ENGINEERING AND PRODUCT DESIGN EDUCATION CONFERENCE
7-8 SEPTEMBER 2006, SALZBURG UNIVERSITY OF APPLIED SCIENCES, SALZBURG, AUSTRIA

INTEGRATION OF PROJECT MANAGEMENT IN THE HIGHER EDUCATION CURRICULUM

Malcolm S Willis, Walter Kaestel

ABSTRACT

In many Universities Project Management is paid lip service within Schools of Engineering & Product Design, in that a Gantt Chart is produced from which students work to enable completion of their task. This paper reflects upon work carried out to introduce a framework for teaching, and for students to experience, Project Management. The framework instills a structure, sequence and systematic understanding to allow the most appropriate techniques to be selected during the generic Product Development Cycle. A secondary, but nevertheless essential aim is an understanding of the resourcing & underpinning necessary to carry out projects successfully. The research shows an increasing complexity of techniques which are introduced at levels from introductory through to advanced techniques which may be applied from initial semesters to post-graduate study. To date these proposals have been introduced at the Heilbronn University, Kunzelsau and in part at Northumbria University and an analysis of results is presented.

Keywords: Product Development Cycle, Life Cycle Engineering, Competence.

1 INTRODUCTION

Product Development organizations exist to supply products at a profit and which satisfy a market need to an appropriate level of quality.

This may be an oversimplification but serves to establish a framework from which this paper develops.

The organization requires to coordinate activities of groups in order to achieve overall objectives. The structure of the organization serves to indicate lines of authority, responsibilities, and reflect the division of tasks. An organization should adapt and evolve and, in the context of innovation, be sufficiently flexible to cope with its more idiosyncratic and individualistic members.

The context of this paper is established through the understanding that practitioners require to be able to demonstrate capability, competence and, through their project, produce an innovative product which maximizes profits for the organization, or conversely minimizes unwanted costs. To enable them to fulfill these requirements necessitates the use of the traditional Product Development Cycle which encompasses demand, concept, detail & embodiment design, integrated with commercial & manufacturing considerations or, the contemporary Life Cycle Engineering throughout the management of the project.

Competence is understood to be:-

- Knowledge
- Skills

- Personal Characteristics

required to achieve demonstrable performance in accordance with occupational, professional and organizational competency standards.[1]
Competence is illustrated by the development of three components:-

- Knowing
- Ability to do
- Ability to adapt & apply

and these three components are introduced & "grown" through levels of junior, middle & senior project management.
Research has shown [2,3] that Life Cycle Engineering (LCE) becomes more crucial when technology changes rapidly and the Product Development Cycle becomes shorter. This has become more evident over many years and is set to continue into the foreseeable future.
With so much emphasis placed upon LCE, and the impending legislation [4] with respect to End-of-Life considerations, it has become necessary to not only build LCE into Higher Education curricula, but also to ensure that the teaching of the subject is fulfilled in such a way as to treat LCE as an integral element within the Product Development & Project Life Cycles, and not taught as separate to Business and Economics students.
Note that LCE has more to do with "Total" considerations taken during Product Development whilst Life Cycle Analysis is carried out post design & development.
These "total" considerations require right decision making at the right time which comes with understanding and competence coupled to the cost impact of those decisions.

2 THE COST CONTEXT

In many industries, there is a growing understanding of the importance of the right decision being made at the earliest possible time within the Project, specifically at the concept & development phases. These phases represent the smallest amount of overall product cost expenditure, but the effect of the right decisions being made at these stages is highly leveraged, because they have the greatest impact on the overall life cycle costs, refer to table 1.

Phase	Incurred Costs of Total	Committed Costs of Total
Conception	3-5%	40-60%
Design	5-8%	60-80%
Testing	8-10%	80-90%
Process Plan	10-15%	90-95%
Production	15-100%	95-100%

Table 1. Leveraged Effect of Design Phases in the Electronic Industry [5]

To enable the optimization of the cost of owning or using physical assets implies the realization of three groups of costs, first, the capital costs of creating the asset, second, the costs of operating & maintaining the asset during its operational life, and third, the costs of asset disposal.

A company involved in a design & manufacture project will incur the following Fixed Costs:-

- Research & Development
- Defining specifications
- Design
- Product Approval
- Manufacture
- Quality control & testing

These will be added to Variable Direct Costs of:-

- Material & components
- Manufacturing (labour content)
- Disposal or End-of-Life

and Variable Indirect Costs of:-

- Quality control & testing
- Maintenance

These three aspects of cost assessment within the design & manufacturing company essentially cover the requirements of costs of owning the physical asset since the costs of operating & maintaining should be embedded within the Product Evaluation phase of all Design & Manufacturing companies.

It is this model of a Product Development Project which forms the basis of research at Northumbria & Heilbronn Universities, or more specifically the informed decision making process within Product Development & Project Management degree programmes.

3 COURSE STRUCTURE

The proposals are initially being applied to an Electronic Product Development module on the BEng(Hons) Electronic Engineering degree at Northumbria and to Commercial and Technical courses on the bachelor degrees at Heilbronn.

The structure of the Project Management course is built around the notion of multiple levels of increasing complexity, namely:-

- Basic Level. This is a fundamental level which identifies the characteristics which must be in place for the activities to be formally identified as a Project.
- Level 1. Introductory, small scale projects associated with up to 4th semester.
- Level 2. More advanced, larger scale projects allowing students to direct their own projects up to Graduate level.
- Professional. Advanced techniques associated with a high involvement with industry. Associated with Post-graduate study.

The traditional texts of Project Management are not constructed in a level by level fashion with respect to teaching, therefore techniques needed to be identified within divisions whereby each division is attended to from level to level.

