Desires of industry, products from academia - Ships that pass in the night?

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Introduction.

The UK-wide Learning and Teaching Support Network (LTSN) was launched in January 2000 following a British Government review of existing learning and teaching initiatives in higher education (HE). Recognition that academics best appreciate, assimilate and implement a pedagogic approach when presented to them in the context of their own discipline, resulted in the establishment of a subject-based support network with a broad focus across all learning and teaching activity.

The aim of the LTSN is to provide support to academics in order to improve the provision of learning and teaching in HE. Funding is provided by the Government's four bodies responsible for higher education in England, Scotland, Wales and Northern Ireland, thereby enabling its services to be free of charge to its academic clients.

The LTSN Subject Centre for Engineering (www.ltsneng.ac.uk), hosted by Loughborough University, is one of the 24 subject centres which form the LTSN Network. LTSN Engineering aims to support engineering academics in their learning and teaching through:

- Co-ordination and *support*.
- Creating a national *focus* which is the point of contact.
- Collating and disseminating *good practice* and *innovation*.

In 2001 the Centre undertook a needs analysis of its stakeholders. The purpose was to assist the Centre in fine-tuning its strategy and work plan, and to ensure it understood the needs of its clients. The consultation exercise sought information on issues, priority areas and on proposed Centre activities and communication methods. It was also the starting point for establishing a register of expertise within UK engineering education.

In order to meet the Centre's aim of enhancing education, the views of all stakeholders to engineering education are important. The needs analysis polled engineers in academia, industry and the professional bodies, plus students on engineering degree programmes, and professionals within learning and teaching. The paper herein focuses on the issues and priorities identified only by academics and industrialists and the subsequent responses from the Centre to those results. Details on the rest of the analysis will be published elsewhere [1].

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Methodology

The consultation began with a pilot study. Fifteen telephone and face-to-face interviews were made with a sample of the Centre's academic department contacts representing the various disciplines, geographical areas, gender and pre- and post-1992 universities within UK engineering. The interviews were semi-structured using a checklist, but with the opportunity for participants to share their experiences and concerns. During the same period two workshops, each with about 25 participants, were held and participants discussed the same subject matter.

The results of the interviews and workshops provided the basis for the design of a questionnaire containing questions that addressed major issues in engineering education and priority areas in which LTSN Engineering should become involved. Respondents also recommended activities for the Centre, noted their preferred means of communication, and provided information on their areas of expertise in education.

The questionnaire was tested at the Institute for Electrical Engineers conference in January 2001 and subsequently modifications were made based on the feedback given. Multiple copies of the questionnaire were then mailed to every engineering department within the UK universities, and distributed to industry through inserts in professional magazines. An independent consultant undertook the development and distribution of the questionnaire.

Recipients of the final questionnaire were offered 13 issues and 11 priority areas to rate using a four-point scale of "not important", "of marginal importance", "important" and "very important". In addition opportunity was given for respondents to comment on any of the issues and priorities and to contribute new items to the lists. Responses to the questions were analysed using SPSS to rank the importance of the topics, to detect whether they differed within and between sectors, and if so where those differences lay. Analysis also enabled issues and priorities that were rated the same within each sector to be grouped together.

Results and Discussion

There were 725 responses received from industry (410) and academia (315). The academic response represented 47% of the 146 higher education institutions in Great Britain (England, Scotland and Wales) and Northern Ireland offering degree courses in engineering. There was some unevenness in the geographical representation of respondents, which probably reflected the extent of exposure that the LTSN network in general and LTSN Engineering specifically had enjoyed at the time of the survey. The distribution indicated the need for the Centre to target specific areas in future visits and events. Women contributed only 13% of the responses. This figure however is consistent with the gender split in UK engineering.

It is recognised that two concerns may be raised about the methodology. Firstly the concern whether the small numbers in our pilot groups (15 by telephone and about 50 at two workshops) truly identified the major topics in engineering education. We believe they did because the questionnaires were developed from a cross section of engineering academics and not just those with specific interest in learning and teaching. Furthermore the questionnaire was tested by

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another 50 people at a conference and subsequently modified to incorporate their suggestions. The validity of the methodology is also supported by the responses to the facility on the questionnaire that allowed comment on the identified topics and addition of other topics of concern. Content of the many comments that were received reinforced the importance of the given topics and very few additions were made suggesting that the offered topics indeed were "key topics".

