Dutch Bachelor's degrees in Engineering

A competence based Bachelor profile 2016

HBO-Engineering

Website: www.hbo-engineering.nl
Telephone: +31 (0)20 623 01 30
Office address: Weteringschans 223
1017 XH Amsterdam
The Netherlands
Postal address: PO Box 15051
1001 MB Amsterdam
The Netherlands

Foreword

The Bachelor profile Engineering is a general description of the attainment targets for all Dutch Engineering programmes, and a key document linking universities of applied sciences. It defines the starting qualifications for engineers upon graduation. The profile reflects the current Bachelor's programmes and provides a framework by which the learning outcomes and the body of knowledge and skills (BOKS) can be legitimated. Considering the diversity in programmes and professional fields they cater for, the profile is as adaptable as possible. It has been written to allow universities to specialise, while at the same time setting a clear minimum level for all programmes.

This publication is a partly revised version of the Bachelor profile that was published in November 2012. The 2012 publication was the second in its kind and replaced the competence model for Engineering from 2006. Since that time, a lot had happened in higher technical education. The aging working population in the technical sector is putting pressure on the labour market. Specific parts of the sector already suffer from a shortage of qualified personnel. This search for technical talent stimulates universities to focus and distinguish themselves by the programmes they offer. These should not be based on randomly chosen or trendy topics, but on designated regional focal points. These choices should be pay heed to the Dutch government's Top Sector Agenda.

The applied technical universities have worked hard, together with government and business, to hold or even raise enrolment levels. The challenge is now to consolidate that growth and share the lessons learned. Our goal is to have a transparent, clear, attractive and sophisticated array of Bachelor's programmes.

In 2016 the publications has been revised as follows:

- The government's decision to reduce the number of programmes from 36 to 13 leads to a new overview of Bachelor's degrees in Engineering;
- The minimum attainments level have been set for each programme and these are summarised in an overview;
- The body of knowledge and skills has been defined on a national level – examples are given in this publication;
- Some new developments, such as lifelong learning, learning outcomes and course-independent examination, have been included;

- There have been adjustments in the structure and outline of the publication.

For the coming years, the Bachelor profile will be a work-in-progress. In concord with the professional sector this document will periodically reviewed and adjusted. Cohesion between competence, BOKS and learning outcomes merits attention in the near future and this may lead to further adjustments.

We hope that the profile is recognisable and will function as a qualification framework for universities of applied sciences and the professional sector alike, specifically with regards to the starting qualifications of the Bachelor educated engineers of the future.

The board of Domein HBO Engineering

Contents

1. Introduction

What is the Bachelor profile?

This document provides a framework for the attainment targets for Dutch Engineering Bachelor graduates. These attainment targets are defined as competences, in which all necessary knowledge, skills and professional attitudes for engineers at this level are combined. A number of knowledge and skill components are highlighted and described separately as the body of knowledge and skills, which forms an integral part of the competences.

For whom is the Bachelor profile meant?

The Bachelor profile is meant to serve diverse audiences: teachers and university managers, the professional sector, (prospective) students and other interested parties in or outside educational field.

What does the Bachelor profile mean for universities of applied sciences?

For universities this document sets a national standard that has been validated by The Netherlands Association of Universities of Applied Sciences ('Vereniging Hogescholen'). The competences described apply to all applied Engineering programmes that award a Bachelor of Science degree. The universities can formulate their own profile, learning objectives and programme description on the basis of this national standard.

This is useful in developing or updating a Bachelor programme and in promoting the university in a particular region. By linking their programmes' profile to this national standard, universities can safeguard the curriculum and learning outcomes of their programmes for national accreditation. If universities adhere to the profile, this also makes it easier to compare programmes.

For Engineering programmes, the professional context is that of industrial production processes utilising technological knowledge. Within technical education Engineering is one of six domains, the others being Applied Science, Built Environment, Creative Technologies, ICT and Maritime Operations. This is a rough classification, because the boundaries exist only on paper. Programmes as Health Technology or Embedded Systems can simply not be confined to one single domain. At the same time all technical programmes share a fair amount of similar activities, such as problem analysis, research, design and some form of manufacture or production.

What does the Bachelor profile mean for the professional sector?

For the professional sector and prospective employers this profile gives an overview of what skills, knowledge and attitude they may expect from Bachelor graduates in Engineering. Precisely because the technical programmes span a wide array, a general description of Engineering Bachelors allows for an up-to-date overview of the starting qualifications of graduates. Apart from businesses this document is also relevant for branch organisations, employers' associations and training funds. Paying heed to the ideal of lifelong learning, and also following business demands, Bachelor programmes allow for more flexibility these days. This profile is also meant to function as a framework for safeguarding learning outcomes in this respect.

