimed at identifying and suggesting possible changes that can be brought into engineering curriculum to make our engineering students better employable.**

***Index Terms*—Blended learning, knowledge, skill, Rewriting curriculum**

I. Introduction

The modern professional education deals constantly with uncertainty and competing demands from stakeholders, viz. students, industries and public. Any restructuring of an engineering curriculum must take into account the correlation between society, engineering competencies and the changing paradigm of engineering education. Institutions are exploring ways to revise the engineering curriculum in order to meet the changing needs of industry and society. The employability of graduates depends on a combination of high technical knowledge and practical experience. It demands technical competence as well as skills.

Employability skills include the following abilities: the retrieval and handling of information; communication and presentation; planning and problem solving; and social development and interaction [1]. Whilst trying to incorporate more human skills into their knowledge base and professional practice, today's engineers must also cope with continual technological change and commercial realities of industrial practice in the modern world [2].

II. Current Scenario

Engineering education research is on the agenda for the improvement of higher engineering education [3]. Development of strategies for solving important issues for the future of engineering education, such as recruitment, the need for new competencies and the ability to deal with new types of interdisciplinary and complex knowledge is on the high.

In recent years, surveys and studies conducted in many countries to determine the technical and personal abilities required of engineers by today's industry have indicated some key points.

1. Present engineering graduates need to have strong communication and teamwork skills.
2. They need to have a perspective of social, environmental and economic issues that concern their profession.
3. The need to apply these knowledge and skills in practice.

Most of the studies indicated that the graduating engineer posses good knowledge of fundamental engineering and computer literacy, but they do not know how to apply that in practice [4]. These studies also have had a major influence on revision of accreditation criteria that has shifted emphasis from 'what is being taught' to 'what is being learned' [5]. This calls for Teaching with Technology and necessitates building employability skills into higher education curriculum.

Forward-thinking higher education institutions are adapting courses to equip graduates with the skills, knowledge and attitudes that are necessary to maximize the positive and far-reaching impact of engineering on society. Importantly, there is often a lack of knowledge of global issues amongst teaching staff and resistance to what is seen by some as a 'dilution' of core engineering content. The research function of academia remains a prime source of knowledge and innovation at national, regional and international levels [3].

This paper emphasizes the need for rewriting the curriculum by planning meaningful learning and understanding. It suggests some of the features that can be modified in the curriculum for bridging theory and practice. The focus is on both content delivery and value addition in order to improve employability of graduating students.

III. Revamping the Curriculum

Restructuring of courses has become necessary after getting feedback from various stakeholders namely the students, employers, alumni, members from industry on the advisory

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panels, and external assessors such as experts on the accreditation panel.

A. Need for Rewriting Curriculum

From the interaction, comments and feedback from the stake holders, it is clear that the profession, the industry and the students themselves are calling for significant changes to the current philosophy and delivery of engineering education. The issues are summarized [2].

1. Engineering curricula are too focussed on engineering science and technical courses without providing sufficient integration of these topics or relating them to industrial practice (indicating that the programs are content driven).
2. Current programs do not provide sufficient design experiences to students.
3. Graduates still lack communication skills and teamwork experience and programs need to incorporate more opportunities for students to develop these.
4. Programs need to develop more awareness amongst students of the social, environmental, economic and legal issues that are part of the reality of modern engineering practice.
5. Existing faculty lack practical experience, hence are not able to adequately relate theory to practice or provide design experiences.
6. Present promotion systems reward research activities and not practical experience or teaching expertise.
7. The existing teaching and learning strategies or culture in engineering programs is outdated and needs to become more student-centred.

In order to satisfy the requirements of accreditation criteria and needs of industry on what they need from engineering graduates, without sacrificing knowledge of engineering fundamentals, there is a clear need to rewrite the curriculum for engineering education at both undergraduate and post-graduate levels. It is clear that these demands are unlikely to be satisfied by a traditional engineering curriculum and 'chalk and talk' pedagogy. A mixed-mode approach or a blended approach seems to be one of the solutions.

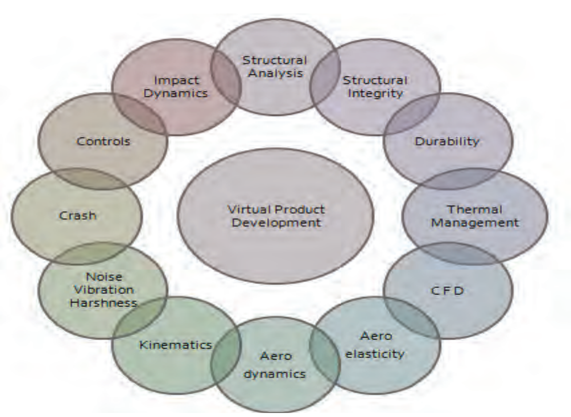

Figure 1. Multiple Intelligence required in an Automotive Product Development

B. Blended Curriculum

The curriculum to be developed must be based on instructional strategy, resources, and learning experiences and provides the required technical competence to the students. Several program-based curriculum revisions have been attempted / experimented by universities across the world. However, it has become difficult to evaluate them since the student is expected to posses' multi-faceted intelligence.

