

Grupo de Reflexão sobre a Formação em Engenharia Civil da FEUP

1. Introdução

O Departamento de Engenharia Civil da FEUP tem sido ao longo dos anos um formador de Engenheiros com reconhecida competência e qualidade. As modificações do exercício da profissão e as condicionantes legais que se têm verificado nos últimos anos criaram a necessidade de se fazer uma reflexão sobre os caminhos a seguir nos próximos dez a quinze anos. Este repensar sobre o futuro das necessidades de educação e de formação da Engenharia Civil é entendido como uma área estratégica de desenvolvimento que pretende dar resposta às exigências colocadas pela sociedade do conhecimento. Por isso a Comissão Científica da Licenciatura decidiu propor ao Departamento em 5 de Janeiro de 2005 a criação dum grupo misto composto por profissionais activos externos à FEUP e por docentes da mesma.

Esta opção, além de incentivar o diálogo com a sociedade envolvente, em particular com os antigos alunos, pretende promover a transparência das actividades universitárias e contribuir para a valorização destes estudos universitários. A aproximação das empresas e de outras organizações à Universidade pretende a melhoria da qualificação e do desempenho dos recursos humanos respectivos, sendo um dos objectivos a conseguir através da organização deste grupo de reflexão. Espera-se também que ocorram outros benefícios indirectos como o estabelecimento de ligações mais fortes entre o DEC e o exterior, além da melhoria da formação dos futuros Engenheiros deste Departamento.

2. Grupo de Reflexão

Foi criado um grupo formado a convite do Prof. Ferreira Lemos, Director do Departamento de Engenharia Civil, que se reuniu quatro vezes (19Fev, 11Mar, 29Mar e 6Mai). As conclusões que se apresentam são consequência do debate e análise feitos durante estas reuniões e da consideração de documentos vários providenciados pelos membros. Os documentos relevantes encontram-se em anexo. As conclusões gravitam em torno do futuro da formação em Engenharia Civil (EC) da FEUP e englobam também algumas considerações relativas ao processo de Bolonha.

As razões principais da criação deste grupo de reflexão foram o debate sobre a estratégia de desenvolvimento dos cursos de EC (1º e 2º ciclos), a necessidade de escolher as competências dos finalistas de cada um desses dois ciclos e a proposta de áreas científicas a privilegiar no futuro. Foram colocadas algumas questões que foram debatidas e apresentam-se as ideias principais obtidas a partir das respostas e do debate.

3. Questões abordadas

Foram colocados alguns temas para debate que, com o evoluir das trocas de ideias e de opiniões, levaram à concentração em alguns aspectos relacionados com a reflexão sobre a LEC e sobre os outros graus. Um dos aspectos abordados foi o de tentar definir quais as competências esperadas dos finalistas do 1º e 2º ciclos. Outro assunto foi o de saber quais as áreas a privilegiar no curriculum da EC que diferenciem os graus de 1º e 2º ciclos da FEUP em relação a outras escolas. Um outro tema foi o de esclarecer se o 1º ciclo de EC deveria ser único ou se deveria ser dividido em áreas de especialização e quais seriam os âmbitos destas. Um outro tópico de debate foi o de encontrar as características que tornariam atraente o 2º ciclo para os finalistas do 1º ciclo da FEUP e de outras escolas.

4. Conclusões

Em relação ao 1º ciclo esperam-se algumas competências transversais, como economia, gestão e liderança no fim deste mas o maior peso destas competências deverá estar no 2º ciclo. Neste 1º ciclo a banda larga no espectro do curriculum é uma defesa da FEUP. Será na diferenciação entre estes dois ciclos que surgirá a competitividade entre as escolas, o que é saudável para a qualidade dos cursos oferecidos. Se a FEUP for obrigada a ter 1º ciclo as competências no final deste devem ser únicas e não deve haver dois perfis, um profissional e outro de preparação para o 2º ciclo. O 1º ciclo, por prudência, deve ser válido para o mercado de trabalho. Este 1º ciclo deve permitir e potenciar a continuação para o 2º ciclo directamente ou após intervalo.

