

VISITING PROFESSORS IN PRINCIPLES OF ENGINEERING DESIGN

A discussion paper based on a review of 1998 responses from participating universities and reports of audit visits in 1997/98

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Executive Summary

So many in society at large take for granted that they have access to power, water, the telephone, radio, television, newspapers, books, computers, e-mail, the motor car, air and rail travel, washing machines and refrigerators, without often realising that it was the engineer who was the source of all these, and many more things, that have improved and enhanced their lives. In the same way it is often not recognised that engineering creativity and design has given rise to many of the great advances in medicine and health care, agriculture and food production and processing, environmental protection, sanitation and water supply, rural energy supply, poverty relief and education.

With all the evidence, it might be supposed that it is not necessary to persuade anyone that engineering is fundamentally important to the life expectancy and quality of life of all those that live on this planet. Unfortunately, experience tells us otherwise, and the “enthusing” and “exciting” should start at the time that appropriately talented young people are making choices that will set them on a path to a fulfilling and rewarding career.

Increasingly, young people want a career that will enable them to make a contribution to the well being of the inhabitants of the planet. They are aware of the need to reduce the number of people that live in poverty, to make progress to gender equality, to create growth and wealth that are sustainable and to provide access to health services and education. Engineering more than any other discipline is the “glue” that links sustainable and environmentally acceptable growth to the demands of the inhabitants of both the developed and developing world.

The Royal Academy of Engineering Visiting Professor [VP] scheme is just one contribution to the process that enables engineering educators and employers to create an environment that attracts appropriately gifted young people to the profession and continues to excite and motivate them through the early part of their career.

This report reviews the results of the scheme that has provided funding for about 140 Visiting Professors at 44 Universities throughout the United Kingdom since it began operation in 1989. The reports from 30 Universities and from 11 recent audit visits have demonstrated that the scheme was considered to be an extremely important and successful step in integrating the skills, enthusiasms and resources of students, academic staff and potential industrial employers.

The report finds that a VP scheme can provide the opportunity and the resource to excite, enthuse and motivate the students and staff of the University about the value of the work carried out by engineers and about the exciting and varied careers that engineers pursue. It can also be used to have an impact on the perceptions of the wider community and most importantly on the schools and their students and careers advisors, and on potential employers.

The role of a VP should include the remit to work with full time staff to arrange visits and workshops. The workshops provide the opportunity for visiting lecturers and staff to give examples and overviews of the impact of engineering on communications, information technology, media, water supplies, transportation, medicine and on other matters which are important to young people in the 21st century. Such events could be modelled on The Annual Lectures at the Royal Institution. The best of these will be of an inter - disciplinary nature and demonstrate the linkages that will often exist in the creative process of design, between different branches of engineering and other disciplines.

This activity should complement a strategy that has, as one of its priorities, the development of working relationships with outside organisations that employ the skills of engineers. These relationships should be seen as a resource for the identification of challenging and real projects which students will recognise as of value to society. Some of the best Business schools for example arrange for their students to work as teams with various types of business enterprise to work on real business problems.

As an example of a VP-led university - industry collaboration, details are given in Appendix 1 of The University of Strathclyde Product Development Partnership Scheme. Such relationships, successfully carried forward, provide an opportunity to enhance the reputation of the University, the quality of its teachers and students and of engineering in general. As in any other enterprise, success breeds success, and it is then more likely that the university will attract larger numbers of entrants to its courses and more support from the community it serves.

Some Business schools again provide a model for the way in which they work with potential employers of their graduates. The best business schools are able to provide placements for all students for working experience and /or project work [depending on the length of the course] during the course, and the demand for their graduates will be manifested by six or more offers of employment being made to each graduate. In a similar way, engineering schools should identify the range of potential business, commercial and government users of the skills they have to offer and seek to build networks with employers that will lead to rewarding employment for their graduates. Good graduates, doing good things for employers, will enhance the reputation of those universities that make the effort. The VP's role should include a remit to work with full time university staff to develop and nurture these relationships.

