ENGINEERING EDUCATION ISSUES IN THE UK

L.E. Davis, R.M. Eley, F.M. Lamb
LTSN Engineering, United Kingdom

ABSTRACT

What are the current engineering education issues in the UK? This paper will present the results of a major consultation exercise carried out by the LTSN Engineering centre during the early part of 2001. In particular, the paper will compare the opinions of academia and industry.

LTSN Engineering is the national engineering subject centre of the UK Learning and Teaching Support Network, providing subject based support to promote high quality learning and teaching to all UK engineering academics. The centre has high visibility within the engineering community and provides information, resources and advice on good practices and innovations in learning and teaching, and a pro-active and responsive service to the needs of the community.

In order to support this activity effectively the UK funding bodies have committed over eight million pounds annually to establish the LTSN comprising 24 subject-based centres and a generic centre. This subject-focused network has been established in recognition that for many in higher education, most networking and exchange of learning and teaching practice and innovation takes place within the subject discipline.

INTRODUCTION

In September 2000, LTSN Engineering commenced a major consultation exercise to establish the issues that are of concern to the stakeholders in engineering education in the UK. The exercise consisted of interviews and workshops with academics, student focus groups and a widely distributed questionnaire based survey. This paper presents the purpose of the exercise, the methodology employed, an analysis of the data gathered from the questionnaire and how this information is being utilised to inform the work of LTSN Engineering. A comparison of the opinions expressed by Academia and Industry is made, drawing out the differences and similarities between these two groups. This is made possible by the considerable interest (over 400 responses to the survey) shown by Industry.

LTSN ENGINEERING

The UK-wide Learning and Teaching Support Network (LTSN), launched in January 2000, is funded at over eight million pounds sterling per annum over an initial five-year period. It comprises 24 subject centres, a Generic Centre and a programme director to manage and co-ordinate the network based at the ILT at York. As well as LTSN Engineering, engineers are also likely to interact with the Built Environment, Physical Sciences, Materials, Languages, Computer Sciences and Mathematics centres.

The Network was established following a review (1) of existing learning and teaching initiatives, which acknowledged that academics best appreciate, assimilate and implement a pedagogic approach when presented to them within their own discipline. It recommended establishing a subject-based support network with a broad focus across all learning and teaching activity.

LTSN Engineering, hosted by Loughborough University, promotes quality learning and teaching by stimulating the sharing of good practice and innovation through the provision of subject-based support. The Centre's three key aims are to:

- Provide co-ordination and support for learning and teaching in higher education engineering.
- Create a national focus that is an accepted and essential point of contact for all involved in higher education engineering.
- Collate and disseminate good practice and innovation in learning and teaching in higher education engineering.

LTSN Engineering wish to provide a useful and an effective service to the engineering academics that form its primary customers. It is essential that the Centre understands which issues are important to this group in order that it can develop operational and strategic plans that will enable resources to be allocated to activities that will make an impact on the way academics deliver engineering education. There are many other stakeholders in UK engineering education including students, industry, professional bodies, the Institute of Learning and Teaching (ILT) and the funding bodies. Therefore, the Centre seeks to consult with and draw upon the valuable knowledge and experiences of all of these groups.

DESIGN OF THE CONSULTATION EXERCISE

The consultation exercise (see Figure 1) was designed to allow all of the stakeholders in engineering education to contribute although the most significant effort was placed on reaching academic staff. The consultation began with a pilot study. The first phase of this study consisted of fifteen telephone and face-to-face interviews conducted with a sample of the Centre's Departmental Contacts. The sample was selected to be a representative sample aiming to achieve a balance between discipline, UK region, pre- and post-1992 universities and gender. The interviews were semi- structured in that a checklist was used to enable a consistent approach to be taken and avoid introducing unnecessary bias. However, the interviews were still variable in the richness of the information collected with some participants openly sharing their experiences and concerns whilst a small number claimed that their department did not have any outstanding teaching issues, which led to a very short discussion. From these interviews, a number of issues and priorities for the Centre were identified. These results were tested at two workshop sessions where the participants were invited to discuss and then rank their major concerns in delivering a good educational experience for their students.

The results of the interviews and workshops were largely consistent which gave the Centre confidence in having identified the major concerns. A questionnaire was designed and then tested at this conference in 2001, which provided useful information and feedback. Using all of the information gathered thus far, a final questionnaire was designed to confirm, or refute, the concerns identified and was widely distributed within the engineering community as an insert in a selection of professional magazines, thus providing an opportunity for the practicing engineer to participate. Academics received an extended version of the questionnaire, which was distributed to all engineering departments in UK universities. This questionnaire included sections about the services that the Centre should provide and the communication methods it' should use. It also sought to identify academics with specific areas of expertise or interest in teaching and learning.

