VPs Motivate a New Degree Programme in Engineering Design

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1. Introduction

We at Bristol have been very fortunate in having our Visiting Professors sponsored by Charter plc and The Royal Academy for the last ten years. Our group of VPs have been exceptional, over the years the following have contributed: Roland Bertodo, Robin Brown, Jeremy Davies, Chris Elliott, Horst Peters, Mike Shears, Ted Talbot. We are very grateful to the companies who provided such excellent VPs namely: AIRBUS, Arup, British Aerospace, Charter, Computer Sciences Corp and Rover.

The group of VPs developed the idea that Bristol could and should put on a new degree course that would help to satisfy the some of the needs of the British Engineering Industry. This paper will describe the goals that they set and some of the ideas that have flowed from the University of Bristol's attempt to reach them.

2. Goals

In 1997 Professor Chris Elliott wrote a paper, which proposed "An Elite Course in Engineering Design" which would educate future leaders of industry by:

1. Attracting and engaging the enthusiasm of the best students, including those who might otherwise have been lost to Engineering.
2. Providing a strong base in mathematics and theory
3. Using design exercises to set theory in context
4. Including all engineering disciplines but students treating one in depth.

The VPs went further and suggested a key set of studies that the students should follow:

5. Mathematics – including control and signal processing
6. Physics – including the properties of materials and surface chemistry
7. Structural mechanics and dynamics
8. Fluid dynamics and thermodynamics
9. Electronic design and software design

10. The use of computer tools in design – including CAD, FEM and simulation
11. Management

The group at the University, who were enthusiastic to support this initiative, first thought that, starting from the departmental model that Bristol boasts, it would be very difficult to implement but £500,000 would do it! We did not get the money but we got a lot of support from The Royal Academy and recruited a set of companies who wanted to go ahead with the idea and promised support namely: ABB, AIRBUS, ARUP, BT, Corus, GKN, GlaxoSmithKline, Hewlett Packard, Motorola, Renishaw, RHM Technology, Rolls Royce and WS Atkins.

3. Implementation

The design fraternity will not need to be told that goals for a design and its realisation are not the same. Some parts of the goals may prove unrealisable and, while thinking about realisation, new ideas come up that may enhance the product beyond that which was originally conceived. It will be another four years before we really know how good the product is – but the signs are good. In this paper it is impossible to discuss all the implementation, so we present just a few of the ideas and problems.

We are aiming to: "Include all engineering disciplines but allow students to treat one in depth"[4]. This creates special difficulties for a university where we have separate degrees in Aero, Mechanical, Electrical and Civil Engineering as well as Engineering Mathematics and Computer Science. The new degree is providing a motive force for the Engineering Faculty to rationalise its teaching of Engineering Science. As a first step we have a set up a new course unit called Engineering Physics, which provides the basics of materials and classical mechanics, with applications to engineering. Conceptually we would like this course to expand to cover all of Engineering Physics including the physics of electrical, fluid and heat systems, but you cannot move the academic world that fast. There are already excellent courses on Thermodynamics and Fluids as well as Electrical Systems given by different departments and we use them. To satisfy the goal that students should treat one discipline in depth we have set up a set of specialisations:

- Aerodynamics & Propulsion
- Communications Engineering
- Design Information Systems
- Dynamical Systems Modelling
- Embedded Computer Systems
- Materials
- Systems & Control
- Industrial Electronics
- Process Engineering
- Software Engineering

[4] The indices relate to the goals numbered in section 2.

- Structural Engineering
- Structural Mechanics
- Water Resource Engineering

Students will select and follow one of these from year 2 onwards, spending a third of each of these years on their specialist subject.

The Degree title and Goals 3,9 and 10 are all about Design. In year 1 we have a series of different design case studies given by lecturers from different disciplines. These case studies fulfill two functions. They provide an introduction to some of the different disciplines that the students can later select as their specialization and secondly they involve the students in a design activity showing how design is done across several quite different subject areas. We are trying to provide an overall model of design using the Unified Modelling Language, UML, but this means trying to involve academics in a strange new world of design modeling.

In year 2 there are 50credits out of 120 spent on design. We will teach the students design representation as practised in all the engineering disciplines and give them small projects upon which to practise followed by a larger interdisciplinary design project to be done as a group exercise.

You will appreciate that this course is quite demanding as the students are expected to understand the basics of several different engineering disciplines, learn about design representations appropriate to several disciplines and then specialise in one sub-area. Worse than that, they must attend courses that are given for students who spend nearly all their time as specialists . We hope to alleviate the strain on the students by two devices. The course is 5 years long with the third year spend in one of the sponsoring companies working close to their chosen specialisation. During the year in industry students will learn more about their special subject and deepen their understanding of engineering basics with help from the university. The second device is a special course unit called "Research & Communication", of which more later.

In the fourth and fifth years of this course, after the students return from a year in industry, we propose to set up large team-based multi-disciplinary design projects that are sponsored by our partner companies. These team based activities offer an opportunity to be closer to real world team work as the students each have their own specialization, whilst in normal university projects all the students have studied roughly the same courses. These projects are going to be a very challenging for both staff and students, we are fortunate in having an outstanding competent ex industrialist to help us. Bristol University has just started developing two large new laboratories specifically for dealing with large scale multi-disciplinary dynamic projects. The BLADE (Bristol Laboratory for Advanced Dynamic Engineering) project is just one of several research developments that will be coming on stream over the next few years. This will provide marvelous opportunities for multi-disciplinary projects and for the sponsoring companies to exploit the new laboratories and associated skill sets.

We are trying to form leaders[1] for the Engineering Industry. Leaders need to have the 'right' personality, we are not sure what that is, but normally can recognise what it isn't. Our sponsoring companies have agreed to help in the task of choosing students for this degree and we have developed with our partner companies' help, quite a sophisticated system of selection.

Leaders need to have good critical skills not only for their own work but for other people's work. Skills of criticism can be developed but only if there is a firm foundation of understanding[2]. The nature of university courses is that students who have taken a course unit and passed it (40%) cannot be re-examined on the same material unless it is included in a following course unit. We all know that students often leave university without understanding all the fundamentals of their courses – so we have invented a course unit that includes a follow up on all key understandings. The Unit is called "Research & Communication". The name comes from the idea that you cannot be a leader if you are not good at finding things out and communicating the results of your thinking.

Finding suitable questions to test students understanding is difficult and we should be very grateful for any help from VPs and other university staff. We could add this as another resource that The Royal Academy offers to support UK Design.

Perhaps we have invented a marvellous new formula for education. We ask the students what they find difficult or don't understand; get each student to investigate one of the subjects, write a short paper and then teach the other students. Finally a set of questions is written by the students to test if the other students have understood. This approach will not be sufficient to fulfil the requirement; but the students seem to enjoy it and, as we all know, 'If you want to understand something, try and teach it'.

4. Summary

The Engineering Design course at Bristol is less than a year old; however we have succeeded in attracting some very bright students, satisfying goal 1. Through our industrial style selection process the students are a cohesive group and seem to be enjoying the course despite the hard pace. We have placed all the students in industry for summer placements – mainly with our partner companies. They will return to university richer and with a greater understanding of Engineering, ready to face the challenges that both they and the academic staff will have as we continue to develop this challenging new degree.

[1] The indices relate to the numbered goals in section 2.