# Experiential Learning: Learning Through Projects

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***Abstract*- There is a need to prepare engineering students for the future world to be good engineers, to be a good engineer the theoretical background of the curriculum that they go through is not sufficient they need to practice what they have understood. In order for students to practice as engineers, they need to have exposure to a number of projects that offer complex problems, along with the uncertainty of factors that influence such problems. In this view Electronic instrumentation program is divided into two verticals embedded system and process automation to provide domain specific Knowledge to students and courses are designed to fit into these domains to satisfy current industrial needs. To provide more hands on experience curriculum and related activities are planned at three different levels. At first level(Second year) along with laboratory course, activities are planned and defined as course projects which augments theoretical concepts and also aids in interconnecting various courses for integrated approach, these activities strengthen the conceptual knowledge of students. Next level (Third year) theme based Mini and Minor projects are planned, themes are decided based on Subject learnt in previous semester and recent technological developments. These activities provide a platform to realize applications belonging to a specific theme. In the final level capstone projects are grouped into Industry projects, product development and research oriented projects. Students are allowed to extend their academic experience into areas of personal interest, working with new ideas, issues, organizations, and individuals. These activities helped students to develop their communication, interpersonal, project management, and design skills. It also provides students with an understanding of the economic, financial, legal, and regulatory aspects of the design, development, and commercialization of the technology with these activities carried out throughout the year we are able to achieve better quality in paper publications, winning awards in prestigious project competitions conducted by industries and academia along with improvement in placements, Semester End Examination and addressing professional and technical outcomes of ABET.**

**Keyword: Course project, Theme based project, Capstone project, Achievements, ABET**

## I. INTRODUCTION

Searching different pedagogical practices that initiate student's passion for learning and increase the learning outcomes effectively is one of the main goals of many people in teaching communal [1] , "Experiential learning is an dynamic and reflective process where students figure out their liberal arts education through its application to a real-world context to advance their personal and professional development", and such learning occurs in multiple, stimulating ways and formats, both to introduce students to possible areas of interest and technical skills. It also helps them further deepen their knowledge.[2]

### A. DEFINITION OF EXPERIENTIAL LEARNING

Various terms have been used to label the process of learning from experience. John Dewey (Dewey and Dewey 1915) discussed "learning by doing," while Wolfe and Byrne (1975) used the term "experienced-based learning." The term "trial and error" learning is used to explain inductive learning processes. The AACSB Task Force (1986) used the term "Applied experiential learning," combining the learning from the "real-world" Situation with the necessary condition of the application of concepts, ideas and theories to the interactive setting. The term "experiential learning" will be used here, but it is intended to cover the same domains as the other terms. [3]

Organization of the rest of the paper is as follows Section II deals with experiential learning through projects, section III discusses about implementation of projects at different levels and its effectiveness, section IV discusses the student's achievements under various categories and section V includes a typical project carried out through the entire process. Finally the results and conclusion are discussed in section VII.

## II. EXPERIENTIAL LEARNING THROUGH PROJECTS

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Many prestigious institutions have strengthened programs that enhance more traditional classroom learning, but in order to make students as good engineers more practices on learning should be highlighted\strengthened. First-year seminars, collaborative assignments/projects, service learning, and research are among the high-impact educational practices that link to strengthen their technical knowledge and hands on for students. To help students to practice as engineers projects at different levels plays a vital role in sight of this vision projects are introduced into the curriculum structure at various levels.

The curriculum structure and the courses offered in Instrumentation engineering program can be broadly categorized as follows

1. Basic Science, Mathematics and Engineering
2. Program Foundation Course
3. Program Verticals (specializations)
4. Integrating Experience

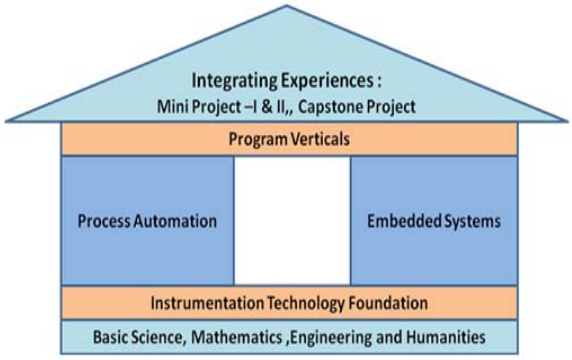


Figure a. Curriculum Structure

The primary objective of this study is to examine the experiential learning process of Students, in order to investigate the nature of knowing. In this study we examined students acquire job-related skills or expertise through projects. There is a convention which asserts that structural learning can be described as a process of three steps: (1) knowledge acquisition, (2) knowledge sharing, and (3) knowledge integration, the design of the curriculum reflects these three steps and helps students to be a better engineer. The Basic Science, Mathematics and Engineering module helps in laying the sound fundamental knowledge and skills required for engineering solution process. The courses also prepare the students for the courses in senior years, they also expose the students to modern tools and laboratory practices that are relevant to engineering profession.

