INTRODUCTION OF PLM CONCEPTS IN A GRADUATE INSTRUMENTATION COURSE

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Abstract

Product Lifecycle Management (PLM) is a vital component of a company's function as it goes through various rites in passage from idea conception to development and finally to product transition. The Electronics Engineering Technology program at UNT offers undergraduate as well as graduate degrees in electronics. A graduate course in instrumentation design is offered as part of the core curriculum. It was decided to enhance the course with introduction of PLM concepts and the use of specific PLM software obtained from EDS, Inc.

The major objectives of this course are instrumentation design techniques, transducer selection, and interfacing control and measurement signals to the system. The use of graphical and structured programming techniques (LABVIEW) in the design of virtual instrument systems forms a significant portion of the course. As an enhancement to the course, PLM concepts will be introduced early in the semester. Students will be introduced to the concepts of product portfolio planning, understanding the requirements of a product, developing a project plan, scheduling various developmental tasks using a task hierarchy concept and finally, simulating the transition of the product to an improved version or phasing out of the existing product.

In order to accomplish these objectives, students will be introduced to EDS, Inc PLM software components – Unigraphics® and Teamcenter®. Unigraphics® provides an integrated and comprehensive family of total product engineering solutions that enable the user to digitally create and capture 3D product definitions. The version of Unigraphics® that will be used is particularly relevant to electronics and consumer products. It is currently used by many of the world's leading manufacturers to perform conceptual, industrial and detailed mechanical design along with engineering simulation and digital manufacturing. Teamcenter® is a software bundle that enables extended enterprises to capture, manage, access, integrate, and leverage diverse types of product information in a web-native environment, including product requirements, project data, engineering design data, parts/documents, etc.

It is our goal to provide our graduate students with a learning component that is relevant to industry as an academic qualification and also simulates the working of a typical industry environment in the classroom.

Introduction

The department of Engineering Technology at the University of North Texas (UNT) offers undergraduate and graduate degrees in electronics engineering technology. One of the core courses in the curriculum is the course on instrumentation design. The objectives of the instrumentation course are to enable the students to understand the following:
1) The theory and working of operational and instrumentation amplifiers.
2) The operation of various transducers.
3) The design and application of analog, active filters.
4) The principles of digital signal processing.
5) The application of signal conversion and interfacing with computer systems.
6) The basic principles of critical thinking, problem solving and technical proficiency in the development of meaning, purpose and argument as related to instrumentation concepts.
7) The application of computer assisted solutions to design problems.
Once the students understand the stated objectives, they will be able to participate effectively in groups with emphasis on listening, critical thinking and responding.

The learning outcomes from the course are:
1) Construct various operational amplifier configurations.
2) Apply transduction theory to signal acquisition.
3) Design various types of analog filters under specific conditions.
4) Analyze a digital filter and determine its parameters.
5) Demonstrate digital filter operation using computer simulation package such a MATLAB.
6) Design a complete I/O system using LABVIEW.
7) Interface an analog system to a computer for data acquisition in real-time.
8) Prepare class presentations that are well researched, grammatically correct and which interpret printed material relevant to instrumentation design.

It was decided to enhance the course with introduction of Product Lifecycle Management (PLM) principles. In addition to the existing laboratory exercises that fulfill the objectives of the course, it was decided to introduce a comprehensive project that would enable the students to apply PLM principles to their academic investigations. The application of PLM principles in various phases of the project would enable the instructor to simulate an industry environment in the classroom. For this reason, it was decided to make the instrumentation course, a capstone course for students pursuing the non-thesis option in their M.S. degree. Students with a thesis option can take the course and are not exempt from the comprehensive project.

Product Lifecycle Management is the term used to group all the tasks and activities required by an organization in the development of products. It is one of the four cornerstones of a corporation's IT structure. All companies needs to manage communications and information flow with its customers (Customer Resource Management) and its suppliers (Supply Chain Management) and the resources within the enterprise (Enterprise Resource Management). For a manufacturing company it must also develop, describe, manage and communicate information about its products.

