Holistic Approach Towards Industry Ready Engineering-Indian Perspective

A novel concept explained using Mechanical Engineering as UG course

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***Abstract*—In the Indian technical education scenario over the past decade and a half, there has always been a mismatch with respect to the employability of our engineering graduates although there are abundant opportunities in the industry for perusal. The primary reason cited for this mismatch is that of the lack of technical aptitude in the graduates who are embarking on the technical journey leaving the portals of the graduating institution. On one side of the scale, we have the ever-changing demands of the industry driven by the innovation and global competitiveness, the other end of the scale, we are stuck with curricula which emphasizes deeply on theoretical expertise. To bridge this precarious predicament, we propose a concept which gradually but potentially enhances the overall technical competitiveness of our students and add value to the society.**

Keywords— Industry-ready Engineers, Employability, Technical Aptitude, Indigenousness.

I. Introduction

In the past decade and half, the technical competitiveness of our engineers who pass out of the portals of the graduating schools across our country is generally not to the industry standards [2]. Industries spend a lot of time and resource to train the newly hired employees in a host of domains empowering the newly recruited graduates with the necessary skills. [1]

A big chunk of that training responsibility ought to be on the graduate schools which are responsible for training the students practically to a general understanding in the engineering domain. As the academic curricula of the undergraduate mostly cater to the theory and practical understanding of the concepts [3][4], an additional training of the real world requirement and the aptitude to sustain in that environment is essential. In order to advance from the existing paradigm, we propose a new concept which would perhaps add more value to the real world technical competitiveness to the engineering graduate.[5]

In the Mechanical Engineering discipline, to concept is explained in detail over four levels, each representing one year of engineering. The idea of this concept is to train and expose the engineering graduate to a host of technical possibilities sequentially rather than giving it all at once during the final year.

The four levels of engineering explained below will provide details of the benefits of the proposed concept stepwise in the engineering journey of the undergraduate student and provides a comparison with the existing system.

The crux of this concept is to alter the existing laboratory practices by a small percentage and bring in the value of inter-disciplinary work culture in order to achieve the desired levels of industrial exposure which is the order of the day.

II. CONCEPT OVERVIEW

As mentioned in the Introduction, the Mechanical Engineering discipline is considered for proposing this novel concept. In this section, details of the four levels are briefly addressed as follows:

*A. **Level I – 1st Year of Engineering***

In the first year of engineering, the laboratory which is selected is the Basic Workshop.

*B. **Level II – 2nd Year of Engineering***

In the second year of Engineering, the laboratories which is considered is Manufacturing Lab

*C. **Level III – 3rd Year of Engineering***

In the third year of engineering, the laboratory component which is considered is the "Mini Project Work"

*D. **Level IV –4th Year of Engineering***

In the fourth year of engineering, the component which is considered is the "Major Project Work"

III. CONCEPT DETAIL

The idea behind creating this concept is to bring about an upward surge in the competitiveness and efficacy in the field of mechanical engineering and thereby integrate the industry perspective into the academic curriculum.

In order to achieve the same, the methodology which is listed in the section II of this paper is employed. Details of the same are as follows:

A. *Level I – 1st Year of Engineering*

In the first year of engineering, the laboratory which is selected is the Basic Workshop.

Conventional approach:

Presently, there are three modules in the basic workshop laboratory viz., Fitting, Welding and sheet metal.

The students are given a briefing about the processes involved with the methodology after which they proceed to prepare the assigned model under guidance. The specimens which the students' work on is procured as raw material in the department first hand. The models which are prepared by the students as a part of their academic work will eventually be given away in the scrapyard after the semester is completed. Although the student has successfully completed the lab work, the level of understanding of the concept and its applicability in the industrial perspective is fairly minimal owing to the conventional laboratory environment. Exhibit.1 represents the general pattern of work flow in the conventional Basic Workshop laboratory.