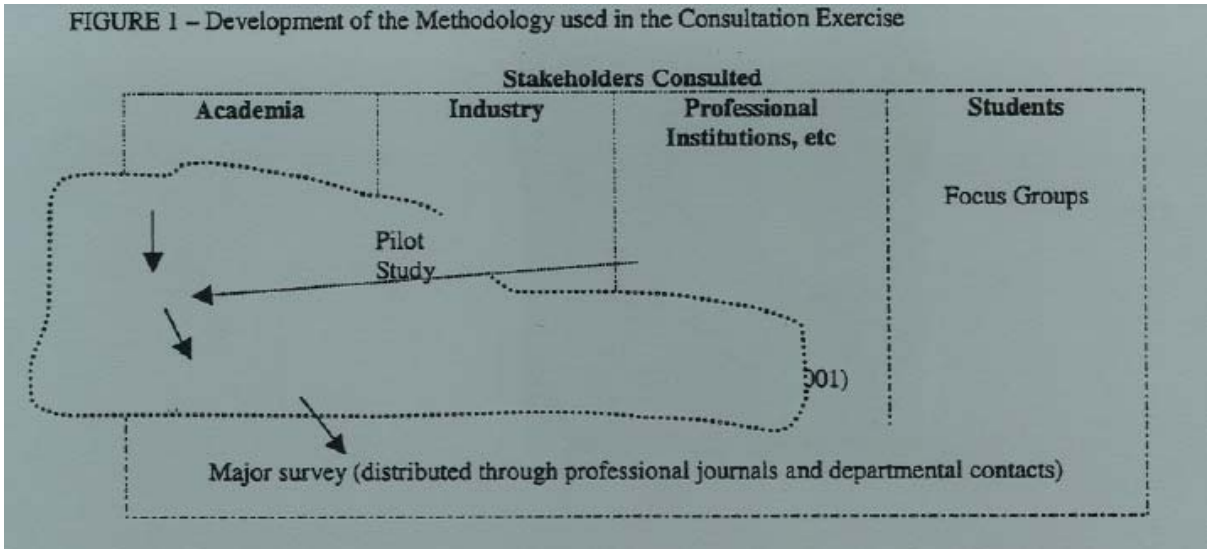
The final contribution to the exercise was to conduct three focus groups with current, final year students so that their opinion could be included. LTSN Engineering recognizes that students are an important stakeholder, but the Centre has limited resources to allocate to this group. It was therefore felt that focus groups was the most appropriate method to use as students' opinions could be canvassed in a short period of time. It was also possible for students to return a questionnaire from the main survey. For a discussion of the student view see Davis (2).

FORMAT OF THE QUESTIONNAIRE

The questionnaire was divided into the following sections:
- Issues in Engineering Education
- Priorities for the Work of LTSN Engineering
- Services and Activities
- Communication Methods
- Expertise

The first two sections were on all of the questionnaires distributed in the main survey, whilst the remaining three were only included on the extended questionnaire targeted at academic staff. The first two sections were

designed to gather opinion on how important the issues and priorities identified during the pilot study were to all of the stakeholders in engineering education. In these sections, respondents were invited to rate the lists of issues and priorities derived from the pilot study from 1 (not important) to 4 (very important).



The third and fourth sections were designed to ascertain how useful engineering academics would find the service that the Centre can offer and indicate their preferred means of identification. In these sections, Academia was invited to rate services and communication methods from 1 (not useful) to 4 (very useful).

The final section asked academic staff to indicate whether or not they were using a variety of teaching methods. This section allowed the Centre to gather information about the teaching methods employed by engineering academics and identify areas where individuals stated an interest in developing their skills or could offer to share their own expertise.

These sections were chosen to allow the Centre to gather opinion on the issues that had been highlighted in the pilot exercise and identify the issues that were of concern to the stakeholders in engineering education.

RESULTS OF THE SURVEY

Over 700 questionnaires were completed and returned, 40% being were received from Academia, 55% from Industry and 5% from other occupations (e.g. students, Learning and Teaching Support, Professional Institutions). This clearly demonstrated that practicing engineers felt strongly about engineering education and wished to make their comments known to the Centre. The female respondents represented 12% of the sample, which is reasonably consistent with the percentage of females known to be pursuing a career in engineering. The age profile of the respondents was 17% aged under 30, 32% aged 31-45, 36% aged 46-60 and 15% aged over 60. The younger respondents were more likely to be drawn from Industry than Academia. The disciplines that contributed the largest number of respondents were Chemical Engineering (22%), Civil Engineering (31%) and Mechanical Engineering (20%), which reflected the professional magazines used in distributing the questionnaire.