In the years following World War II, managers in a wide range of settings introduced one of the great advances in modern business, the march for better, more integrated product development

[1]. From 1950 to 1980, the focus was on processes and structures that brought people, ideas, information and resources together across functions, and often across discrete organizational and geographic boundaries. From 1980 forward, the potential for better integration has emerged through information connectivity, flexible organizations and functional collaboration [1].

Over the last decade, the meaning and popularity of product lifecycle management has grown dramatically, in essence, this collaborative tool is about: information resources and knowledge management that support product development and business operations; integration between and among product developers, supply chain partners, manufacturing, marketing systems, operations, demand chain partners and other stakeholders; generating results and business value enhancement through faster and intelligent development and resource management.

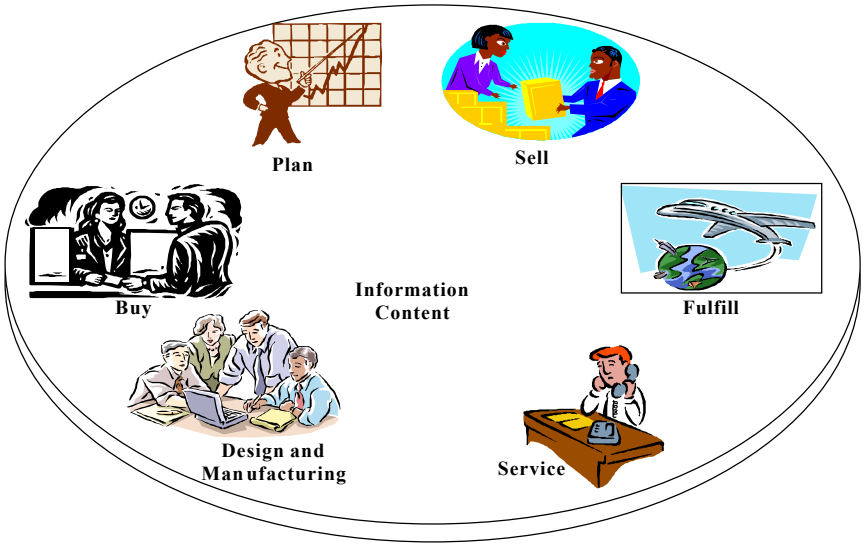

Figure 1: Various components of a business

Figure 1 shows the various components of a business. Content or data is the foundation on which the various business processes are built. Let us start first with the R&D organization. The design team makes decisions about which parts to use, how many parts are being re-used, which products to launch and when. Product lifecycle management plays an important role in the day to day functioning of the design team.

A robust PLM solution will allow the design team to collaborate with design partners, aggregate part and supplier content, manage the use and re-use of parts, plan an entire product portfolio, to get product to market quicker, at lower costs. The second business process that we address is procurement. The procurement organization makes decisions about whom they should source form, how much to source, and when. They buy, both strategic goods used for production of products, as well as the non-strategic goods like office supplies and MRO (Maintenance, Repair and Operations) products. Then we come to planning, within the planning organization, one makes strategic and tactical decisions about what to make, when, and in which facility. The sales and marketing organizations make decisions about what products to sell, at what price, and when

they will be available to customers. Within the logistics and fulfillment processes, one makes decisions when and how to ship raw materials or products to customers. The service organization is faced with decisions about balancing customer service levels while maintaining optimal levels of service resources and assets. One needs to make decisions about which replacement parts to keep in inventory, and at which locations; how to allocate and schedule service personnel to respond quickly to customer service requests, and how to deliver superior customer service while reducing overall inventory costs.

Previous work in the integration of management and engineering, to our knowledge has been focused on project management in capstone senior design courses [2,3]. Attempts to include concepts of risk management allied to product development in the form of a pre-senior design course have been reported [4]. It is also interesting to note that a two-way integration of these concepts has been attempted in a management course by adding a field project experience [5]. The electronics engineering technology program at UNT has decided to incorporate a business angle to the highly technical instrumentation course. This will be accomplished by encouraging the students to work on their design project using PLM principles used in industry. In order to facilitate this process, PLM software, worth $6.25 million, obtained from EDS, Inc., will be used in the class for the student design project.

