

IBS Madrid - "Education in the New Millennium" November 24th - 28th, 1999

Discussion Group 1 The role of Practical Training in Engineering Education

Participants

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Introduction

In this group we have been talking about the role of practical training in engineering education. The structure of our discussion has been divided in several sections. We started by defining the types of training, and afterwards were talking about the use of the training, in order to define the needed qualifications to be a good engineer. Then finally we used this perspective to discuss the role of practical training compared with the role of the courses. In relation with this we also talked about the role of stakeholders.

1. Practical training

We have divided the practical training in two major sectors; where one is more focused on the training of technical skills, and the other provide additional knowledge.

1.1 *Technical training*

The technical training consists partly of activities at university and of activities in companies. At the university there are the labs, making you understand the connection between theory and reality and learn to use the devices.

The big projects can be developed with or without co-operation with companies.

The internship in companies will teach you the practical things, and make you able to work on your own (versus labs where the teacher tells you exactly what to do).

1.2 *Non-technical training*

The non-technical training contains the voluntary work in student organisations (humanitarian, political etc.)

There are some other fields concerning non-technical training, which are the alternative courses (economics, humanistic, management, laws, social, arts), group work, work and other activities besides university.

2. Use of practical training

The main activity of practical training is the internship. This type of practical training teaches you to adapt your theoretical knowledge to practise. It is like discovering the real world, confronting theory and practise. It helps you to focus on the need of functionalism, and the

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leak of exact and precise theory. It also tutors you to be responsible, to come in touch with other people (interconnections) and to know what the structure and the regulations of the companies are. You have also the opportunity to test your ideas concerning engineering and to decide if this is the ideal job for you. At last, but not least, the internship will make you understand what kind of qualifications is important in the real life and it will open your mind.

2.1 Labs

Another field of technical training is the activity in the laboratories. They are creative because they develop team spirit and help you get a technical background and knowledge about the basic technology. It will make you able to understand the technology and its concepts, and continue the development

2.2 Projects

The last kind of technical training is the project work. You learn how and where to research, get informed about deadlines and learn also about financial aspect.

2.3 Non-technical training

The non-technical training mainly consists of voluntary work. The main advantages of this kind of work are that it teaches you to co-operate with different kind of people and make important contacts with other students. It also helps you to learn how to convince the others and express yourself. It is an ideal way to get beyond your limits and learn about your strength and weaknesses, in other words, it develops your personality. You have the responsibility to lead a project from the beginning to the end. It is also important to know and understand people from other sectors, deal with juridical, financial and environmental matters.

The group work has to be mentioned afterwards. It helps you to co-operate and communicate with other people, but it also teaches you to be rational because you have to make compromises to reach and achieve your goals.

The process of working is also important because it also teaches you to co-operate and you gain experience through that. It improves your research skills and you get an idea what is like to respect your boss.

3. What kind of qualifications is useful?

We have discussed what kind of skills our ideal image of engineer should possess, in order to figure out what kind of qualities there should be focused on during the education.

The most important thing is obviously the technical knowledge that the entire engineering work is based on.

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By learning these basics the student will also obtain the following skills:

- knowing how to find information,
- learn to learn,
- adaptability in the learning process.

But to be a good engineer having the technical knowledge is not enough. It is as much important to be aware of the social, economical and regional context in which this technology is applied.

To be part of a team in a company the engineer should also be able to work in a group, and there for to have communication skills, know how to present the project is working on.

To solve a technical problem it is often necessary to enlarge the perspective, and therefore the engineer should be able to:

- improvise
- adapt the schedule to the changing conditions
- change projects or plans
- think logic
- realist
- be able to analyse a problem make decisions
- take responsibility
- be critic

When exercising his/her leadership, he/she should furthermore have the ability of coordinating, motivating and managing.

So the development of these qualities should be taken into consideration while building the different curricula and also while allocating university grants and materials to student's organisations, or simply easing the academic life of the students involved in practical work through extra-curricular activities.

Even if other activities have to be organised inside the university structure, they could open other fields of experience to the students: social work, sports (leadership, teamwork), economics, languages, geopolitics...

3.1 *Inside the Curriculum, those teaching ways are possible*

3.1.1 *Projects*

Good for practising before a real internship

Learn technical stuff

When you have a lot of projects you do not have as much time for the courses

After having made a project you will not feel like going back to school

Priority to the education

There has to be credits for the projects

Not to many projects, because that is what you will do when you are going to work, and at the university - you should focus on courses.

To be able to take advantage of the projects, you have to learn how to do it first

The professor has to gradually introduce and raise problems

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In the last years you should have some new technologies, in the beginning it is important to learn about basics

Problem solving

3.1.2 Non-technical training

They give you flexibility.