Secondly there is always a concern with voluntary returns of questionnaires as to how representative are the respondents of the community at large. This study is not exempt from such concern, especially as many respondents were likely to have particular interest in learning and teaching. Whether these views are representative of those engineers who have little interest in learning and teaching was not determined specifically. However the responses to presentation of preliminary results to many individuals in industry and academia who have no bias towards learning and teaching, have supported the belief that the results do represent the views of the engineering community. Finally it can be argued that even if the issues are biased because of skewed response the fact that attention has been drawn to them is of significance.

Important Issues in Engineering Education.

Results for the topics covered in *Important Issues in Engineering Education* are summarised in Table 1 by presenting the topic in order of overall importance (rank) and the ranking group into which each topic fell within either the academic or industrial sector. The overall ranking was adjusted for unequal numbers of respondents within each sector.

Each numbered group within sectors is significantly ($p<.05$) different. For example academics ranked *Decreasing mathematical knowledge* and *Limited resources available for innovation in HE* highest (Group 1), and higher than topics in Group 2.

Table 1. Rating of importance of issues in engineering education.

Rank	Issues	Academic	Industry
		Group	Group
1	Preparing graduates for industry	2	1*
2	Content of degree programmes	2	1*
3	Decreasing mathematical knowledge	1*	2
4	Professional status of engineers	2	2
5	Students' motivation to learn	2*	2
6	Students' key skills	3	2*
7	Assessment of students' learning	3	2
8	Limited resources available for innovation in HE	1*	3
9	Use of IT technology in degree programmes	3	3
10	Continuing professional development	3	2*
11	Relative status of teaching and research in HE	3*	4
12	Development of flexible/distance learning	4	4
13	Threat to HE by commercial organisations	5	5

Preparing graduates for industry was ranked first when both sectors are considered together and also ranked in Group 1 (with *Content of degree programmes*) by industry where 65% of respondents rated this issue as being "very important". Although academics also noted the

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issue's importance with 83% rating it "important" or "very important", only 43% gave it the higher "very important" rating. They considered other issues (i.e. *Decreasing mathematical knowledge* and *Limited resources for innovation)* more important.

Significant differences between sectors are indicated by an asterisk (*) appearing in the sector column that ranked that topic of higher importance. Thus academics considered *Limited Resources, Maths Skills, Motivation of students* and *Relative status of teaching and research* more highly than did industry. In contrast *Content of degree programmes, Student skills, Preparing graduates* and *Continuing professional development* were more highly rated by industry.

With the exception of the *Threat to higher education by commercial organisations* all issues had a combined rating of "important" or "very important" by over 50% of the respondents in each sector, thus endorsing the pilot studies that revealed these issues as being "key". Overall, the rankings demonstrate that academics value the importance of the process of learning and teaching while industry place more importance on the final product, i.e. the resultant graduate.

The difference between sectors were not unexpected; for example that *Continuing professional development* was more highly rated by industry as this issue affects engineers in industry far more than in academia. Similarly *Limited resources available for innovation in HE* has far greater effect on academics.

Nearly 500 of the 725 respondents provided comments to the issues. Although some merely endorsed the importance of one or more of the issues, many, particularly from industry, revealed a high degree of discord between the knowledge, skills and abilities of the graduate engineers provided by academia and those demanded by industry.

Skills and abilities of graduates received 37% of all comments from industry. This emphasises the importance of the issues *Preparing graduates for industry, Content of degree programmes* and *Students' key skills*. Many of the comments suggested that the current graduates do not meet their needs. For example

"We need to concentrate on good old-fashioned fundamental engineering skills".

Others noted the need for inclusion in the curriculum of other relevant engineering skills (e.g. health and safety, languages, design practice, all round manufacturing process) and new skills (such as IT).

The greatest emphasis however was on the need to increase the practical aspects of courses with more industrial attachments and projects.

"Course content needs to be more industry related"
"Practical skills and not just theory have to be stressed"
"Greater familiarity with industrial practice is essential"

It was stated on a number of occasions that more interaction between industry and academics was required in order to enable academics to acquire more knowledge themselves of what is

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expected within an industrial setting. Academics need a "*reality check"* was the controversial phrase used by one person.

The industrial sector was also very prolific in comments in the area of student or "key" skills (information retrieval, interpersonal skills, writing, teamwork, business, finance, legal skills, human resources and management).

