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Dis-Integration from unitisation

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Abstract
This paper investigates the dis-integrative effects of unitisation/modularisation on the so called integrative and application orientated topics of Engineering Applications, and suggests possible solutions to the identified problems.

Within the main aims of increasing student choice, providing flexibility and enhancing credit accumulation and transfer, many Universities have unitised their courses. In addition most University engineering departments are accredited by the relevant professional body which requires courses to provide a specified minimum of hours to ‘core’ units which has resulted in an overall reduction in hours given over to units which provide for the applications of those core units thus providing for a Total Engineering education. To resolve this problem requires departments to discover new ways of implementing the ideas of Total Engineering in a Total Teaching way. The paper looks at ways of increasing different modes of teaching within a traditional Electronic Engineering degree course. It is suggested that within an educational world of diminishing staff resources directed study and open-access facilities must be fully utilised.

Introduction
It has been some time since the Finniston Report suggested that the education of engineers fell short of that required by only teaching fundamental core subjects. To complement this shortfall he suggested the adoption of Engineering Applications, conveniently referred to as EA1 & EA2, where EA1 concerned itself with an understanding of materials, components and other resources, their uses and limitations; and EA2 concerned itself with the application of materials, components and fundamental knowledge to solve real world engineering problems in an integrated way, figure 1. The intention of Finniston, within EA2, was for students to experience the true conjunction of not only being able to turn theory into practice but also to experience the impact of the true development process from Market Need, Planning, Costing, Design for (X), Quality & Reliability, Production etc. All institutions of higher education requiring accreditation of the major engineering institutions were required to restructure courses to build in a continuous thread of E.A. running throughout their courses. Not to do so implied academic suicide to those departments aspiring to teach to professional engineer level.

To this end institutions of higher education will now encompass not only those elements of the true development process but also elements designed to develop the full potential of the student and their preparation for employment through the development of enterprise, competencies and personal skills. These elements can, for convenience, be grouped as Core Abilities as follows:
- Effective communication
- Managing and applying intellect
- Working with others
- Self management

Since the implementation of the Finniston recommendations many institutions of higher education (IHE’s) have Modularised or Unitised their courses to satisfy an ever changing market-place and shrinking resources. Such courses, within the National CATS scheme, now consist of nominally 12 units of 10 credit points in each of three levels (equating to the old style three years of academic study) giving a degree requirement of 360 credit points. The perceived advantages of such a structure are many and varied:
- Student mobility
- Increase in student choice
- Flexible modes of study
- Rationalisation of units
• Realisation of academic time for research
• Utilisation of resources
• Course structure standardisation

Context
The University of Northumbria at Newcastle (UNN) runs a full time/thick sandwich course BEng(Hons) Electrical & Electronic Engineering which is accredited by the Institution of Electrical Engineers giving full exemption from the academic requirements for corporate membership. This course reflects the ever increasing demand for Professional Engineers at first degree level with a broad range of expertise in the Electrical & Electronic fields, skilled in Management and Business Studies, Manufacturing and Operational Engineering and the aforementioned Core Abilities. Whilst there is a element of option choice at the final level, great emphasis is placed upon providing industry with Engineers adaptable for a wide variety of functions within the Electrical & Electronic Industrial market-place.

If one were to endeavour to identify subject matter threads running through the course then the following could be identified:
• Electronic Engineering
• Power (Electrical & Electronic)
• Control & Instrumentation
• Computing & Software Engineering
• Signal Processing & Circuit Theory
• EA (inc. Management, Business, Projects & Case Studies)

This industrial demand may be regarded as reasonable since an engineer may be required to revisit ‘engineering’ topics from time to time. Whilst some engineers will spend much of their lives in this engineering work, others may, in light of their career prospects, be expected to operate within wider cultural and management matters.

Problem Identification
Since two of the aims of unitisation were to provide:
• Student Mobility
• Increase in student choice
then each unit, regardless of level, should as far as possible be self contained.

This inherently constrains unit designers into supplying unit descriptors which are free from interdependency and integration. This approach does not lend itself to the broader philosophy of Finniston and the industrial requirement of Total Design and Concurrent Engineering without a radical change to the current methods of engineer education.

It would not be argued in academic circles that the acquisition of analytical skills and practical skills in electronic sciences is paramount in the design activity system. However, this is only partial design, in that to succeed in today’s market requires a rigour of the highest level which encompasses design, engineering, commercial awareness, process awareness, people awareness and organisational abilities. The combination of these rigours is what has
become known as Total Design. To ensure this message comes across to aspiring engineers with minimal culture shock in the transition from academia to industry requires that IHE’s adopt Total Engineering Education. The crux of this problem is that the process Totality must be integrated in a synchronised way which is at odds with the ‘free-standing’ requirement of unitisation. Ways must therefore be found to compress the process Totality into unitisation blocks of teaching.

An Analysis of Learning

In order to identify which mode(s) of teaching to adopt to resolve the identified problems requires an initial analysis of how students learn. In a study regarding learning several questions were posed to students, the following is an abbreviated set of results.