Section 3 of the report summarises the key observations made by Universities that participated in the scheme and these have been used in Section 4 in an attempt to suggest some "Best Practice" guidelines that may be used in employing Visiting Professors from industry.

1 Introduction

In the period May 1997 to August 1998, The Academy made formal visits to about a quarter of the universities participating in the Visiting Professor Scheme. These visits confirmed that the scheme was achieving much of what had been expected but identified a number of improvements that could be made to make the scheme more effective. In order to seek further inputs that might identify ways, in which the scheme could be further improved, feedback was also sought by way of a brief written report, from the forty-four Universities participating. The thirty reports received, taken together with reports prepared by The Academy following the series of audit visits to eleven of the participating Universities have now been reviewed in order to update the report "Visiting Professors in Principles of Engineering Design-Interim Report: May 1994". **In particular it is the aim of this report to identify those elements of the VP scheme that might help to define a "Best Practice Guide" to participants.**

2 The reports from The Universities

The letter from The Academy sent to participating Universities in August 1998, asked respondents to summarise the major accomplishments of the VP scheme, and to highlight any problem areas that had impeded the achievements of the objectives that had been established. As indicators of the range of issues that had been identified in the course of the audit visits, the following list was provided to help prompt a response.

- Co-ordination between the VP's
- Contacts between the VP's and first year students
- Contributions made by the VP's [including their attendance record], and the impact upon this of both travelling distance and changes in personal circumstances
- Inter-discipline teaching [and how much had taken place] and how the VP's had contributed to this
- Impact of VP's on changes to course content
- Impact of VP's on facilitating site visits for students
- Support for the VP's from industrial colleagues that may be more closely involved in day to day design activities
- The desirability [and existence] of formal written terms of reference and job specifications for the VP's

As expected, the reports received illustrated the many different ways in which the VP scheme has been used in an attempt to achieve broadly similar aims. They also report a range of experiences that reflect the different constraints particular to each institution and the availability and experience of the Visiting Professors.

3 Observations made in the University reports

The following list of observations made in the 30 University reports is provided as a means of assisting the identification of some common themes that may be used to guide the manner in which the VP scheme can be deployed to optimum effect. This section highlights some of the problems encountered in a generally highly successful scheme.

3.1 VP Availability. VP's are usually very busy people with other professional commitments, at a very senior level. The limited availability and other diary commitments of the VP's can frequently result in difficulties in co-ordinating their input with often rigid academic timetables. Some universities had foreseen this potential constraint and been able to devise a strategy to make best use of the VP's to accomplish the goals of the VP scheme.

3.2 Distance of VP's from the University. In general, and not surprisingly, it has been found that when a VP lives and works in close proximity to the University, it is more likely that the timetable can be arranged to include the VP in various activities relevant to the scheme's aims. Where a long journey is necessary, the VP might find it difficult to justify spending an entire day out of his office in order to give a one hour lecture, to attend a meeting or to provide supervision for a student project.

3.3 Time tabling. A common observation closely connected to those above, is that academic timetables are often inflexible. Those Universities that appear to operate the most effective VP schemes would appear to have recognised that this would be a constraint, and have devised programmes to use the VP's to take account of timetable constraints and the availability of their VP's.

3.4 Site visits and projects with industry. One of the often quoted aims of the VP scheme is to use the VP's to increase the number of site visits for students and to identify opportunities for students to work on projects outside the University environment. The reports suggest that this was often not the case. Reasons given for the failure to meet this expectation, include the shortage of financial and academic resource, the shortage of time of "busy" VP's, and time tabling difficulties.