What does the Bachelor profile mean for (tomorrow's) students?

For (prospective) students this profile provides information about the various Engineering programmes. With the ageing working population in the technical sector it is more important than ever that this information is readily available and easily accessible.

How was this profile compiled?

The new profile for Engineering Bachelors was created by Domein HBO Engineering, a national platform representing 16 universities of applied sciences that offer Engineering programmes. In appendix I the creation of this profile is described in more detail.

2. Terms and definitions

Bachelor profile : a professional profile for one or more Bachelor programme within a professional field.

Professional image : the collection of possible professions, jobs or tasks and related competences for an engineer.

Professional domain : the context of the professional field, characterised by one word (or a short combination of words).

Professional field : a collection of all professional occupations in which the Bachelor of Applied Sciences graduate is likely to find employment.

Professional profile : a (national) standard describing the collection of competences that a professional needs to master in order to fulfil a job or position. Universities are expected to develop students' competences to the level of the starting professional.

Body of knowledge

and skills : a description of the specific knowledge and skills in a programme that define the theoretical basis and practical activities of a professional field. Or: the collection of knowledge and skills that students need to master in an Engineering programme to become a competent engineer.

Competence : a cluster of knowledge, skills and attitudes that 1) is necessary to carry out a particular job/task in a particular context; 2) can be measured and tested against accepted norms; 3) can be improved by training and development.

Competence profile : see *Professional profile*.

Context : the applied or natural scientific environment in which Engineering companies operate.

CROHO : the Central Register of Studies in Higher Education registers all the studies funded by the Dutch Ministry of Education, Culture and Science.

	:	a competence at a specific level that someone needs to have mastered as starting professional at the end of the programme (see also *Qualification*).
Position	:	a collection of activities, executed by one or more persons working in a specific context, aimed at contributing to a product or service, utilising certain competences.
Attitude	:	a concrete translation of a competence: a student shows he has mastered the competence by acting in a particular manner.
Qualification	:	a competence at a specific level that someone needs to have mastered at a certain moment (see also *attainment target*).
Learning outcome	:	a description of what a student knows, understands and is able to do after the learning process has ended.
Course-independent examination	:	an assessment of students' learning outcomes, in which the applied methods and instruments have not been aligned with the specific (flexible) course structure of the student.
Programme profile	:	a description of how universities define the curriculum for their programmes, that allows students to develop the competences listed in the professional profile.
Product creation process	:	a number of coordinated phases in the realisation of a service or a product, in which an engineer can play a part.
Interdisciplinary programme	:	a programme that applies Engineering to a different discipline.
Validation	:	acknowledging and valuing relevant learning outcomes realised by an individual student outside a programme.

3. Engineering as a professional field

Dutch universities of applied sciences have always educated engineers working in at home and abroad in very diverse fields, generally with a strong focus on technology. With the continuous developments in the professional practice and technical science the curriculum for higher technical education is changing rapidly.

The technical subjects are both deepening, through nanotechnology and material research, and broadening, because disciplines as energy, sustainability, healthcare, social welfare, mobility, security, design and art are asking for technological knowledge and solutions. The term 'T-shaped' engineer has been used to describe these two dimensions. The past years this broadening has become evident through new programmes and specialisations, bringing technology to other disciplines and sectors. All programmes should tie in with the qualitative and quantitative demands of the labour market. The coming years the labour market for higher educated technical personnel will remain tight. At the same time the entry qualifications for a number of positions are rising.

Based on an analysis of The Netherlands' labour market and economic position, the Dutch government aims to stimulate knowledge and innovation through its Top Sector Agenda. The Agenda lists nine sectors in which businesses, universities and government will work together: Water, Agro Food, Life Sciences, Chemistry, High Tech Systems & Material, Energy, Logistics, Creative Industry and Horticulture & Starting Material.

In these sectors engineers with their different specialisations play an important part. The multidisciplinary approach that is common in all of these sectors requires a combination of thinking and doing, researching and applying. What is needed are people with competences as collaboration with non-technical disciplines, innovativeness, creativity, inquisitiveness and open-mindedness. Most employers in technology and industry work with foreign partners, suppliers and customers. As such, an international mind-set is essential.

4. Engineering as an educational domain

The domain Engineering

Engineering is one of the six technical domains in higher vocational education as defined by The Netherlands Association of Universities of Applied Sciences. The other five domains are:

- Applied Science;
- Built Environment;
- ICT;
- Maritime Operations;
- Creative Technologies.

Naturally, there is some overlap between Engineering and the other domains. Embedded Systems, Installation Technology and Health Technology, for instance, combine Engineering with respectively ICT, Built Environment and Applied Science.

Engineering programmes per 2016

Table 1 lists the 13 programmes that make up the domain Engineering.