Method of Analysis

For each of the sections in the questionnaire a summary table were drawn up. The tables indicated how important or useful each item was considered and, in the case of "Expertise", how many academics were using different teaching methods. The items for the first four sections were ranked in descending order by summing the percentage of respondents rating it either 3 (important or useful) or 4 (very important or very useful), where a tie occurred then the ranking was based on the percentage of respondents rating it at 4. For the first two sections ("Issues" and "Priorities") a comparison between responses from Academia and Industry was made by firstly showing their ranking on the summary tables and then using two tests to demonstrate if there was any statistically significant differences between the responses given by these to groups. The tests used were Chi-Squared and the Spearman Coefficient of Correlation. These tests were selected because of the non-parametric

nature of the data. The Chi-Squared test was conducted on the ratings given by the respondents and demonstrates if one group rated an item higher than the other. The Spearman Coefficient of Correlation demonstrated the level of similarity between the rankings of the items – a coefficient with a value near 1 would indicate that there was a strong correlation indicating that each group's rating of items produced a similar ranking. A significance level of $\alpha=0.05$ was selected, which means that there is only a 5% probability that any relationships or differences observed are due to chance.

Issues in Engineering Education

Thirteen issues were listed on the questionnaire and respondents were invited to rate them from 1 (not important) to 4 (very important) from which the rankings were calculated (see Table 1). The Spearman Coefficient of Correlation shows that the ranking for the Industry Group is more highly correlated to the overall ranking than that for Academia and the rankings for
Industry and Academia are weakly correlated (see Table 2). This shows that Academia and Industry have differing views on what they consider to be the most important issues in engineering education today. Industry is more concerned with the product (high quality graduates ready for employment) and Academia is more concerned with the process (teaching and learning) to produce that product. This is not a surprising result as Industry are seeking to recruit useful employees whilst Academia is required to deliver engineering education within limited resources. The overall ranking is strongly influenced by the views of Industry, which formed the largest group of respondents.

The results of the Chi-Squared tests support the assumption that Industry is more concerned with the product than Academia. Industry rated "Preparing graduates for industry", "Content of degree programmes", "Students' key skills" and "CPD and matching sections" higher than Academia. This is clear from the rankings in all cases except "Content of degree programme". In this case, the ranking is the same (both rank it at number 2), but 53% of Industry rate this as very important compared to just 39% of Academia.

TABLE 1 – Ranking of Issues in Engineering Education

	Ranking (percentage responding 3 or 4)		
Issues	Overall	Academia	Industry
Preparing graduates for industry	1 (88%)	5 (83%)	1 (91%)
Content of degree programmes	2 (88%)	2 (86%)	2 (89%)
Professional status of engineers	3 (81%)	6 (78%)	3 (82%)
Students' motivation to learn	4 (80%)	4 (84%)	6 (77%)
Decreasing mathematical knowledge and skills acquired at A level	5 (79%)	3 (84%)	8 (76%)
Students' key skills	6 (79%)	9 (75%)	4 (81%)
Assessment of students' knowledge	7 (78%)	7 (77%)	5 (79%)
Limited resources available for innovation in higher education	8 (73%)	1 (89%)	10 (63%)
CPD and matching sections	9 (73%)	11 (64%)	7 (77%)
Use of information technology in degree programmes	10 (71%)	8 (76%)	9 (67%)
Relative status of teaching and research in Higher Education	11 (63%)	10 (72%)	11 (56%)
Development of flexible/distance learning	12 (52%)	12 (51%)	12 (53%)
Threat to Higher Education by commercial organisations	13 (28%)	13 (27%)	13 (28%)

TABLE 2 – Spearman Coefficient of Correlation for Ranking of Issues in Engineering Education

Rankings Compared	Correlation Coefficient
Overall with Academia	0.74
Overall with Industry	0.92
Academia with Industry	0.50
Note: all coefficients are statistically significant at α=0.05	