Program foundation course module which includes 9 courses with 26 credits builds up required fundamental knowledge and equips students with skills that will help them to progress to more specialized courses of the IT program in the higher semesters, as a part of these courses students carry out their projects related to the same subject at a lower level named as course projects.

### II. A- INTEGRATED EXPERIENCE

Integrated experience is a multi-disciplinary, design-project-based approach consisting of 5 courses with 25 credits. It emphasizes engineering design and incorporates fundamentals from several engineering disciplines such as instrumentation, electronic, electrical, computer science, automobile and mechanical involving science, mathematics, humanities and engineering components. Through the mini-projects, course projects and capstone project modules, it helps in producing an engineering design or a product. It provides an opportunity to progressively acquire a thorough grounding in the concepts and skills of the central topics in engineering. It provides a specialist knowledge base and skills to specify and design the electronic systems relevant to a particular area required in a business context to achieve an economic solution. It will improve both practical and academic skills on individual to prepare for a wide range of opportunities either in employment in industries, R&D or higher education.

Research experience for undergraduates (REU) offer an opportunity to gain valuable research skills and present and publish papers in various journals. It also ensures the breadth of learning, beyond technical aspects of engineering discipline. Courses under integrated experience are listed in Table I.

Table I - Integrated experience

| Course Code | Course | L-T-P | Credits | Class hours |
|---|---|---|---|---|
| ITP301 | Mini Project | 0-0-3 | 3 | 3 |
| ITP302 | Minor Project | 0-0-6 | 3 | 3 |
| ITP403 | Capstone Project-I | 0-0-3 | 3 | 3 |
| ITP402 | Capstone Project-II | 0-0-10 | 10 | 10 |
| REU401 | REU | 0-0-6 | 6 | 6 |
| | **Total** | **0-0-25** | **25** | **25** |

Mini-project, course project, capstone project and REU, helps students to apply basic

science, math's and engineering skills to address and solve the real life problems through research under a progressive multidisciplinary learning environment with an objective to provide a share of service to the societal, personal and professional growth. This also addresses the ability to apply the project and finance management skills for its effective delivery.

### III- PROJECTS CARRIED OUT AT VARIOUS LEVELS

As discussed in the above section integrated experience helps students to acquire multidisciplinary knowledge, the methodology practiced throughout the process is discussed here

**Course Projects:** The course projects are introduced in the courses where the concepts can be well understood and higher level of learning can be achieved by developing application or a product or a process. Normally course instructor suggests the theme/s of the project and the students carry out the projects in a group of 3 or 4. The assessment is carried out on continuous basis using rubrics. The project is a base for the student to take a dynamic part in exploring the subject area, as suitable for an advanced course. Thus, a project must be chosen that will clearly extend the knowledge and understanding of some area of relevant to the course. Moreover, the primary criterion for evaluating the project will be what the student have learned and discovered from the problem statement they had arrived but, not the amount of work complexity or the amount of code written or the number of pages they have documented. Thus, students should define the project with this consideration in mind and work for results finally communicate with what they have learnt to the instructor by creating a document or a presentation. The project is also intended as a valuable prototype experience for those going on to progressive work at higher levels of the program.

There are three aspects to a course project:

- Define a problem statement respect to the course and carryout literature survey.
- Follow Engineering Design process
- Finally implementation and experimentation

Sample description: Course on analog electronics focuses on the operation, modeling and applications of analog electronic devices. It helps students to build and troubleshoot analog electronic circuits using appropriate techniques and test equipment.

**Mini Projects:** Mini project is carried out in 5th semester. A mini project is offered to help students understand and appreciate the open-endedness and complexities involved in formulating a problem, and thereby develop practical ability and knowledge to identify and solve problems in the real-life related to the society/industry. Students shall work under the common theme decided by the department and student teams have to select a problem from any one of the application areas specified or they are allowed to carry there course project completed in previous semesters to the next level. The theoretical knowledge already acquired from a cluster of courses provides the necessary foundation/principles to develop reasonable solutions. Students shall apply methodologies learnt in Engineering Design Course at the lower semester; prepare working model and proper documentation for the entire process. The mini projects are carried out in a group of 3 or 4 students. The themes for mini projects are decided by the departmental faculty committee

**Minor Projects:** Minor project is a 6 credit course carried out at 6th semester. The theme of the minor project in the department has been to introduce students to the concept of system approach in design of artifacts. As part of this task student teams work on design and develop Embedded System leading to proof of concept and product prototyping, which involves the top down approach for system functionality and architectural definitions followed by bottom up design development comprising: sensor and sensor interfaces, data acquisition hardware, embedded software development. The team size is 3-4 students per team. One mentor assisted by 2 faculty members will monitor the progress as per the review and assessment plan to ensure the accomplishment of course outcomes.