3.5 Quality and Quantity of Input from VP's. The quality and quantity of input from VP's are reported as very variable. When the scheme was last subjected to detailed audit, it was found that the average VP input was 16 days per year, with a typical range of 10 –20 days. Frequently the VP's selected hold senior appointments elsewhere and their commitments to the University have had to take lower priority, with consequent disruptions to schedules. Where disappointments have been experienced, it was often because the VP has not acknowledged and recognised the commitment he has taken on and/or because the University has not defined a role for the VP that could be realistically filled.

3.6 Remuneration.

Many of the participating Universities have used some of the funds provided by the RAEng to provide an honorarium for the VP and also to pay for travel and accommodation costs. In other cases it seems that Universities may expect the VP to work without an honorarium, and in addition expect the VP's company to provide benefits in kind to the University. This issue is obviously most acute if the VP is either self-employed or works for a small company. A participating University should carefully consider their working and financial relationship with the VP and his/her company. The enthusiasm and commitment of both the VP and their employer might wane, if over a period of time they can see no value in the relationship. The most effective schemes are most likely to result from relationships that are of benefit to the VP and his employer as well as the University.

3.7 Formal Participation

It is generally accepted that, if VP's are to fulfil their role, they need to be integrated into the departments and faculties concerned, such that full time academic staff consider them as colleagues able to make a real and valued contribution. Various ways have been found to do this. They include the involvement of the VP's in:

- Design Forum where VP's are members [or Chairmen] of a group which include academic staff from the Department concerned and from other departments in other faculties where multi-disciplinary design teaching is taking place, Heads of Departments and Deans of Faculties.
- VP Forums where all the VP's in a University meet to co-ordinate their activities.
- Departmental and Faculty groups where VP's can provide inputs to curriculum design, teaching strategy, the establishment of new courses, design workshops and seminars, tutorial and project policy, site visit initiatives etc.

VP's must be able to meet on a regular basis with Heads of Departments and other academic staff in one or more of the ways described and it is evident from the reports that in some cases this opportunity is not provided.

3.8 Awareness and publicity

In some cases it would seem that the VP scheme operating in some Universities has been little publicised, so that some students are not aware of its existence or of the role that the VP's might play in their education. In other cases, the scheme may only be known to members of a particular department and not to other departments in a faculty or to other faculties. In such circumstances it is unlikely that a multi disciplinary approach to design will be/or become a reality.

3.9 Enthusing and exciting

In some Institutions visited, it was said that Students found it easier to ask questions of VP's and that they were more approachable than staff members were. It has also been observed that academic staff value regular interaction with VP's to be a valuable learning experience. One can conclude from such observations that one of the most valuable inputs a VP can make is to enthuse and excite both academic staff and students about engineering and design. VP's can do this in a variety of ways that include project supervision, tutorials, formal and informal seminars and workshops, and site visits. In many cases, 1st and 2nd year students are not exposed to VP's, and this would seem to be a wasted opportunity. A formal or "informal" talk from a VP could be used to introduce students to the challenges and excitement offered by engineering and by various means explain the relevance of the course they are about to take to the "real" world of engineering. Such talks should be motivational and rely on the practical experience and knowledge of the VP so that it would involve minimum preparation and could be time tabled to suit the VP.

3.10 Definition of the role of the VP

Though it is commonly observed that no written job specification has been prepared for VP's, it would seem that the most effective schemes have made strenuous attempts to define clear aims and then to define clear roles for the VP's. It would seem that it has been easier to motivate staff, students and VP's where there has been a single focus to the VP programme. Examples of such programmes are given in Appendix 1 to this report.

4 Some Best Practice Guidelines

The Academy scheme enables distinguished senior engineers in business to work with their academic colleagues to provide a bridge for undergraduates from education to industry. Their role is to demonstrate and transmit to students and staff that design is the integrating theme in all the engineering disciplines within the University. Beyond this, there has been no blueprint. To date, each participating University has joined the scheme with a well-founded proposal and each has been experimenting to find the best way of harnessing the resources and expertise of its Visiting Professors to suit its particular requirements. In the ten years since the scheme was first

implemented [with eight professors in four universities in September 1989], it is now possible at least to identify some guidelines that may be used in order to increase the possibility of a successful outcome for any particular university VP scheme. A review of the reports received from 30 universities in 1998, taken together with the reports of audit visits to 11 universities in 1997 and 1998, have been used to summarise guidelines under the headings that follow.