They force you to adapt yourself to the current environment.

They give you different points of view on engineering work.

4. Stake-holders

The stakeholders can be listed as follows: the university, the students and their organisations, the professors, the companies and of course, the government.

The university is the stakeholder that is planning the education and the structure of the courses. It also guarantees the quality of the equipment, of the teaching methods, the materials and the infrastructures. The university could contribute for the development for extra curriculum activities and could also control the professors. It has also the responsibility to decide whether there should be non-technical matters or not.

The professors are the ones that motivate the students to work on projects and the non-technical subjects. They try to convince the students that practical training is important. They also make the information (about curriculum of the courses) accessible to the students.

The government is planning the structure of the education, is putting up the goals for it and they are financing the whole system. They provide also their contribution for the development of different courses.

Conclusion

We hope that with this paper we had been able to underline the future structure of what should or could be the introduction or the emphasise of practical training into the European engineering curriculum. Some of those concepts are really widely spread all over Europe. But although, some like internship are quite common for some students and university environments, some other countries do not have any experience on the subject. It seems then to us that some should help the others to get to know the best methods to make the most of their resources in terms of teaching staff, technical resources and companies contacts, in order to always improve the level of practise of the European engineer-to-be.

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Discussion Group 2

Influence of industry on Educational Matters

Participants

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Abstract

There is a need in the technical education of clearer influence from the industry. In this report the existing channels for communication between the technical university, students and companies are defined. The dangers and the benefits of a clearer influence from the industry on education are also summarised. The existing channels are, however, not ideal in an education improvement context. Criteria for ideal channels of communication and information exchange are defined and a couple of ways to construct such channels are proposed.

Introduction

In the technical education that exists in most parts of Europe today there are no clearly defined channels for exchange of opinions and needs between the universities, students and companies. In our meetings and discussions we tried to evaluate the current state of affairs between the involved parts, try to provide some new sort of solutions and improve on existing ones, to bridge the gap between the industry and the technical education.

Structure of the discussion

To accomplish this, first, our group set out to answer some pertinent questions on the subject, like, *'should companies be present in technical education?'* To what degree should this influence extend? What are or could be the advantages and drawbacks of such influence? Next we focused on the need for communication between all of the concerned, tried to analyse the existing communication ways, and on how to use and optimise them and tried to discover some new possible channels and then defined them.

Summary of discussion

Should companies be present in technical education?

Universities are structurally quite inflexible and old fashioned organisations. Input from companies (who due to market economical reasons have to be very adaptable to the marketing demands and changes) would certainly, if done in the right ways, improve education. The technical students also need information from the companies to be able to build up a picture of what it will be like to work as an engineer in industry. And the companies also need to know about students' view of future industry and working conditions. Therefore we could

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quite easily agree on that companies influence on education is necessary. There are however dangers with companies having too much influence on the universities. Companies have to think in economical terms, which means that their thinking seldom involve a longer perspective. In declaring their needs they can only see for the next 5-10 years. A longer perspective (and investment) gives no direct profit. Too much influence might lead to education focused on existing needs and no future planning and no basic non-profitable research. Another danger is that the students will become mere products and the universities producers for the industry.

How to get interaction and avoid the dangers?

Nowadays, exchanges of information and contacts already exist. The existing channels could be classified after the direction of the information flows and the goals of the companies in spreading the information. Students and the university get information from the companies through company presentations, job fairs, company visits, advertisement and teachers working part time in industry. Through surveys to students, the companies get information from the students about what they think of working in companies, expectations etc. Companies also have different motives for their information. Advertisement is always for selling the company name - either products or in announcing for new employees. That kind of information is focused on showing the best sides of the company and spreading the company's name. Another channel of information is when the companies need a job to be done: could be through internships, projects in co-operation with the school, Master Thesis and PhDs.

To achieve the benefits of an exchange between the three parts, university, industry and students, and avoid the dangers a couple of criteria must be fulfilled. Together the criteria form an ideal channel.

The ideal channel must be continuous. That is updated information must be provided from all parts within not too long intervals. The information flow must be balanced and come from all the three parts: students, university and companies. The information must also be as good a reflection of reality as possible - for example, not only focusing on the best sides of companies, but also giving a more complete picture. Through the channel the needs of all three parts must be expressed. There must be knowledge and wisdom to analyse the information, not all ideas are good and of an improving kind - these must be sorted out. Good ideas though must be taken care of and therefore power of implementation is needed. The channel should be immune to manipulation that may jeopardise the interests of all involved, political for example.