Theme of the Minor project: Internet of Things (IOT).

Application Areas:

- Automotive Electronics
- Agriculture
- Process Automation
- Health Care

Design and develop innovative applications on these themes using Internet of Things (IOT) concept. The objective is to incrementally build competence and skill set under the defined themes and to evolve the system architecture, design and develop Embedded System leading to proof of concept and product prototyping.

Implementation method: This theme emphasizes on separating the functionality of a program into independent, interchangeable modules, such that the device or program is logically divided into "black

boxes" with specific inputs and outputs. Once the interfaces between the units have been defined, the detailed design of each unit can proceed separately. The elements defined in the interface are detectable by other modules.

1. C/C++/MATLAB/SIMULINK/LABVIEW based languages can be used. Modules to be realized through i) Functions ii) Inline functions iii) Interrupt service routines iii) Header files
2. System should have feedback / closed loop for control application.
3. The system has to be tested for performance using timing analysis.
4. Finally the software has to be interfaced with any hardware using GUI leading to an application.

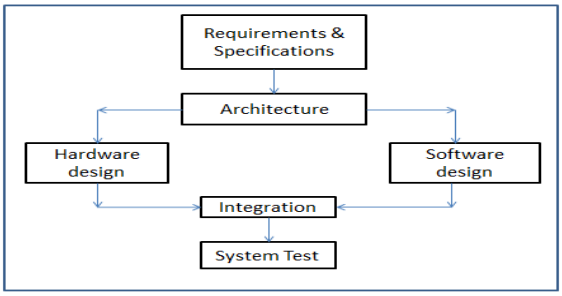


Figure b. Flow chart of Mini/Minor Project

**THEME WISE CHARACTERIZATION**

**Internet of Things**

1. Wireless electronic notice board using multipoint receivers
2. Monitoring of water supply to sinter plant ore
3. Smart office management using IOT
4. Intelligent digital fuel level indicator
5. Remote monitoring system for DG/transformer using technology in light house
6. Automatic Gas booking
7. IOT based garbage management system

**Automotive Electronics**

1. Theft protection by controlling the ignition system of the vehicle
2. Driver's Consciousness analysis
3. Car's headlight tilting
4. CAN cluster
5. Accident detection and rescue system
6. Automatic steering control detecting barrier obstacle
7. Automated guided vehicle using internet
8. Automatic jack system

**THEME WISE CHARACTERIZATION**

**ESDM (Electronic System Design & Manufacturing)**

1. Automatic light and fan control
2. Automated coffee vending machine
3. Autonomous serving and swabbing bot
4. Smart door lock

**Health care & Agriculture**

1. Smart wastage collecting hopper
2. automated irrigation system
3. Health care monitoring system for ATM

**Process Automation**

1. Commando bot
2. Intelligent digital fuel level indicator
3. Vacation Bus System
4. Smart wastage collecting hopper
5. Balancing tech using gyroscope
6. smart home automation
7. Garbage monitoring system
8. Air analyzer

Figure c. Theme wise characterization of Mini/Minor Project

**Capstone Projects:** The projects executed by students in their final year have a primary objective of giving an integrated experience to solve complex engineering problems. Typical expectations from these projects are: identification of the problem, researching the literature, identifying objectives, constraints & functions, developing alternate solutions, choosing the best solution, verifying the solution through analysis and simulation, prototyping, testing and documenting. All the projects are evaluated continuously and at the semester end through the assessment rubric developed for the purpose. The projects are not only assessed for technical competency but also for the professional competencies required by the outcomes.
The quality of the projects is ensured through the following process

- ✓ Setting clear objectives: For all the projects, clear set of outcomes are specified. Based on the desired outcomes the themes for the projects (mini and minor projects) or scope of the projects are defined.
- ✓ Clarity of assessment strategy: Detailed assessment strategy and rubrics which clarify the expectations of the project are developed and shared with the students.
- ✓ Engineering design process: It is ensured that a systematic engineering design process is followed in the execution of the project.
- ✓ Regular reviews: Regular reviews and continuous assessments are conducted with predefined rubrics for each of the review.