> *"Interpersonal skills differentiate leaders"*
> "*Graduate engineers seem entirely unaware of the basic fundamentals of business – costs, invoicing, tendering etc do not seem to be part of their educational vocabulary"*
> *"Graduates appear to regard profit as unclean, more emphasis is needed on modules on money/business practice/psychology relevant to business management."*

However not everyone was happy with an emphasis on key skills and some respondents did note that too many key or "soft" skills were being taught at the expense of engineering skills,

> "*Emphasis on soft skills risks masks the reality that many of an engineer's decisions are based on hard maths and firm understanding of basic mechanisms"*

Some noted that the key skills can be taught in the work place and did not need to be dwelled upon at university.

> *"Communication and management skills are the responsibility of the employer; foundation skills cannot be taught by the employer"*
> *"Universities should teach what they do best and leave industry to complete the education process"*.

It is interesting to note quite contrasting views from industry with regard to the extent of both engineering and key skills that graduate should have. There were very different perceptions as to what constitutes a good student and a good education. Although some respondents considered a good student as being someone who had the foundation skills upon which the employer builds,

> "*Key issue is the quality and level of thought; skills can be acquired post-graduate"*.

more shared the belief that a good student is one who can walk into a specific job with all the skills, tools and knowledge to "*hit the ground running*"

> "*With relatively high salary levels for new graduates it is important that they are of immediate use to employers*".

It is possible that these attitudes may reflect the demise of "on-the-job" training owing to financial constraints. However it is clear that many of the respondents from industry do not believe that university education should be just a small part of a lifelong learning exercise that provides a framework upon which to hang later acquired skills and knowledge. They do not appear to accept the consensus of opinion that education is more than learning specific skills; rather it is about acquiring knowledge of principals that can be used in all sorts of arenas.

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Priorities for LTSN Engineering

The priorities that the sectors believe should be the focus of LTSN-Engineering's work are presented in Table 2 in the same format as for "Issues in Engineering Education" above.

Table 2. Priority areas for LTSN Engineering.

Rank	Priority area	Academic Group	Industry Group
1	Promoting understanding and sharing of good practice	1	1*
2	Locating high quality materials	1*	2
3	Advising on implementation/embedding of good practice	2	2
4	Establishing links with shareholders	2	2*
5	Identifying sources of funding	2	2
6	Source of information for L & T issues	3*	3
7	Introducing learning technology	3*	4
8	Encouraging research in L&T	4	4
9	Addressing implication of subject review	4	4
10	Building a register of expertise	4	4
11	Addressing needs of diverse learners	4	4

Promoting the understanding and sharing of good practice and innovation was considered of highest priority for the Centre by both sectors. Thereafter other topics that addressed the location of information and the provision of teaching and learning materials and technologies (*Locating high quality materials, Advising on implementation/embedding of good practice , Source of information for L & T issues, Introducing learning technology*) were considered by academics to be of higher priority than industry. That these topics were identified supports the establishment of the LTSN Network and the work already begun by LTSN Engineering.

Interaction between the two sectors and other stakeholders (*Establishing links with stakeholders*) was recognised as being a high priority. Comments from industry reinforced the higher emphasis place on this by industry. The Centre's role in facilitation of networking is considered to be important in this respect.

> *"Provide industry with a clear view of the latest steps in engineering education"*
> *"Establish a mechanism to the source of learning from industry"*

It is interesting that *Encouraging research in L&T* was rated so low by academics. This perhaps reflects the poor recognition that learning and teaching gets in staff assessment exercises. Within the UK academic staff development is keyed far more to research activities than those associated with learning and teaching activities (including research into those activities).

It is suggested that the importance of *Addressing needs of diverse learners* would now be higher following the Government's recent policy decision regarding wider participation. The Government's aim is that, by 2010, 50% of young people should have the opportunity of benefiting from HE by the time they are 30. This inevitably will increase the diversity of learners and affect aspects of teaching and learning ranging from mode of delivery to course content.

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General discussion

The results, although not unexpected, do provide more than just anecdotal evidence, which is the norm when these topics are discussed. When the results are combined with the comments received from the respondents, a clear picture emerges of differences across the sectors in what is expected from a university degree. A shortfall occurs between what is desired and what is currently applied.

The difference in profile of the engineering graduate as demanded by industry and as supplied from academia appears to be getting greater and greater. At least it is the perception of the respondents to this study. How much of this is true? Has academia changed with the times to accommodate new technologies and skills? Has industry changed in its demands requiring trained rather than educated people? To answer these questions the influences and constraints to the sectors must be examined.