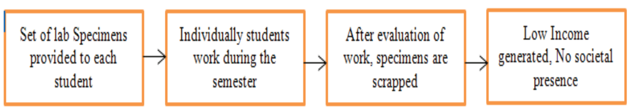

Exhibit.1: Process flow in Basic Work Shop

Holistic approach:

In the proposed concept, it is desired to tweak the existing system a bit in the line of achieving better results considering the intellectual and the financial spheres of the workability of the workshop. In order to explain the same, let us consider the example below:

Fitting: In the fitting section, instead of just providing a laboratory level model for working, it is proposed to consider a low technology fitting problem from the industry and the same is distributed among the batches of students effectively in such a way that the overall fitting process will be accomplished when all the students collectively work and finish their individual sub-modules. It will be the duty of the lab personnel to keep a vigil and interact with all the students of the batch and ensure that the batch is working to achieve a common goal.

At the end of the semester, Instead of scrapping the lab specimens of fitting worked by the students, the new model, which is a result of the collective effort of the entire batch who have worked sub modules individually can be finished using mechanical processes by experts and the product can be given away in a subsidized price to a social concern which will benefit the public and the society at large. Exhibit.2 represents the altered work flow pattern in the Basic Workshop laboratory.

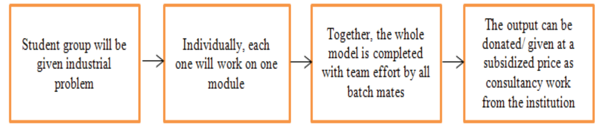

Exhibit.2: Process flow in Basic Work Shop considering Holistic Approach

Welding: In this section, along with the conventional form of welding two metal specimens, a general application which will be useful for the society may be considered and the entire batch can work in tandem to achieve the preset goal.

Sheet metal: In this section, instead of finishing the models in the existing framework of the lab, the students can be encouraged to apply all the sheet metal working principles into producing a workable model and the same can be given away as a social project to the community.

B. *Level II – 2nd Year of Engineering*

In the second year of Engineering, the laboratory which are considered is Machine Shop

Conventional approach:

Presently, in the machine shop, the students are given training on the usage of different machines viz., lathe, milling machine, drilling machine and shaper and the students are expected to manufacture the given type of specimen as advised by the supervisor in the existing laboratory environment. Exhibit.3 represents work flow pattern in conventional manufacturing laboratory also known as 'machine shop'.

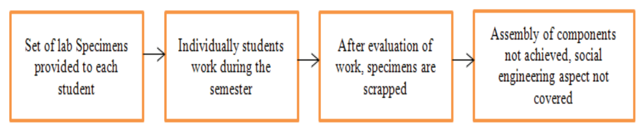

Exhibit.3: Process flow in Machine Shop

Holistic approach:

On the lines of the proposed concept in the basic workshop laboratory, here in the machine shop too, the intention is to enhance the productivity of the laboratory by incorporating industrial applicability into the academic curriculum.

In the present scenario, the instructors handhold the students in experiencing the skill required to operate the machines and thereby execute the given model with the level of desired precision. After the laboratory is completed, the models are scrapped collectively.

In contrast, applying the newly proposed concept, the lab experience can be enriched additionally by involving the laboratory curriculum in the line of industrial production.

A predefined curriculum is to be set keeping in mind the end product which is going to be accomplished and on the same line, the laboratory is to be modeled and desired results are to be achieved. Exhbit.4 represents the altered work flow pattern in the Machine Shop laboratory which will yield in higher order problem solving skills.