**Phases of Project Work:**

- ✓ Select an application
- ✓ Literature survey and analysis / Field visit
- ✓ Problem Statement and Objectives of the proposed work
- ✓ Alternate Designs
- ✓ Methodology /Work plan
- ✓ Experimental Work with Results and Discussions
- ✓ Conclusions and Scope for Future Work
- ✓ Preparation of the Report

## IV ACHIEVEMENTS THROUGH PROJECTS

The approach of execution followed in the learning process at the departmental level has initiated good results in terms of overall performances like Best Paper awards, Paper Publications at National and International level, participation in technical conference across the country, product development, Interaction with industry experts and take up industry projects at capstone level

**Methodology**: To have a higher level of achievement and attainment in terms of Knowledge and Awards at departmental level initially the list of journals, project competitions, Technical conferences, organized by Industry and academia are listed by the department project coordinator and each event will be allotted a separate faculty to monitor the status of that particular event and make sure participation is encouraged among the student groups, the following table gives a clear picture of the format followed.

Table II– Allotment of faculty to competitions

| Organization | Title | Department Coordinator | Tentative dates |
|---|---|---|---|
| Infosys | Aspirations 2020 | Ashwini K | August 2015 |
| KPIT | Sparkle | Kaushik | Sept 22nd |
| TCS | Tech Wiz | Vishal P | 05-Aug-15 |
| Texas Instruments | Innovation Challenge India design contest 2015 | P C Nissimagoudar | August |
| Cadence | Design contest | Nagaraj V | 09 March 2015 |
| National Instruments | Engineering & Science Innovation Summit | Tanuja Javali | Jan |

As discussed in the section of projects mentioned earlier the Themes for carrying out Mini and Minor projects will be identified by the departmental faculty teams, the teams will interact with head of the department by keeping the view of themes defined by the industry and academia for competitions, once the themes for projects are defined it is exposed to the student groups to select their domain of interest to work and continuous assessment is carried out with certain process defined earlier under projects. Finally the projects completed will be applied under various categories defined in the competitions by industry and academia.

The advantage of this process is students will be well exposed to the recent technological advancements in the world and helps them to asses themselves better wrt to technology at the end of semester in-house project exhibition and competition among student groups will be arranged to increase the motivation among students.

The process followed above has clearly witnessed the status of achievements has increased numbers in overall categories the following comparison between old practice and the one followed now can signify the importance.

Figure d. Exhibition of Mini/Minor Project during academic year 2015-16

Table III. Students' achievements through projects at different levels

| Instrumentation Department Students Achievements for the year 2015/16 | | | |
|---|---|---|---|
| **Sl. no** | **Name of the students\Staff** | **Technical Paper/Position** | **Conference /Competition** |
| 1 | Abhinandan D Supreeta Gudi Swati B | Finalist for Technical paper presentation | Nov 24th Bosch Inscribe-2015 |
| 2 | Shriya Desai | 2nd place | COSMIC odyssey at BITS Pilani Goa |
| 3 | Nagaraj V Sameer K Abha K Ramya Joshi | 3rd place for Paper presentation on" Piezoresistive ARM cup" | Nov 24th Bosch Inscribe-2015 |
| 4 | Megha Hegde Anusha K Anusha N Marmika | Best paper award For" Design and Modelling of MEMS based Pressure sensor" | "International Conference on IOT and applications for Smart city, Tirupati" 18th March 2016 |
| 5 | Rakesh Tigadi | Excellent paper award for " Design and development of E-saving Meter to prevent wastage" | 21st IRF international conference at Bangalore, 3rd April 2016 |

| | | | |
|---|---|---|---|
| 6 | Neha Sheik, Ravi Hadli, Shivanagouda Vinayak S | 1st in Endurance, 2nd in Autocross | HVC Championship – Hybrid Vehicle Challenge Bhopal. |
| 7 | Ravi Hadli and Shivanagouda G | 1st in Drag race 2nd in Endurance and cross road stages | Ultra Golf KART Championship 2016 |
| 8 | Shraddha Bhatt Varsha Prabhu Srilakshmi K | 1st place for Paper presentation on "Stand alone Power system" | ISA Bangalore Section and VIT university IACT-4th March 2016 |
| 9 | Manjunath D Dinesh P Mahesh Mirje Krishna P | 2nd place for Paper presentation on " Automatic Two wheeler Stand " | ISA Bangalore Section and VIT university IACT-4th March 2016 |
| 10 | Radhika N Pooja K | 1St place project-"Active Toy to foster to imaginative Play" | Sristi -2016 Kottayam Kerala 27th January |
| 11 | Laxmi D Keerthi N Anjushree H | Best Project award "SMART WASTE COLLECTING HOPPER" | Sristi -2016 Kottayam Kerala 27th January |
| 12 | Amarnath Jha and Team | 1st place | ARM Tech Symposia 2015 Bangalore. |
| 13 | Abhinandan D Supreeta G Govardhan A | Runner up | TATA mind Rover Consent by TATA motors-Pune |
| 14 | Goutami Bhat Divya shree | 2nd place for paper presentation | National Symposium MIT Manipal |