E.g. Figure 1 shows the various environments involved in development of an automotive product. In order to be employable in a automotive industry, a student needs to be aware of the various environments. It is clear from the figure that this field involves multi-disciplinary and complex approach. The student is required to acquire new competences and the ability to deal with new types of interdisciplinary and complex knowledge. A mixed-mode curriculum is likely to provide the necessary learning and training.

In order to emphasize the theoretical content of a subject and practical applications of this theory, a blended curriculum is suggested. Blended curriculum is a hybrid of traditional face-to-face classroom learning and a 'self instructional' lab component of the course. Instruction occurs in the classroom and laboratory component training becomes a natural extension of traditional classroom learning.

The syllabus for every course should have the theory part to be taught in the classroom and an accompanying laboratory part where acquiring skills to use a relevant hardware or software tool is compulsory. The student gains the knowledge in classroom learning and simultaneously applies to the laboratory exercises to acquire required skills. Curriculum development in every branch of Engineering should address this need for simultaneous education and training on the subjects relevant to their branch.

E.g. in Mechanical engineering curriculum, theory subject on Design of Machine Elements is to be blended with Design laboratory which normally is covered in different semesters as per the traditional curriculum. The laboratory component may involve use of experimental setup or use of Computer Aided Engineering (CAE) software tools or both.

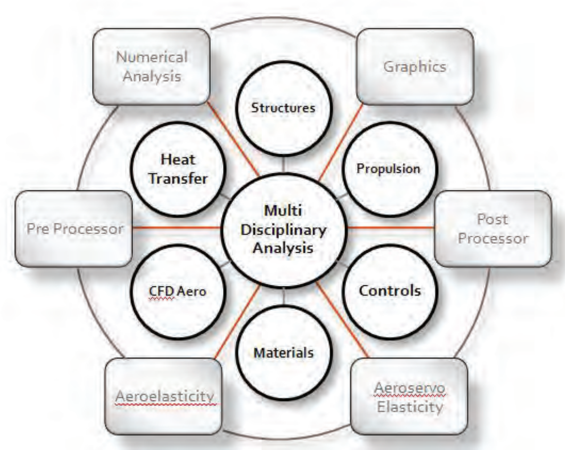

Figure 2. Multi Disciplinary Analysis involved in an Aerospace Product Development

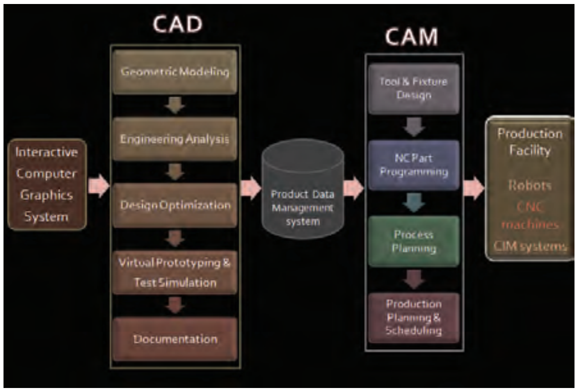

Figure 3. Stages involved in an Automotive Product Development

Figure 2 indicates the multi-disciplinary analysis involved in development of a product in Aerospace industry. It also emphasizes the need of use of Computer Aided Engineering software tools in acquiring the required skills [6].

Figure 3 indicates the various stages, type of data, and the systems involved in a product development in a Mechanical Engineering Manufacturing Industry. Use of CAE tools is inevitable for the modern industry scenario which is evident from the above figure. Use of CAE tools along with the necessary theory will make the student acquire skills that include the following abilities: retrieval and handling of information; communication and presentation; planning and problem solving; and social development and interaction.

In Electrical engineering domain, theory subject on Electronic Circuits can be blend with Circuits laboratory to conduct experiments and/or use of software tools such as PSPICE for simulation. For subjects like Modern Control Theory, the laboratory component may involve use of software tools such as LABView in doing programming.

Surprisingly this applies even to Mathematics as a subject where the Laboratory part should focus on use of MATLAB. In many cases, a critical assessment of current capabilities of available Software tools will provide the student a greater awareness about the subject and the current practical scenario. This itself is a promising research area.

Ultimately this may even remove independent laboratory courses in the new curriculum.