TABLE 3 – Ranking of the Priorities for the Work of LTSN Engineering

	Ranking (percentage responding 3 or 4)		
Priorities	**Overall**	**Academia**	**Industry**
Promoting understanding and sharing of good practice	1 (88%)	2 (84%)	1 (89%)
Advising on the implementation and embedding of good practice and innovation	2 (81%)	4 (80%)	2 (80%)
Locating high quality materials	3 (80%)	1 (85%)	4 (77%)
Establishing links with all stakeholders	4 (78%)	7 (75%)	3 (80%)
Serving as a source of information and advice	5 (77%)	3 (81%)	6 (72%)
Identifying sources of funding to support learning and teaching initiatives	6 (75%)	6 (77%)	5 (74%)
Assisting academics in the introduction of learning technology	7 (70%)	5 (78%)	7 (64%)
Encouraging research on learning and teaching	8 (63%)	8 (66%)	8 (60%)
Building a register of expertise	9 (57%)	10 (56%)	10 (55%)
Advising on meeting needs of diverse learners	10 (56%)	11 (53%)	9 (59%)
Addressing implication of subject review	11 (55%)	9 (57%)	11 (54%)

TABLE 4 – Spearman Coefficient of Correlation for Ranking of Priorities for the Work of LTSN Engineering

Rankings compared	Correlation Coefficient
Overall and Academia	0.87
Overall and Industry	0.97
Academia and Industry	0.76
Note: all coefficients are statistically significant at α=0.05	

An analysis of the comments made under this section clearly supports the product/process division. Industry made many comments on the importance of key skills whereas comments from Academia demonstrated that they felt strongly about the falling standard in mathematical skills and the motivation of students. A difference in the Industry and Academia view of the "Professional status of engineers" was also shown. Both groups rated it highly and are concerned with the public perception of engineering, but Industry saw this issue as relating to their own personal status (including salary) compared to other professions and Academia considered it in the context of recruiting high calibre students.

It is also interesting to note the issues that were not highly rated or did not raise many comments. The "Development of flexible/distance learning" was ranked l2lh with only 50% of the respondents considering this to be an important issue, which could be of concern to the current UK Government, given its commitment to widening access and lifelong learning. Gender was mentioned by two respondents and environmental issues (including sustainability) by six, which indicates that the awareness of these issues still needs to be increased.

PRIORITIES FOR THE WORK OF LTSN ENGINEERING

Respondents were invited to rate eleven possible areas of work for the Centre and these were ranked as before (see Table 3) and the Spearman Coefficient of Correlation was calculated (see Table 4). The rankings and the correlation coefficients demonstrate that the opinions of Academia and Industry were more closely aligned than when rating the issues. The Chi-Squared tests showed that Academia rated "Locating high quality materials" and "Assisting academics in the introduction of learning technology" higher than Industry, whereas Industry rated "Advising on meeting needs of diverse learners" higher than Academia.

The priorities ranked at or near the top of the list, demonstrate that both Academia and Industry believe that sharing current good practice and materials is very important. In the comments, Industry emphasised the importance of better links between Academia and Industry so that "suitable" graduates could be produced. Academia focussed its comments on suggesting that LTSN could be involved in recruitment of students and addressing the increasing workload of academic staff. Academia was also concerned that the Centre concentrate on issues that were specific to engineering.

The low ranking of "Advising on meeting the needs of diverse learners" shows a lack of awareness of the disabled learner, which is disappointing in the light of the Special Education Needs and Disabilities Act which takes effect from 1 September 2002. This is probably due to the low number of disabled students taking engineering courses. It was surprising to note the low importance placed on "Addressing implication of subject review" as the new "light touch" assessment procedure is to be introduced in January 2002 with the engineering departments being visited first.

Services and Activities

TABLE 5 – Ranking of Services and Activities

Service	Ranking (3+4)
Case studies of implementation	1 (82%)
Collection of teaching resources	2 (80%)
Reports of good practice	3 (79%)
Workshops and seminars	4 (73%)
Web-based register of expertise	5 (69%)
Working groups	6 (61%)
Software and book reviews	7 (57%)
Question banks	8 (57%)
Local/regional contacts	9 (56%)
Regional events	10 (56%)
Supporting academics to publish	11 (51%)
One-to-one advice	12 (49%)
Learning and teaching journal	13 (47%)
National conferences	14 (42%)

Only Academia were invited to rate the suggested list of services and activities that LTSN Engineering could pursue. The rating ranged from I (not useful) to 4 (very useful) and, as before, rankings were based on the percentage of respondents rating the service as 3 (useful) or 4 (very useful). The ranking shows a high interest in services directly related to teaching with activities concerning publishing ranked at the bottom of the list. It is noticeable that 69% thought that a "Web-based register of expertise" would be useful when only 56% of Academia considered building such a register as an important priority for the Centre (see Table 3).