The engineering curriculum in UK academic institutions is influenced by a considerable number of stakeholders. The formal ones such as Professional bodies (22 accrediting institutes); Government bodies (Quality Assurance Agency); Academic bodies (universities, Engineering Professors' Council, Research Assessment Exercise), and the more loosely articulated needs of students and employers. The undergraduate curriculum must strike a balance. The needs analysis results clearly imply that it is not.

Academic departments are facing financial shortfalls, lower recruitment owing to increased competition and decreased popularity of the discipline, and academic staff who are mainly judged on their research and not teaching outputs. Wider participation inevitably means even more diversity in student abilities and background. As a consequence more foundation work is required and overloaded curricula result. The academics departments then receive somewhat conflicting advice from different quarters. The professional bodies influence the curriculum by accreditation of those that meet prescribed standards. The benefit to this accreditation is that it ensures standards, however to date graduates have to a large part not required chartered status for employment. The difficulty with the accredited scheme is that to date it has stressed technical and not the other skills. In contrast the Quality Assurance Agency and Engineering Professors Council are stressing broad-based skills. As a result the current three-year programme curriculum is overcrowded and too full to do all that is desired. Many courses tend to be content driven, resulting in too many contact hours and too little time for reflection. Students adopt strategic approaches to achieve results and the emphasis on knowledge of assessment outcomes allows them to do this. Traditional attitudes of what should be taught sometimes result in outdated curricula.

Industry seeks capability, competence, technical awareness and immediate usefulness from graduate engineers. Different parts of the industrial sector however appear to have different ideals. Those in the highly changing fields e.g. telecommunications, recognise that technology becomes obsolete very quickly. Their preference is to stress basic skills and key skills. In contrast mechanical engineering appears to have preference for more technical engineering skills. Clearly these different demands are hard to satisfy. Furthermore with changes in the economic climate the tradition of post graduation on-the-job training has been largely curtailed

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and sponsored “sandwich” and masters courses have also been reduced. Industry expects far more than is currently offered by many academic courses and is slow to accept that current graduates differ from those of previous generations. To combat the perceived inadequacies some larger companies are now sponsoring university courses and applying some influence on content.

Students state that they wish courses to be exciting and enthusing, with exposure to cutting edge technology to provide a launching platform for their career and a basis for their professional development skills. They are far less accepting than previous generations and demand value for money especially now that university fees have been introduced. Students are not prepared to be the recipients of traditional lectures and practicals; they demand more interaction and input into their programmes than ever before. Many academics do not see the need to change. They believe students’ desires are not borne out by practise; that surface learning still predominates and that students want “spoon feeding” to achieve examination success. However the bottom line is that departments have to adjust to market forces and academics have to adjust and incorporate new practices.

Clearly changes within all sectors need to be addressed. Certainly a more balanced curriculum meeting the aspirations of all stakeholders is needed and requires changes in learning and teaching. Fortunately new methodologies exist and when coupled with technology this allows changes to occur both in teaching style and material. For example group work, project work, flexible learning, problem based learning, video conferences, simulations etc are available to complement the traditional “chalk and talk” teaching method. Academic staff require support to learn, adopt and embed new learning and teaching methods and LTSN Engineering can provide many of the service they need to accomplish this.

Responses to some of the priorities and issues are already in place within the Centre. We offer a focal point for engineering academics; an accepted place of contact, where academics and other stakeholders can exchange ideas and materials (e.g. through establishment of working groups, running of regional events and seminars). We can also provide information (location of funding sources, notice of events), resources (question banks, software reviews), advice (on assessment, maths material) and support (workshops, funds for small projects).

Several issues were not addressed in the analysis but will be addressed by the Centre. For example new legislation concerning disabled students will have major effect on academic departments and the Centre is preparing good practice guides that are discipline specific. Other examples of issues to be addressed are sustainability, gender and the effect of policy of widening participation on student recruitment and retention.

In conclusion, from the need analysis exercise LTSN Engineering has identified areas where it is most needed and can offer most value for money. Some of the issues are beyond the remit of the Centre. For example the professional status of engineers, remuneration for academic staff and continuous professional development issues will not be addressed directly. However other issues map well with what we can offer and these resources and services that we provide will play a part in bringing those “ships that pass in the night” closer together.

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Biographical information

ROB ELEY received his PhD from the University of Florida in 1980. He then moved to Africa, where, following a two-year period as a university lecturer, he studied primates for ten years. In 1992 he became Education Officer for a Kenya-based international agricultural research institute. He returned to the UK in 2001 as an Academic Co-ordinator with LTSN Engineering.

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