Em relação ao 2º ciclo este deve ter uma componente de investigação. Na definição deste 2º ciclo a formação tecnológica deve ficar a cargo das empresas e a técnica deve ser dada pela universidade. As formações depois do 1º ciclo devem incluir opções para carreiras de investigação e docência ou para especialização. Estas formações poderão ser constituídas por um 2º ciclo contínuo ou por acumulação de acções de formação discretas que permitam a acumulação de créditos. Os cursos de 2º ciclo da FEUP em EC poderão ter modelos diferentes conforme as áreas.

Os cursos, de ciclo ou de educação contínua, devem procurar a excelência. A filosofia destes cursos da FEUP deve ser conducente a formar engenheiros com as mais elevadas capacidades e competências. As características básicas, além das técnicas, adquiridas pelos que concluem com sucesso estes cursos, devem ser as de uma cultura humanista, integrando conceitos de responsabilidade e de sustentabilidade social e ambiental. Este conjunto de características deve incluir as capacidades de conceber, de adquirir conhecimentos novos e de liderar. Acrescenta-se ainda uma orientação para responder às necessidades duma sociedade competitiva e global – orientação para a criação de valor, seja pela componente de I&D seja pela melhoria da produtividade. Uma razão do sucesso destes cursos é a de poder captar os bons alunos. A aposta mais promissora para a EC da FEUP é a admissão de alunos do 2º ciclo e os cursos de educação contínua, podendo estes ser uma fonte de financiamento adicional. A diferenciação da EC da FEUP será também baseada na educação contínua e nos doutoramentos que poderão ser feitos em ligação com as empresas.

5. Membros

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6. Anexo

Lista de Competências das Escolas de Engenharia Holandesas

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Foreword

This is the second, revised edition of the booklet *Criteria for Academic Bachelor's and Master's Curricula*. It gives a more detailed interpretation of what is meant by academic education at our institutions. The development of a systematic framework for this purpose was originally started at Eindhoven University of Technology. The results of this effort have by now been adopted by Delft University of Technology and the University of Twente.¹

The changes in the second edition are based mainly on experience gained during a pilot project involving the description and analysis of the academic profiles of two Eindhoven programmes of study. In addition, a number of international publications have been consulted. The most significant changes are the removal of overlaps, the sharpening and clarification of criteria where necessary, and the strengthening of the structure. Moreover, the areas of competence of *doing research* and *designing* are treated more analogously. Finally, the nomenclature of the seven areas of competence has been made consistent.

We trust this booklet will lay a solid foundation for discussions about academic education at our three technical universities, and hope that it will play a useful role in the development, execution, and evaluation of our Bachelor's and Master's curricula, as well as in accounting to external bodies.

January 2005

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¹The criteria for academic education have also been adopted by the Radboud University of Nijmegen. A separate edition of the booklet has been published in the context of two collaborative projects between the universities of Eindhoven and Nijmegen.

It is the mark of an educated mind to be able to entertain a thought without accepting it.
Aristotle (384 – 322 BC)

The question of what it means to have an academic education appears, at first sight, to be a simple one. Someone is academically educated when he or she has successfully completed a university education. This, however, is the very answer which it is no longer possible to give in view of the present system of accreditation of higher education programmes in the Netherlands. For, in this system, the question of whether a programme of study merits the predicate 'academic' no longer depends on the institution in which that programme is embedded, but on the content-related characteristics of that programme. And this means that the institutional answer given above to the question of what it means to be academically educated needs to be replaced by a content-related one.

For the universities, this means that they need to reformulate what they stand for in the field of education. What is the university's educational mission, what is its position in the educational spectrum in the years to come, and what is the relationship between education and scientific research? The answer to this question will vary between the different scientific disciplines and programmes of study. There will, however, also be a shared core: that which university programmes stand for in common. This can be described in terms of academic education.