4.1 The preferred qualities of a VP

- 4.1.1 The VP's should be highly regarded in their field of expertise, have sufficient time to devote to the post, and be required to make a contribution that is well matched to their particular interests and expertise.
- 4.1.2 In this regard, one of the primary objectives of this scheme is to encourage ***Inter - disciplinary*** teaching. It is therefore essential that all VP's are capable of reaching students in disciplines other than those in which they may be particularly experienced.
- 4.1.3 Candidates who can offer the services of engineering designers from their organisations as visiting lecturers, to support their own efforts, should be particularly welcomed.
- 4.1.4 It is important that the VP's are accepted fully by the Department and Faculty in which they are to work. One way of ensuring that the staff are "signed on" is to ensure that nominations are sought widely and vetted carefully by a Departmental or Faculty Board on which the staff are represented. The selection process should be designed to ensure also that those selected have the skills and experience that will provide a balance with and be complementary to those of the full time academic staff.
- 4.1.5 The process of selecting VP's is of course in many ways similar to the task of selecting any other member of staff in any organisation. It is best carried out only when the organisation knows what goals it wishes to accomplish, has prepared a plan to achieve its objectives, and has defined the roles and skills required of the team they wish to accomplish these goals.
- 4.1.6 It will almost always be the case that VP's who live and work close to the university in which they will work, will more easily be able to meet the commitments they take on. It would also be an advantage if the VP's employer is pursuing a business that makes it more likely they will see some mutual benefit in supporting the work of the VP's, in terms of the time they and any support staff are committing to the university.

4.2 Relationships

As previously stated it is fundamentally important to integrate the VP's into the departments and faculty in which they work so that they are considered by other staff to be part of "the Team". Universities have found different ways to ensure that integration takes place. Those commended, include:

- VP membership [or Chairmanship] of Design Forum that include full time academic staff, Heads of Departments, and Deans.
- VP's Forums where all the VP's in a University can meet to discuss issues.
- Membership of other Departmental and Faculty Groups where VP's can give input to curriculum design, the establishment of new courses, design workshops and seminars, tutorial and project policy, site visit initiatives etc.

If the university is to gain fully from the experience and the network that a well-chosen VP can provide, it is important to give some emphasis to developing mutually beneficial relationships with industry. If this is well done, it is more likely that “real” design projects can be identified, that additional resources and inputs will be made by industry, and that more site visits and working secondment opportunities will occur. Good working relationships with industry are also likely to provide career opportunities for graduates. It is therefore important to design a VP scheme that will give VP’s a primary role in developing such relationships. If product design projects are carried out with the co-operation of industrial partners and sponsors, the VP’s can play a major role in guiding, reviewing and helping to supervise work and to act as a link with the industrial sponsors.

It is also fundamentally important that VP’s are used to enthuse and excite both staff and students about the importance of engineering design. Their practical and commercial experiences should be a resource which universities can use so that all students are exposed to the career possibilities that lie ahead for engineering designers. In this respect it is imperative that *first* and *second* year students should have contact with and be addressed by VP’s. It is in these years, where there is an emphasis on analysis and “number crunching”, that enthusiasm for engineering has been seen to wane in ways that seriously impact on the profession’s access to high quality graduates who may start to be attracted to other careers once they have graduated. VP’s should be given the opportunity via specialist lectures, workshops and seminars to relate their experience in appropriate ways. Where possible the VP’s network should be utilised to identify worthwhile and appropriate site visits.