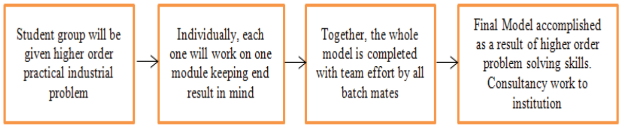

Exhibit.4: Process flow in Machine Shop considering Holistic Approach

C. *Level III – 3rd Year of Engineering*

In the third year of engineering, the laboratory component which is considered is the "Mini Project Work"

Conventional approach:

In the existing scenario, the students mostly do the study project or carry out small time experimental investigations in their pre final year of engineering and prepare a report of the same as an outcome for the mini project work. The work which will be carried out will generally be study oriented where the student learns the theory behind an industrial problem theoretically and apply the findings in the form of a report.

Challenges in the existing process:

The student is getting the exposure academically in the pre-final year of engineering and has considerably less time before he advances to the final year where the final project is to be carried out.

The student might not be fully conversant with the level of workability of an industrial problem as he/she hasn't developed the required skill to tackle the technicality of the problem.

Application of the concepts learnt previously will be challenging to apply at once considering the inexperience in understanding industrial environment.

Holistic Approach:

As the student has undergone specific levels of training already viz., Level I and Level II, he/she stands a very good chance intellectually to encounter an industrial problem which is chosen in the mini project in the third year of engineering. Although the allotted task can be accomplished using the conventional approach too to accomplish the required academic credits, this approach will suitably add more value to the higher order problem solving skills of the budding mechanical engineer.

D. *Level IV – 4th Year of Engineering*

In the fourth year of engineering, the component which is considered is the "Major Project Work"

Conventional approach:

In this level, the student who is in the final year of his engineering course is expected to carry out a project, be it experimental or analytical or combined and record all the findings of the project into the dissertation in order to successfully complete the required credentials to be awarded the degree.

The student will generally be given an opportunity to choose the place of project work either in house or in an industry/ research institution. The student is expected to learn all the technical concepts pertaining to the defined problem statement and carry out the research work in a specified interval of time of around six months.

As an outcome, the student will record all the findings of the project work, compile it into the report and submit the same for completion. However, in the undergraduate level, generally, the students who undertake project works will not be presenting any research articles over the technical work they have carried out as their final year project work.

Challenges in the existing process:

The student might not be conversant with the industry culture of working as he/ she is exposed to the industrial environment newly.

The student might find it challenging to absorb the technical inputs which he/she is provided as the same might be relatively unfamiliar owing to conventional approaches.

Holistic Approach:

In this segment of engineering, unlike the last three levels, not a lot of changes are to be incorporated. Infact, all the three levels will pave as foundation blocks for the student to perform well to the best of his/ her capability while executing final year project work.

It is the final year project work of the student which gives the complete idea of the level of technical aptitude the student has developed in the past four years of his undergraduate education. It is the technical aptitude acquired during the project work which will hold as the stepping stone for all the upcoming technical endeavors of the student which in most of the cases, industry driven.

In this regard, it is of paramount importance to train the students to achieve a high level of technical prowess and to ensure that there are credible levels of sustainability in their technical caliber; they should be channelized in the right direction from the beginning.

In the present scenario, there is no emphasis for the undergraduate students to publish research articles owing to competency reasons. In that case, the challenge would be to find out alternatives to enhance the competency of the undergraduate students to ensure the development of research aptitude from the Undergraduate level.

The same is an open ended process which can be infused into the curriculum by incorporating syllabi which is mostly application oriented. Once the student gets trained in the conventional subjects with application oriented training, he/ she would gradually develop the capability to design and create newer and better systems for higher optimal utilization. In this regard, if the student has undergone training for all the subjects like specified considering few examples in levels I, II, III and IV, it can be certain that the technical mantle of the undergraduate students at large will substantially improve thereby creating better opportunities for industries and research institutions to absorb highly competent personnel for latest research and development in the field of choice.

IV. HIGHER ORDER THINKING

This entire concept is developed in order to raise the bar of the level of thinking process of a student undergoing technical education in the undergraduate perspective. Although, the existing curriculum is doing its part to meet ends meet w.r.t the demand and supply of the HR potential for the industries, somehow, there has been a missing link in the chain which has led to a huge gap in the competitiveness perspective of the budding engineers of the subcontinent. One major attribute which is influential for this situation is the lack of development of higher order thinking skills. *Table.1* gives the mapping of Bloom's Parameters of Higher order thinking with to different levels of Engineering.