Communication Methods

Again, this section was only offered to Academia. The two methods appearing at the top of the ranking are concerned with electronic communication showing that academic staff want to exploit quick and focussed communication methods about issues that are of immediate concern to them. Academia showed a lack of interest in receiving paper-based communication or in joining a discussion group.

TABLE 6 – Ranking of Communication Methods

Communication Method	Ranking (3+4)
Email	1 (88%)
Web-site	2 (78%)
Briefing papers	3 (66%)
Information pamphlets	4 (53%)
Paper mailings	5 (46%)
Computer-based discussion groups	6 (37%)

Expertise

The teaching and assessment methods used by most of the respondents in this section were the ones traditionally found in engineering, for example, lectures, group work, tutorials, labs, oral presentations, dissertations and essays. The methods where the most interest was shown for development were student centred learning, computer/ web based learning and self-assessment, which could indicate a desire for academic staff to reduce their contact with students and hence their time spent in teaching activities. Less than 20% of the respondents admitted to having expertise or a particular interest in any of the methods, which suggests that academic staff in engineering do not have great confidence in their abilities as teachers.

IMPLICATIONS FOR LTSN ENGINEERING

LTSN Engineering is developing its operational and strategic plans to encompass the issues highlighted as a result of this consultation exercise. The views of Academia are given priority in this process, as it is this group that the Centre seeks to serve. It is obvious from the results of the exercise that academic staff are concerned with finding readily available solutions to issues facing them and do not consider researching or publishing on pedagogical issues of particular interest or importance. This supports the Centre's decision not to run its own conferences or produce a journal. The Centre does actively support other organisations involved in these activities, such as its involvement with this symposium and making regular contributions to the British Engineering Education Society (BEES) Journal.

The Centre is responding to the need for accessible resources and advice by developing a high quality web site where resources can be accessed and good practice disseminated. During the first year of the Centre's operation, the web site was structured and launched, in the second year the focus will be on developing the content. This will be done in part by the Centre's staff, but more importantly the Centre will be commissioning work that will result in high quality and current material being made available. This will be through collaboration with HEFCE funded engineering projects and by funding its own projects. The Centre also uses email lists to distribute information and promote discussion quickly and effectively.

Some of the activities the Centre is undertaking to address the major issues of concern include being a leading partner in a major project looking at the "maths problem" with the Mathematics Centre and funding engineering academics to carry out mini-projects, which address these concerns and produce information and/or materials that can be shared across the community. The Centre is also playing its part to raise awareness of the low priority issues, such as employing an academic consultant to develop disability awareness related resources (3) and supporting the Balance Project which is developing resources to help departments address the gender imbalance in engineering (4).

The Centre must also educate the engineering education community, particularly the academic staff, to understand its role to support leaning and teaching. Currently, many academic staff want the Centre to be involved in recruitment issues, representing their views with the professional institutions over issues of accreditation and addressing the bureaucracy and workloads that they face. The Centre certainly wishes to be seen as having a valuable viewpoint in consultation issues but it is not an organisation that can lead campaigns. It can however support Academia to make changes in its learning and teaching practices that can result in a positive impact being made on these issues.

A significant outcome of the exercise is the identification of academic staff with interest or expertise in particular teaching methods. This information will be utilised to identify subjects for workshops and case studies and possible contributors to these activities.

This consultation exercise cannot be seen as a completed activity. LTSN Engineering will continue to update the data and review its activities in the light of future findings.

CONCLUSION

Through the consultation exercise carried out, LTSN Engineering is confident that it is allocating its resources to address the issues that are important to the academic staff providing engineering education in the UK. These

concerns can be seen to centre on delivering an effective education to students with decreasing mathematical knowledge and motivation with fewer resources available. Academic staff need effective solutions readily available and hence the Centre is using electronic methods as its main means of communication with its community. It is evident that Industry views the outcome of the education process as more important than the process itself and has expressed its desire to develop links with academics in order to obtain "suitable" graduates. This exercise has been successful in promoting debate and the Centre will update it annually with a smaller scale consultation of the stakeholders in engineering education.

REFERENCES

1 "An evaluation of the; CQD1puters in Teaching Initiative and Teaching and Learning Technology Support Network", 1998, HEFCE Report 98/47

2 Davis, L, "Students Focus on What They Want", 2001, presented at PROGRESS1, University of Hull

3 http://www.ltsneng.ac.ukIer/disability/index.asp

4 http://www.balance.ac.uk