Moreover, for the universities of technology justice needs to be done to the complex world of the engineering sciences. Here, design and application play an important role in addition to the development of theories. They are not just concerned with the analysis, modelling, explanation or interpretation of phenomena, but also with the synthesis of knowledge for designing and making new technological artefacts and

systems in a concrete social context. This is why imagination, creativity, problem solving, and integration of knowledge are important characteristics of an academically educated engineer.

Academic Competences

The starting points for this document were the final report by the Accreditation Committee Higher Education,¹ an unofficial list of qualifications for Bachelor's and Master's degrees of the VSNU (Association of Universities in the Netherlands), and a memorandum on designing at an academic level prepared earlier by the Platform Academic Education of the TU/e. Although it is very important to technological universities, little attention has yet been paid to this last topic in the national debate about academic education. On the basis of the above material and supplementary analyses, a number of areas of competence that characterise a university graduate have been distinguished.

The results were published in the first edition of this booklet, and their usefulness was subsequently tested in an extensive pilot project. Two TU/e programmes were described and analysed in terms of the areas of competence. The contributions of all the compulsory courses to the development of the academic competences were mapped out. This was done on the basis of thorough interviews with the lecturers involved. This project led to a number of adjustments such as the removal of overlaps, the sharpening of formulations and the strengthening of the structure.² A number of international publications were also consulted for this revised edition. The academic competences described here can be regarded as the translation into operational terms for universities of the far broader Dublin descriptors which were formulated from 2002 onwards, and which are used by various policy agencies.³

¹ Final report Accreditation Committee Higher Education, December 2003 (Dissoluble, A. Heer and P. de Heer) (Unversum Committee), published by the Ministry of Education, Culture and Science, 2004.

² The authors would very much like to extend their gratitude to the lecturers of the Industrial Engineering and Management Science and Technological Innovation Sciences programmes for their valuable comments about earlier versions of this publication.

³ See <http://www.jointquality.org/> for the Dublin descriptors. There is also a link with the competences distinguished in the European Union project (Final Report, Phase 1, Bilbao, 2003). See http://europa.eu.int/comm/education/policies/edu/indus/indus_en.html

On the basis of the aforementioned research, it is possible to distinguish seven areas of competence that characterise a university graduate. He or she

1. is competent in one or more scientific disciplines

A university graduate is familiar with existing scientific knowledge, and has the competence to increase and develop this through study.

2. is competent in doing research

A university graduate has the competence to acquire new scientific knowledge through research. For this purpose, research means: the development of new knowledge and new insights in a purposeful and methodical way.

3. is competent in designing

As well as carrying out research, many university graduates will also design. Designing is a synthetic activity aimed at the realisation of new or modified artefacts or systems with the intention of creating value in accordance with predefined requirements and desires (e.g. mobility, health).

4. has a scientific approach

A university graduate has a systematic approach characterised the development and use of theories, models and coherent interpretations, has a critical attitude, and has insight into the nature of science and technology.

5. possesses basic intellectual skills

A university graduate is competent in reasoning, reflecting, and forming a judgment. These are skills which are learned or sharpened in the context of a discipline, and which are generically applicable from then on.

6. is competent in co-operating and communicating

A university graduate has the competence of being able to work with and for others. This requires not only adequate interaction, a sense of responsibility, and leadership, but also good communication with colleagues and non-colleagues. He or she is also able to participate in a scientific or public debate.

7. takes account of the temporal and the social context

Science and technology are not isolated, and always have a temporal and social context. Beliefs and methods have their origins; decisions have social consequences in time. A university graduate is aware of this, and has the competence to integrate these insights into his or her scientific work.

There are relations between the areas of competence mentioned above. They concern (a) the domain of the university graduate – understood here as the fields of study involved (areas of competence 1, 2, and 3), (b) the academic method of thinking and doing (areas of competence 4, 5, and 6), and (c) the context of practicing science (area of competence 7).

The figure below gives a graphical representation of the areas of competence.