C. Evaluation Process

A revolutionary change is also necessary in the evaluation process. The knowledge gained and skills acquired have to be evaluated together. The syllabus for every course, in each branch of Engineering should therefore address this new requirement.

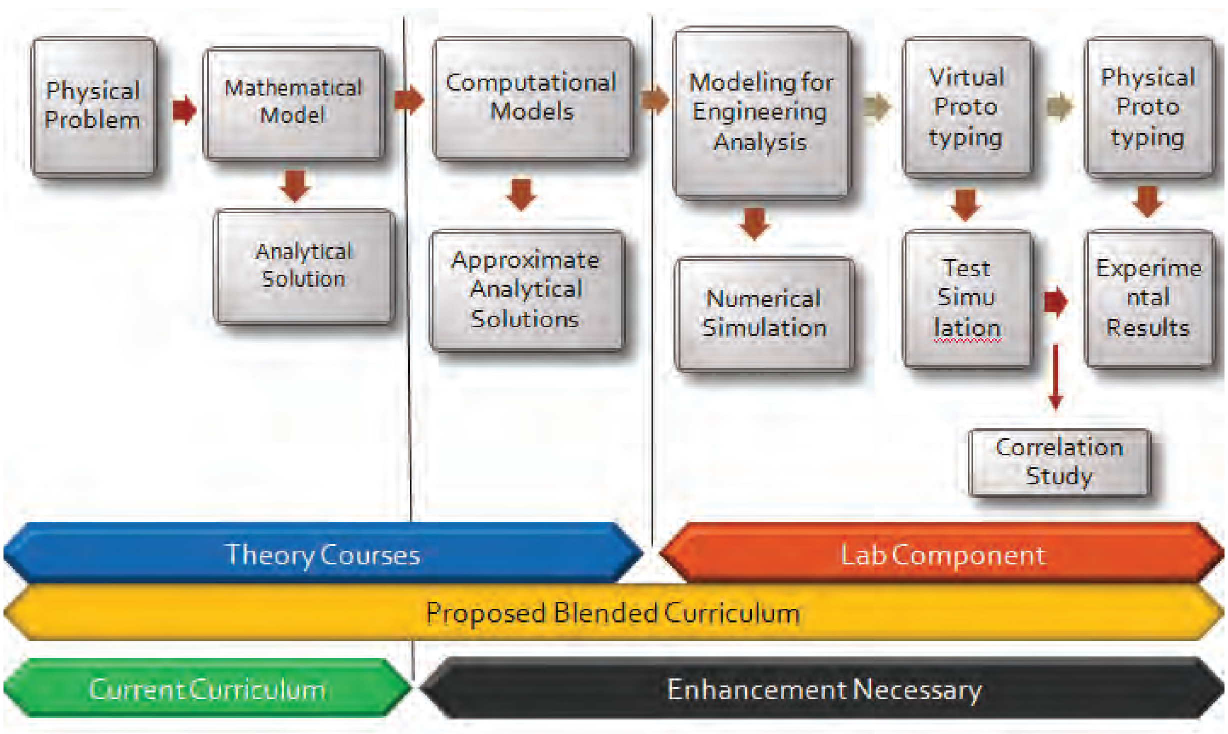

Figure 4. A schematic of proposed curriculum having Laboratory component blended with theory class

Figure 4 shows a layout of the Blended curriculum for an existing theory subject. It has the traditional face-to-face classroom teaching (part of current curriculum) and a 'self instructional' lab component of the course that needs to be integrated to the theory course. Instruction occurs in the classroom and laboratory component training becomes a natural extension of traditional classroom learning.

While framing the curriculum, the syllabus has to be framed keeping in mind the requirements of stake holders across various branches, since there is rise in interest in increasing interdisciplinary studies.

IV. Redefining role of Teacher

Teachers are the most influential factor in the Education change. The current requirements place a necessity on teachers to acquire adequate practical experience and expertise in additional to the classroom teaching experience that they can adequately relate theory to practice or provide design experience.

The teachers in Engineering education in addition to carrying out Research must be provided with robust professional training from time to time in order to improve their technical competence and provide value addition to the content delivery.

V. Conclusion

Engineering as a profession, has to deal with scientific and technological matters. It should also take into account the increasingly economic, societal and environmental aspects. Restructuring of Engineering curriculum at both undergraduate and post-graduate level has become necessary for quality improvement, increasing technical competence and employability of students. The institutions in addition are required to develop attractive programs of study and challenging learning environments.

Blended curriculum suggested here is thus a flexible approach to course design that supports blending of theory and practice. It would provide a better educational experience than either classroom learning or conducting experiments in laboratory at convenience. This structure will not only develop required subject knowledge and intellectual skills but also cultivates generic skills among students to make them better employable.

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