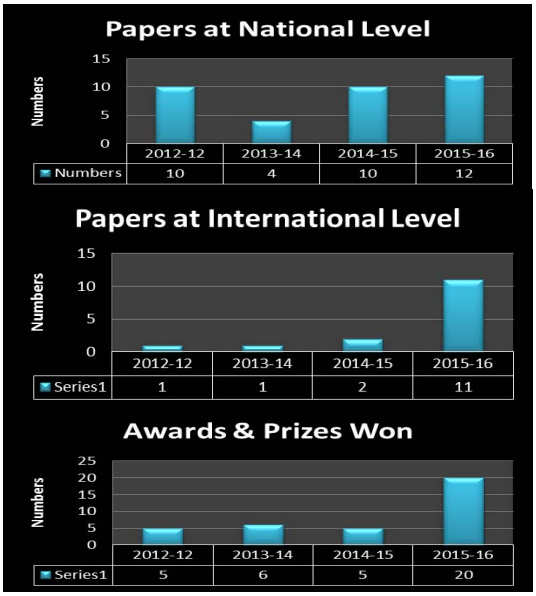


Figure e. Comparison of student's achievement

## V- Example of project Executed:

AUTOMATED GUIDED VEHICLE

Automated guided vehicle is the project carried out by the student group of four members under two project levels namely Minor and Capstone stone. Let's discuss how they carried the things from lower level to higher level and finally ended up with a prototype that can be used in real time. This project was selected by the student group under the Theme Automotive electronics where the concept of electronics to drive mechanical body was used.

**Minor project**: Under this heading students started doing their literature survey of AGVs used in industry's for various applications and started implementing the basic concepts of driving the vehicle using electrical motors, because of the load\speed variations of the vehicle they changed several motors and ended up with using servomotors to drive the mechanical body and as the vehicle should move automatically they started using Line follower robot concepts and implemented their idea on a breadboard and executed it to the defined objectives.

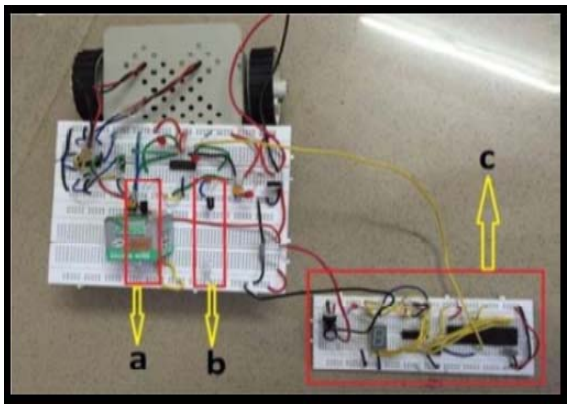


Figure f. Bread board implementation

Figure g. Final Prototype

Once the project was demonstrated the faculty group during review started exploring the constraints

present in the vehicle to carry the documents given to the robot, and suggested to remove the line on the floor and move the vehicle using IR sensors, with few more discussions of pros and cons of the project finally students decided to carry the same project with different application i.e. they started designing the robot which is suitable to carry and follow the person in the shopping malls and took the redefined objectives as their final year project and ended up in doing the AGV shown in figure g, the work done was published in reference[9]

## VI- CONCLUSION

In conclusion, experiential learning, as outlined in Kolb's theory, can be effectively implemented through Project based learning method into engineering curriculum. In order for students to practice as engineers, they need to have exposure to a number of projects that offer real-world problems, along with the complexity and uncertainty of factors that influence such problems the curriculum designed in the work is such that projects are part of each semester so that students have a good hands on experience from basic level to higher level, students can integrate their projects and carry the same project in higher semester with up gradation, as the themes defined at minor project levels are part of industry competitions students can be easily exposed to the recent technological developments as well.

The assessment strategy discussed in course project and minor project can help students to redefine their problem statements and take their ideas to product levels, the achievements in overall sectors for the academic year 2015-16 clearly indicates the success in project execution. Our results conclude that we are able to achieve better quality in paper publications, winning awards in prestigious project competitions conducted by industries and academia along with improvement in placements, Semester End Examination and addressing professional and technical outcomes of ABET.

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