4.3 Optimising the use of the VP resource

Many different ways of using the resource of a VP have been identified in the nine years that the scheme has been operating. It is therefore not sensible to be prescriptive in defining the best way of using a VP. It will obviously depend very much on the particular goals and objectives of a particular department or faculty, the resources they already have and the skills, experience and network of the VP who they have selected to be a member of their team. As a general guide, it is however possible to suggest the following;

- The VP’s should not be required to deliver core design teaching. This should be the duty of full-time staff.
- A role should be defined that uses the expertise of the VP’s in areas selected to complement those of the full time members of the academic team in order to meet well-thought out objectives. Such areas might include:
 - Developing policy
 - Designing and developing curriculum and new courses
 - Reviewing design teaching
 - Giving specialist lectures and seminars
 - Giving “motivational” talks to students [particularly in their 1st year] and staff
 - Helping to set up and supervising design projects
 - Networking with industry for “a purpose” e.g. to identify and develop relationships that will provide practical design problems for projects that industry would support.
 - Contributing to research strategy
 - Organising or facilitating the visit of other engineers from industry to give specialist lectures
 - Supporting staff in special initiatives [e.g. the organisation of workshops, seminars and conferences to “advertise” the skills and resources available to local industry and by this

means attract further support from industry, encourage industrial - academic partnerships and develop career opportunities for graduates]

- Identifying opportunities for academic staff to collaborate with industry
- Identifying suitable topics to attract research funding for engineering design in the department.

4.4 Publicity

If students, the department, the faculty, the wider university, local industry, commerce and schools are to be persuaded of the importance of engineering design in particular and the beneficial impact on society of engineering in general, it is clearly important to use the VP scheme as a vehicle to publicise the work of the university. This can be accomplished in a variety of ways. As a minimum, it might be expected that the department, faculty and university use all their regular publications to give details of the scheme and include a description of what they expect to accomplish, and give brief details of the VP's and their employer's. Attempts should also be made to publicise the awards and the university's work in engineering design in the local press to maximise the possibility of establishing contacts with local industry, commerce and local and national government organisations.

4.5 Remuneration

At the time a VP is to be appointed, it is clearly important to establish a proper business relationship that defines the number of days that a VP is expected to commit to the university and to define the financial relationship between the parties. As a minimum, travel and accommodation expenses and an honorarium should be offered. It should be the prerogative of the VP to decide whether to refuse reimbursement.

APPENDIX 1

Some examples of “best practice” VP programmes

1. The University of Strathclyde

The Product Development Partnership Scheme

This scheme aims to provide a model for collaboration in product development between University engineering students and industry. The scheme was structured to provide:

- Students with design experience on real projects
- Closer working relationships between the University and industry, providing an opportunity for technology transfer
- Companies with access to University resources, new technologies and new methods
- Assistance for companies in the development of new products and product concepts, improvements in their design processes and opportunities for leadership and management training of young staff. In the pilot year, fourth and fifth year students from the Product Design Engineering degree course were involved with five companies in undertaking eight product development projects.

The projects were:

- A Ship Waste Disposal System
- Ship's Husbandry Improvements
- Redesign of a yacht windlass
- Concept design of a yacht bow thruster
- Design of a ship cradle
- Redesign of production line equipment for petfood manufacture
- Design of a crane using a logging device

The students worked in teams and each company allocated a member of staff to each project. The students spent part of their time in the company. Each team gave two presentations to company staff - an interim and a final presentation. At the end of each project the companies were provided with a project report, complete with product drawings and were visited by Visiting Professors and Academic staff as part of the scheme evaluation process. The scheme continues with an increased number of participating companies.