The gathered information should come from several sources so both the realism reflection and the manipulation criteria can be met. The same access to information should be given to everybody.

Possible solutions for channels

Although not perfect, we tried to bring to light some workable solutions as close to the ideal channel as possible, such as:

1. A forum: field presentation
2. Alumni: informal gatherings
3. Interface council

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1- The forum

This is a presentation organised by students (could be part of a job fair), who invite companies that operate (hire) within their fields, to present (for free) their operations and specific needs. Keeping in mind that this should be as strictly non-advertising as possible and that all companies (big and small) should be allowed to speak, so that the coverage is wide as possible.

The targets of this presentation should be university students from all years (which earn first hand knowledge of what's ahead), finishing high-school students (helps making their decisions before enrolling) and University's teachers and ruling bodies (these are essential because of their paramount importance in manipulating the curriculum of the courses).

Included in the program can be debates between company representatives, researcher engineers, university teachers/rulers, and students.

This kind of program, although local in principle (each local field group has it's own forum), it can be widespread. The main advantage is that if this kind of program gets an identification name, and it is implemented in countries/places with a higher acceptance/participation level, it's success could push the more resistant to these kinds of activities into participating in that same program.

2- Alumni: informal gatherings

The alumni (the more recent graduates) can be invited to informal gatherings (like Christmas parties, new year's eve gala balls, etc., organised by students, possibly also connected with job fairs), with attendance from the university's community. These kinds of informal gatherings (already implemented in some places) generate a healthy exchange of information between the companies, the students and the teachers.

3- Interface council

This is a body, made up from both the student and the university's teachers/rulers, who's only function is to research and analyse the industry's demands in terms of education. It then informs the university of what is happening and acts like an advisory board in whatever measures should be taken (if any). Some practical information that can be analysed is the information that results from the companies' human resources benchmarking reunions. Also, analysing what kind of training the companies are giving their recently hired engineers, if a kind of knowledge is needed enough places, it may warrant a change in the curriculum to embrace that specific topic.

Conclusion

This topic clearly deserves more discussion, as the subjects and solutions addressed here are obviously not all embracing. Also the implementation of solutions may differ widely depending on local realities. Hopefully the presented solutions can at least serve as a starting point for a more efficient contact between universities, students and companies.

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Discussion Group 3

Influence on the curriculum

This group has been discussing about the topic of creating a curriculum

Who is responsible of a student's curriculum?

We think that the student is responsible for his own education and the academic institution is responsible sustaining the content of a degree (e.g. preserve its value/ Masters degree or diploma in engineering).

Universities ought to provide the education and means of learning, that is needed in students' professional career and fulfilment of their search of self-development.. He should also have a possibility to get knowledge from the areas that his is interested in even though those areas are not directly connected to his primary field of studies.

Making it possible for a student making wise choices, he has to be well informed. There must be available sufficient qualitative information and consulting. This guidance should consider both, the further studies and professional career. Contact with professional engineers could also help the student decide about his education, giving a picture of real life and the professional role as an engineer.

Some curricula models

Considering the curricula of all engineering educational programs, one can (in a slightly over simplification) easy divide them into three categories: "Totally fixed curriculum system", "Totally free choice" and a "Mixed system". Each of those has its own good points and drawbacks.

The totally fixed system

In this system the university decides every part of the curriculum. The academic world does not have to worry about some student finding an easier way to their degree. Unfortunately this system is very rigid and hard to change and the individual needs of the students are not taken care off, which makes it quite demotivating.

The totally free system

The student is supposed to choose subjects without any guidance or constrains. In this case a big risk is that the reputation of a degree can be damaged and the degree becomes meaningless. Mobility among students would certainly improve. The system cannot motivate students by making connections between courses since all students will not have the same curriculum.

The mixed system

This subject can consist of a number of combinations and is fairly flexible for universities having their own variants.

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One ideal system

Starting from the mixed system above one good system can be created. By dividing subject/courses in three groups, "General Technical knowledge", "Subjects in the field of specialisation" and "Subjects outside field of specialisation" we can make it possible to reduce the compulsory part of the curriculum while preserving a guarantee that each student still will be an expert in his field.

We tried to build a system that would provide qualitative basic knowledge and at the same time give the student enough freedom to build up his own curriculum. Such a system can be motivating from the very first day. The line dividing compulsory to free of choice is drawn such as the centre of mass is located in the field of "General technical knowledge" bordering to "the field of specialisation". In both the specialisation and non-technical subjects are mostly free of choice. As seen in enclosed example the amount of compulsory subjects will decrease every year and the amount free of choice will increase. It should be possible to choose free subjects from any technical-university to increase mobility among students.