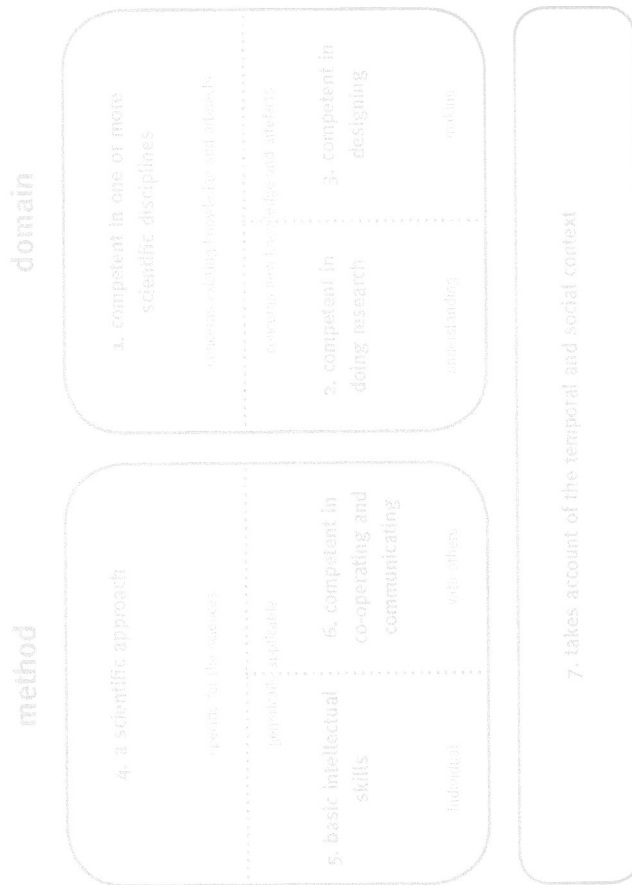


Figure 1: the areas of competence of a university graduate

The seven areas of competence are further developed in this booklet. In doing this, a distinction is made between Bachelor's and Master's competences. The Master's competences should be interpreted as an extension of the Bachelor's competences. As the formulation of competences sometimes places the emphasis where it is not intended, it will always be indicated by means of k, s, and a whether the competence concerned relates mainly to knowledge, skills or an attitude. In the analysis below, skills are almost always combined with knowledge for university graduates, and Master's competences mostly have an attitude aspect. It is not sufficient for a Master to know or to be able to do something – he or she must also have the attitude to use that knowledge or skill in relevant situations.

Dimensions

What is still lacking from the characterisation of the competences is an indication of level. There are usually gradations of competences – from less competent to more competent. With academic competences, such levels will often be expressed in terms of complexity. A university graduate can think and act, research and design, reason and reflect, and so on at a certain level of complexity. Instead of giving levels for all competences, four dimensions which are characteristic of academic thought and action are distinguished below. Scales, along which levels of competences can be specified, can be associated with these dimensions.⁴ The dimensions are:

a. analytic

Analysing is the unravelling of phenomena, systems, or problems into sub-phenomena, sub-systems or sub-problems with a certain intention. The greater the number of elements involved, or the less clear it is what the elements of the resulting analysis are, the more complex the analysis.

b. synthetic

Synthesising is the combining of elements into a coherent structure which serves a certain purpose. That result can be an artefact, but also a theory, interpretation or model. The greater the number of elements involved, or the more closely knit the resulting structure, the more complex the synthesis.

⁴ See Ijja (Bergmans, Authier, Meijers and Kees van Overveld, "Vier Dimensionen van Academische Vaardigheid" (Four Dimensions of Academic Proficiency), <http://www.bur-afes.academiceducation.nl>, for a more detailed discussion of this.

c. abstract

Abstracting is the bringing to a higher aggregation level of a viewpoint (statement, model, theory) through which it can be made applicable to more cases. The higher the aggregation level, the more abstract the viewpoint.

d. concrete

Concretising is the application of a general viewpoint to a case or situation at hand. The more aspects of a situation are involved, the more concrete the viewpoint.