How Students Learn
- Wanting to Learn (motivation, thirst for knowledge)
- Learning by Doing (practice, hands-on approach)
- Learning from Feedback (others comments, seeing results)
- Digesting (absorbing, making sense of)

Where & When Students Learn
- At their ‘Own Pace’
- At times and places of their ‘Own Choosing’
- With others or their ‘Peers’
- When they feel ‘In Control’

Learning can be Independent when academics facilitate as follows
- Providing students with ‘Resources’
- Whetting appetites, ‘Inspiring & Motivating’
- Providing a means of ‘Self Testing students Learning’
- Giving feedback on ‘Progress’
- Assisting students in ‘Understanding what they have Learned’

What are Student Peer roles
- Maintaining a sense of ‘Perspective’
- ‘Clarifying Understanding’ to one another
- ‘Decision Making regarding resources & processes
- ‘Learning from others mistakes’

Although the above results are a distillation of the total research it is apparent that students tend to learn independently more than they do by lecture or other ‘driven’ mode. It is also very apparent that, at a time when staff-student ratios are higher than was and the unit of resource is continuing to reduce, emphasis should be placed more on the learning of students rather than the solely on the quality of teaching.

If one considers the cross-boundary remit of EA2 then it could be argued that not only efficiency of teaching but also effectiveness of learning becomes of prime importance to ensure the motivation of students remains at a high level. It becomes evident that Project-based teaching is a most suitable vehicle for the teaching of EA activities, however as EA1 is essentially a free-standing unit which underpins EA2 activities then it must be carried out sequentially prior to EA2 activities. A suggested sequence is as follows:

By way of a reminder, this course is a traditional Electrical & Electronic Engineering course and the above topics are to be built in to an already time constrained syllabus, it is not a course in Design nor Manufacturing Systems Engineering. The project is an exercise in Electronic Product Development whereby teams of six students work toward producing a product with an identifiable market.

Each student takes up an individual responsibility:
- Team leader/Marketing
- Circuit development
- Printed circuit board development
- Costing
- Unit design
- Technology development
In its present format the project may be looked upon as directed study whereby students project manage their own progress and learning, hence it satisfies the requirements for independent learning and therefore proves to be an effective teaching mechanism. Resourcing or facilitating becomes an ever important element in all mechanisms of this sort. Resourcing within this context may be looked upon as consisting of three main elements:

- Materials
- Facilities
- Academic/Technical support

All project work or indeed practical work inherently involves some aspect of materialistic support and group work tends to minimise the outlay. Facilities, however, within the context of Concurrent Engineering and Total Design, need to be available from the concept of the project throughout to completion. It may then be argued that the most efficient way of implementing this requirement is to ‘open access’ those facilities with day to day technician support in the role of demonstrator and equipment trouble-shooter. Academic support would be to facilitate learning and would necessarily take the form of consultancy to the project team. It is important to realise at this stage that the academic support must be cross-departmental due to the nature of the EA2 project.

The project and its accompanying topics at Level 2 are an idealistic way of presenting one years worth of academic study. In practice, these topics would be split into two semesters worth of activity, namely:

The problem now arises when one is forced, via unitisation, to ‘fit’ a not insubstantial quantity of material into semester 1, and yet allow students to effectively learn that material. Traditionally this would have been carried out by lecture together with its inherent low levels of effectiveness. Semester 2 possesses similar problems but is not so acute, in that, the major problem is not one of teaching method but one of time available to the students to fulfil the requirements of the project. The experiences at UNN relative to this problem is that giving the students open access to laboratories on a ‘9-till-9’ basis does resolve the problem, since these students working in project mode tend to possess a high degree of motivation compared to the same students in lecture mode. The semester 1 topics could of course be taught in project mode but would not covered within the limitations presented by unitisation. An alternative mode of teaching would be directed study. The interpretation of directed study in this context is not a case of ‘...here is a set text, go away and read it’, it is more a case of framing the directed activity in case study format with activities for the student to carry out Holistically or within the philosophy of Total Design.

Conclusion

Unitisation, certainly within the short-term is here to stay but market demands must be seen to be accommodated. To this end integrative EA units need to be designed with prime learning outcomes reflecting the unit title, with secondary learning outcomes reflecting the interdependent nature of the unit. In addition, to take on board resourcing requirements the teaching mode must, in as far as possible, be open access laboratories under directed study. This paper intended to provoke discussion regarding the resourcing of teaching within higher education, more specifically Electronic Engineering using as a vehicle the teaching of EA and Product Design and Development, as it is in this area where the demands of resourcing, industry, along with the relevant professional bodies collide. It is perhaps worthwhile concluding by reflecting upon the role & responsibilities of
the Chartered Engineer, which draws home the integrative nature of engineering education which unitisation seeks to disintegrate:

Chartered engineers are concerned with the progress of technology through innovation, creativity and change and should be able to develop and apply new technologies, promote advanced designs, introduce new and more efficient production techniques, marketing and construction concepts and pioneer new engineering services and management methods. They need the ability to supervise others and in due time the maturity to assume responsibility for the direction of important tasks.

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