Methods

Students in the class will be divided into groups of 3-4 and each group will be designated as a company. Each company will be required to create a website and post all relevant information such as: product description, contact numbers and email addresses, and progress report on the project and sales descriptions. Each company will be assigned a unique problem. They will be made aware of the resources at their disposal and the constraints they will need to take into consideration. The constraints could be any of the following: availability of laboratory facilities, university holidays, and non-availability of specific components and limited availability of specific software.

The students will tackle their assigned problem using the following PLM outlines:
Product portfolio planning
Requirements planning
Development scheduling
Transition Planning

Product Portfolio Planning: This is the conception stage of the product. In this phase of the product lifecycle, students would define the assigned problem in a way that would enable them to identify the design path. They will develop a plan for their design and list the features of the product under consideration. They will also develop a first pass design and use that to generate their first Bill Of Materials (BOM). They will conduct a cost analysis keeping in mind availability of components and status of the inventory. In this phase the students will break down the project into tasks and activities and develop a tentative schedule of their work breakdown structure. By the end of this phase, the students will have developed a complete dossier or portfolio on the product they plan to design.

Requirements planning: In this phase the students will plan the haves and have-nots for their products. They will use this phase of the product lifecycle to weigh the inclusion of one feature

over another and arrive at a decision to include certain features in their product design and exclude others that they deem inappropriate at that juncture. The product development is still in its conception stage.

Development scheduling: Having completed their product dossier and detailing all the requirements, the students are now ready to enter the development phase. The laboratories in the electronics program offer the following software to students to accomplish their design: PSPICE. LABVIEW, ALTERA MAX PLUS 2 and MATLAB. In this phase, each student company will use the concept of work breakdown structures to simplify their design project. The project will be broken down to tasks and activities and resources will be assigned to them. Student companies will be graded on the inclusion of the following tasks in their development stage: use of simulation software, visualization of the final product design using EDS' Unigraphics® CAM software and adherence to quality (computer aided inspection). Students will build their hardware and test their prototypes in this phase. Students will use EDS' Teamcenter® software to complete their development scheduling.

Transition Planning: In this phase of the student project, the student companies will consider an optimum time to introduce their product in the market (phase in) and also consider such actions as: re-introducing an improved version of their product in the market or gradual phase-out of their product.

We would like to emphasize that the design project in the instrumentation course is in addition to the exams, laboratory exercises and other assignments that are routinely part of an academic curriculum. Students will be given duration of 4 weeks to successfully complete their project incorporating all the stated PLM principles.

Conclusion

PLM covers all stages of a products life from concept specification, through design and manufacture to disposal. It should not be seen as a single software product but a collection of software tools integrated together. Whatever the application or software, PLM principles reinforce the product development process and need to be integrated into engineering curriculum.

We believe that this is a unique concept in the instruction of a course and will enhance our graduate curriculum and enable the students to experience typical processes that are part of industrial employment.

Students will be evaluated on the adherence to PLM principles in the completion of their project. At each phase in their product lifecycle, students will be required to provide updates on their websites. Students will be asked to schedule company meetings that will be attended by the instructor in the role of an observer. The use of PLM principles is an important part of the course, but not at the expense of technical merit. Students will be evaluated on use of simulation software, complexity of design and testing techniques. Students will be required to maintain a record of all their technical procedures and attach it to the appendix of their project report. Students will be required to submit a project report that is worthy of publication in a relevant journal.

In addition to technical merit of the project, students will be asked to evaluate their company

members on the extent of their participation and effort in the completion of the project. Students will be provided handouts on conflict resolution and teamwork. Evaluation by their peers will be taken into account in the grading process.

A project of this nature would not be complete without a presentation by students in front of their peers and faculty. Industrial advisory committees attach great significance to presentations and the ability of students to be team players. Taking this to heart, students will be required to make a formal presentation of their project and will be graded on poise, presentation skills, technical merit and interaction with audience. It is hoped that a presentation of this nature will benefit the students to round off their technical skills.

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