Explanations and examples of the competences and the dimensions will be given in the form of hyperlinks in the electronic version of this document where necessary (see <http://www.tue.nl/academiceducation>).

Criteria for Academic Bachelor's and Master's Curricula

The above competences and the associated dimensions can be used in many ways in university education. Firstly, they not only describe the characteristics of a university graduate, but they also provide the basis for the *generic* learning targets of a university curriculum. After all, academic programmes aim at educating people who have developed these competences to a certain level. In addition, they can be used as a conceptual and judgmental framework in the development, description, analysis, and evaluation of programmes. They can also serve as a source of inspiration for the determination of learning targets of individual courses.

A very different type of use is the articulation of the *academic profile* of a programme. The areas of competence will not have the same relevance for all university programmes. The area of competence *designing*, for example, will play a more important role at a technological than at a general university. This means that programmes can define essential aspects as well as minimum levels in terms of academic competences. Such an academic profile can also be visualised. One way of doing this is on the basis of the amount of study time (eds) spent on a particular area of competence. This yields a so-called radar plot (see figure 2).

different position on the same scale. And, secondly, developments in higher education force universities to be explicit about the final qualifications of their graduates. This calls for clarity with regard to both the concept of academic education and the manner in which it is deployed in the programmes of study.

It is certainly not the purpose of this document to end the debate about academic education. First of all, this would be impossible. And, secondly, it would be undesirable. The debate about academic education is as old as the university itself, and will need to be conducted again in every era. The contribution of this document to this debate is to translate the idea of academic education into operational terms for the Bachelor's and Master's curricula.

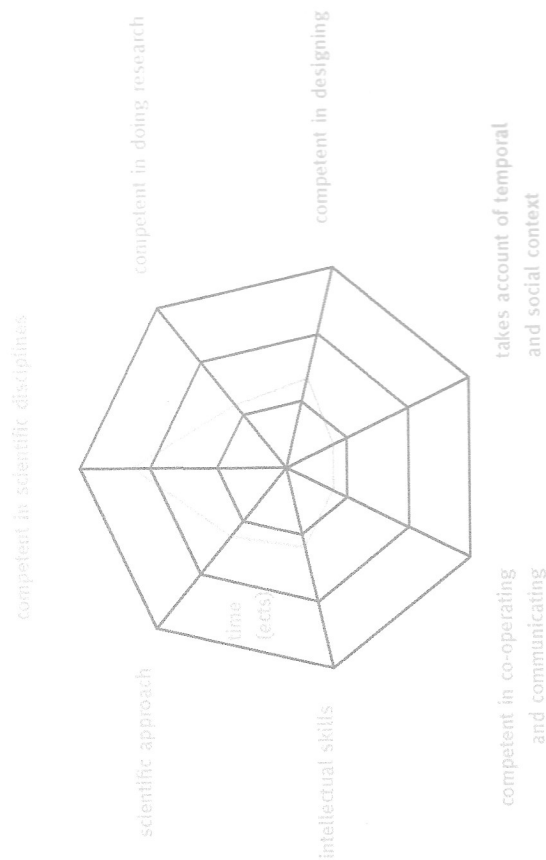


figure 2: example of the academic profile of a study programme

Still another type of use is the testing of students in terms of the academic competences. This can be done in various ways: as an entrance test (Bachelor's or Master's degrees), as an exit test (Bachelor's or Master's degrees) or as a self-test as part of competence-oriented education.

To conclude

Sceptics will believe that it is impossible to analyse the concept of academic education further, and to translate it into operational terms for the purpose of university education. It is too strongly related to erudition which is the result of a lifelong practice of science. The authors of this booklet, however, believe that such a view amounts to throwing in the towel prematurely. First of all, it remains to be seen whether erudite scientists satisfy criteria which are qualitatively different from those applied to graduates, for example. It is quite possible that they merely occupy a