In order to enhance the capabilities of the student in developing higher order thinking skills, this particular concept is proposed which will certainly add additional value if not revolutionize the entire teaching learning paradigm in the country. The concepts explained in the concept can be compared with Bloom's Taxonomy [6], which is the standard tool which gives details about the higher order skills, in the table below, the details of the comparison and mapping of the same is carried out. *Table.2* as opposed to *Table.1* gives better significant outcomes as the same is application oriented which is derived from the holistic approach.

Level/ Bloom's Taxonomy	Level I	Level II	Level III	Level IV
Creation				
Evaluation			✓	✓
Analysis		✓	✓	✓
Application				✓
Comprehension	✓	✓	✓	✓
Knowledge	✓	✓	✓	✓

Table 1: Mapping of Bloom's parameters for conventional approach

Level/ Bloom's Taxonomy	Level I	Level II	Level III	Level IV
Creation	✓	✓	✓	✓
Evaluation	✓	✓	✓	✓
Analysis	✓	✓	✓	✓
Application	✓	✓	✓	✓
Comprehension	✓	✓	✓	✓
Knowledge	✓	✓	✓	✓

Table 2: Mapping of Bloom's parameters for holistic approach

V. NEED FOR INDUSTRY READY ENGINEERING

Come 2020, India will be the youngest country in the world [7], there is a great opportunity to capitalize on the raw talent of our youngsters. This can be harnessed into a greater level by providing adequate training and encouragement.

The indigenous capability of our country's industrial sector is something which needs to reform if we are to become a globally competent super power in all domains. [8]

The research potential of our country needs a great push comparison to the rest of the world, which would yield in new product development and innovation skill.[9]

In terms of the patenting and new product development too, the essential phase shift needs to come in which drives high competency through strong academic and research aptitude which yields as a strong force in positive economic development.[10]

Whatever the field is, it is the indigenous strength which is derived by the high quality educational standards which aid in transformation of the acquired skill into meaningful products.

All the parameters listed below would have one thing in common, which is "strong emphasis to fundamental concepts" and that's only possible in the undergraduate learning of the student.

Although many institutions undertake short term trainings called "Finishing schools" to patch the gap between the Industry and Academia, it will add up to facilitate for better employability. [11]

It is required to address the challenge from the root level and one such alternative is to ensure application oriented learning in each level of the academic course which results in gradual empowerment of the student's skill of real time problem solving abilities.

VI. CONCLUSION

It is of paramount importance that the technical mantle of the nation's engineers is of highest orders to sustain in the global technological perspective. The competitiveness in the global market which is an offshoot of the industry requirement and the need latest research methodologies is the driving force for ensuring very high quality standards are set in the engineering curriculum. A high degree of emphasis should be given to the application of engineering concepts in the undergraduate course which can be translated into reality by incorporating near industry' research environment in house.

In this regard, it is the duty of the regulating bodies to ensure that a refined curriculum is essential to accomplish the mission. In that line of thought, this concept is proposed to add into the refinement which hopefully brings in the required change and yields in creation of engineers who are trained to work with higher order thinking skills, who eventually will be responsible to create a host of engineering systems which befittingly be indigenous if not globally competitive.

POSITIVE OUTCOMES OF EMPLOYING THIS CONCEPT

- Igniting Creative thinking from early days of Engineering.
- Application of concepts based on Bloom's Taxonomy for outcome based learning.
- Collective effort ensuring coordination and teamwork.
- Cost and resource analysis ensuring optimal utilization of existing resources.
- Industry level learning of the concept.
- Experiential learning of the concept owing to more retentive capabilities.

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