In this case, the VP's were employed predominantly on the development and running of the scheme. Their key activities were:

- To make contact with potential product companies and to establish a series of product development projects
- To visit and liaise with project companies throughout the duration of the projects
- To meet on a weekly basis with project teams to assist in project progress
- To provide tuition in elements of project and team management
- To assist in the evaluation and development of the scheme's structure

In addition the VP's made contributions to the University as follows:

- Assistance with individual Undergraduate and Postgraduate student projects
- Involvement with a departmental industrial design panel
- Advice and assistance to research programmes and student research dissertations

- General debate and discussion of University and Departmental Development

The University said that the scheme would not have succeeded without:

- The “insider” contacts of the VP’s
- The assistance of the VP’s in managing the [often difficult] relationships between the students, staff and industrial partners
- The impartial advice [very much appreciated by the students] offered by the VP’s who were seen as independent of both company and academic influences
- The input of VP’s in prompting inputs from the industrial partner

It should be said however that the University found the establishment and operation of the scheme to be very time consuming and efforts are now being made to standardise documentation and procedures.

2. Imperial College, London

Technology Design Themes

The Imperial College VP scheme was formally launched in October 1994 with a team of five VP’s. Imperial College was the first University to choose a technical theme to link the VP’s. The theme of Power Generation was selected and all the VP’s had a significant background in some aspect of power generation and utilisation. One of the projects carried out was the design of an Advanced Turbine Generator and this was the major thrust of activities over a 3-year period. During this time a dedicated nucleus of staff within the Mechanical, Electrical, Aeronautical and Materials Departments progressed the project in conjunction with inputs from the VP’s. Students in all years of the course were involved and the success of this project has established the profile of the VP’s within the University.

Some limitations of the pilot phase of the scheme at Imperial have been identified. These included difficulties in involving a large number of students and of scheduling activities between the staff and students of collaborating departments which had little or no co-ordination between their timetables. Future development of the scheme will now include an expansion of the number of multi-disciplinary projects, with lead roles being taken by all participating departments. It is hoped that the scheme will create an opportunity to develop projects that require more than just technical excellence, e.g. techno-economic aspects, marketing, user requirements etc. The Imperial College scheme represents a major attempt to identify a vehicle for a multi-disciplinary approach to design and to encourage co-operation between departments.

3. The University of Cambridge

Integration with the teaching process

The University of Cambridge scheme now has six VP's. The University report states that the VP scheme "has made a significant impact on both raising the profile of engineering design teaching in the country and on the actual delivery of design teaching in Universities". At Cambridge it is reported that the VP's are integrated members of the Engineering Department and that they contribute to:

- The development of the design teaching in both undergraduate and postgraduate courses
- The development of the design research in the Cambridge Engineering Design Centre
- The increase in status and visibility of engineering design within the department, the University and the outside world.

The University has found that in their case the best role for the VP's was to use their expertise in carefully selected areas. These included:

- Developing policy
- Reviewing design teaching
- Giving special lectures and seminars
- Supervising design projects
- Networking with industry
- Contributing to the research strategy of the Cambridge Engineering Design Centre

The contributions of the VP's have included the organisation of the very successful Conference on "Design for Wealth Creation" held in September 1994. VP's have also chaired key committees and helped to establish the Sir Frederick Page Fellowship.

The University makes the following observations with respect to the selection and use of VP's:

- i) It is important that VP's are accepted fully into a Department. This was achieved at Cambridge by ensuring that nominations are sought widely and vetted carefully by a Faculty Board Committee for Visiting Professors.
- ii) VP's are selected who are highly regarded in their fields and who have sufficient time to devote to a Department.
- iii) A balance is found between supporting the design teaching and research, and hands on delivery of teaching and research. At Cambridge they adopted the view that it is the duty of the full-time staff to deliver the core design teaching. VP's are asked to use their experience and special expertise to guide, review and help in specialist areas, such as project supervision.
- iv) The VP's are co-ordinated as a group
- v) The VP's represent a spread of expertise that matches that of the Department. This was achieved at Cambridge by asking all the subject groups to propose candidates for VP's.
- vi) The contribution of each VP is matched to their particular interests and expertise. Some have acted in a guidance capacity whilst others have been more involved in design project supervision and design research support.