The following six generic divisions have been implemented:-

- Stakeholder. Requirements of, relationship to & communication with.
- Team Dynamics. Understanding of & capability in group dynamics.
- Organisation. Preparation for Project commencement.

- Planning & Control. Dynamics & control of the Project throughout execution.
- Money & Time. As key deliverables
- Miscellaneous. Tools necessary for students to carry out projects within Higher Education, ie Project Management software, self time management, problem solving, assessment & presentation.

3.1 Division Contents

Stakeholder

Basic Level: Customer & Stakeholder to include End-of-Life and Legislation/Legal requirements.

Requirements & specifications, expectations.

Communications & negotiations, contract & project charter.

Level 1: Change management, prioritizing objectives, stakeholder analysis.

Level 2: Metrics of satisfaction, logistics of communication, variations in contract.

Professional: High risk projects, high coordination stakeholder communications,, risk priority number minimization. Public relations.

Team Dynamics

Basic Level: 4 team membership, team leader selection & responsibility selection, commitment, meetings & team behaviour strategy.

Level 1: Negotiation of goals, identification of commercial, technical & team risk. 4-10 team membership, work techniques, leadership, team liaises with facilitator.

Level 2: Creativeness, decision analysis with respect to LCC, self organizing, team conflict & motivation.

Professional: Coordination & dynamics of >10 team members.

Organisation

Basic Level: Project Management guidelines, dynamics & content through lectures (min. 2 days)

Level 1: Role of project leader, standardization of documentation, steering committee (operated through academics). Checklist of objectives.

Level 2: PM notebook, establishment & acceptance of authority, equipped area of work establishment, cross disciplinary steering committee, product development technical steering committee.

Professional: Role play, roadmap, matrix organization hierarchies.

Planning & Control

Basic Level: Work breakdown structures, bar charts, milestones, decision analysis.

Level 1: Financial resource estimation, tracking/status over life cycle, status reports, change management, team meetings at milestones, PM software.

Level 2: Critical Path Methods, accounts, control & cashflow.

Professional: Coordination of internal & external resources, FMEA & organizational risk analysis, state/actual analysis, mind mapping.

<u>Money & Time</u>
Basic Level: Time estimation, goals & completion. Life cycle costs to IEC60300-3-3 using software. Students work on project for 1 semester minimum. Euro150
Level 1: Time management & resourcing extra time, individual cost accounts, on-line status access. 2 semester duration. Euro 1000.
Level 2: Increasing financial responsibility, sensitivity analysis during decision making with respect to LCE. Euro 10000.
Professional: Concentrates more upon efficiency, effectiveness & control of projects. >3 semesters duration.

<u>Miscellaneous</u>
Basic Level: Lessons learned at project closedown, documentation for follow-on projects, presentation.
Level 1: Poster presentation of results & good practice, benchmarking with industrial projects.
Level 2: Project Management software eg Microsoft Project or Prince, procurement techniques & strategies.
Professional: Problem analysis techniques, project management assessments and awards.

In todays Higher Education many students may well enter the Institutions at a level other than basic, and therefore there will require to be a degree of flexibility within the content to ensure each subsequent level is sufficiently underpinned. This of course may be carried out through a short programme of "bridging studies" in conjunction with other subject matter eg Manufacturing Systems, Thermodynamics or other as is the case at Northumbria.
It is felt by the authors that assessment is best carried-out through continuous assessment rather than a summative examination due to the developmental nature of the subject matter. This then provides students the opportunity for feedback, self development and creates a more dynamic learning environment.

4 RESULTS

The original concept behind the course structure was put together some two years ago and is in the process of "rippling" through the implementation stage at both Universities. Therefore the results should be interpreted as fluid and dynamic.
All divisions at both Universities at Basic and Level 1 have been largely achieved.
The steering committee philosophy has proved difficult to implement as it is regarded as being a departure from current academic structure. Planning & Control at Heilbronn wasn't fully implemented at Level 1 as project work is limited to 1 semester, this wasn't the case at Northumbria as Electronic Product Development is a 2 semester module.
Funding limits the delivery of large projects at both Universities and LCC is largely implemented at Northumbria using Relex Software Sensitivity Analysis during decision making.

5 SUMMARY

Much work has been implemented and will continue to be implemented to Professional Level in due course.
However key concerns have been raised:

- Lack of financial resource to run projects to Professional Level. Much of the funding for this must be sought from industry, and the biggest drawback of this is convincing industry of the quality of students at the appropriate academic level.
- Higher Education Institutions need to adapt to the substantial benefits to be achieved, educationally through students learning through projects.
- Every effort must be made to instill the necessity for a "macro" viewpoint being developed within students to integrate LCE within project and product development work. A blinkered approach to learning is still evident.

REFERENCES

[1] Turner J.R., Developing Competence of Project Management, *Project Management Today,* Vol. 17, Issue 8, August 2005, pp8-14.

[2] Kawauchi Y. and Rausand M., Life Cycle Cost Analysis. *Oil & Chemical Process Industries.* 1999.

[3] Burnstein, Life Cycle Analysis & Product Costing, *Life Cycle as a Concept*, 1988.

[4] Industrial council for Electronic Equipment Recycle, March 2005

[5] Shina S G, *Concurrent Engineering of Electronic Products*, Van Nostrand Reinhold, 1991

CONTACT

Malcolm Willis
Northumbria University
School of Computing, Engineering & Information Sciences
Ellison Place
Newcastle upon Tyne
England NE1 8ST
Malcolm.Willis@UNN.ac.uk

Walter Kaestel
Hochschule fur Technik und Wirtschaft
Standort Kunzelsau, Daimlerstrasse 35
74653 Kunzelsau, Germany
Kaestel@hs-heilbronn.de