Table 1: Programmes that make up the domain Engineering

1.	Automotive
2.	Aviation
3.	Electrical and Electronic Engineering
4.	Engineering
5.	Industrial Product Design Engineering
6.	Logistics Engineering
7.	Aeronautical Engineering
8.	Mechatronics
9.	Health Technology
10.	Maritime Technology
11.	Industrial Engineering & Management
12.	Mathematic Engineering
13.	Mechanical Engineering

National coordination with the professional field

To ensure that developments in the professional field find their way to the national curriculum, there are regular conference meetings with employers, branch organisations and employers' associations. The most important of these are:

FME	:	employers' association of the technology industry;
Uneto-VNI	:	employers' association of the installation sector and electro-technical retail;
De Koninklijke Metaalunie	:	employers' association of the steel sector;
Ingenieursvereniging KIVI-NIRIA	:	branch organisation of engineers and Engineering students;
NLIngenieurs (formerly ONRI)	:	branch organisation of consultancy, management and Engineering firms.

These employers' association and branch organisations also play an important part in developing Engineering positions and aligning them with international technological developments and the international business context.

International educational standards

In 2005 the Framework for Qualifications of the European Higher Education Area was ratified by the European ministers for Education. Within the framework the requisite learning outcomes for a Bachelor's, Master's and PhD degree are defined. These so-called Dublin descriptors have been the starting point for the board of Domein HBO Engineering in the first version of the attainment targets for Bachelor's degrees in Engineering.

5. The professional profile of the engineer

Introduction

This chapter will discuss the competences and body of knowledge and skills for Engineering. The context for these competences is formed by those professional fields that concentrate on the technological development and construction of products and systems through applied science. Alongside these competences there are four important standards by which the Engineering Bachelor graduate can be judged:

- The Dublin descriptors;
- The Dutch Bachelor standard;
- The European Qualifications Framework (EQF);
- The Standards for the Accreditation of Engineering Programmes (EUR-ACE).

In appendix I the standards are discussed in more detail, and in appendix II will be explained how the competences relate to these (inter)national standards.

The Engineering profile consists of eight competences:

1. Analysis
2. Design
3. Realisation
4. Control
5. Management
6. Consultation
7. Research
8. Professionalisation

The structure of the competence profile will be discussed In the next paragraph, as it explains how the competence relate to attitudes and competence levels. In the paragraphs that follow after, the competences will be defined in terms of attitudes.

The structure of the competence profile

The competence profile has an unambiguous structure that allows for changes at several aggregation levels:

- national level;
- university level;
- programme level.

At the national level the eight competences for Bachelor's degrees in Engineering are fixed. They form the framework that all affiliated Engineering programmes adhere to.

Every competence consists of one or more attitudes. These attitudes are also defined in the publication. An attitude operationalises a competence: a student shows that he commands a competence by acting in a specific manner.

On a national level, (minimum) levels are assigned to the competences within a programme, and a body of knowledge and skills is defined. Together, they form the national programme profile. The national profiles of two different Engineering programmes will share the same competences, but differ in competence levels and bodied of knowledge.

Lastly, a university can promote a given programme by giving it a certain focus. The competence levels could be raised, for instance, or the body of knowledge and skills is adjusted accordingly. A programme with a strong focus on product design would presumably choose to set higher levels for the competences 'Analyse' and 'Design'.

Defining competence levels

A Bachelor graduate is expected to function at competence level 3. There are three lower levels, namely 0, 1 and 2, of which level 0 can be taken as the entry level for higher vocational education. The levels are further specified in table 2. The following factors have a bearing on these levels:

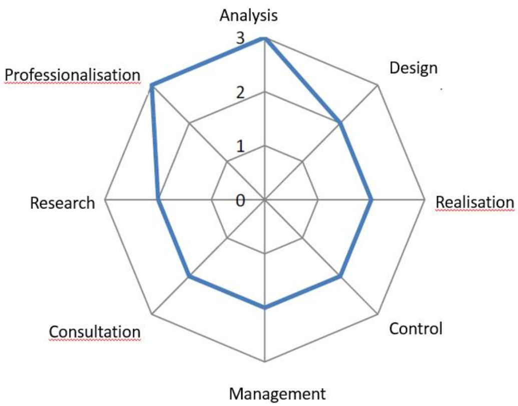
- the size and complexity of the task;
- the complexity of the professional context;
- the degree of independence and responsibility.

Table 2: A definition of competence levels

Level		Nature of the task	Nature of the context	Degree of independence
0	Intake level (HAVO[*] 5 / MBO[†] 4 exit level)			
I		Straightforward, structured, involves direct application of familiar methods according to established standards	Familiar; straightforward, monodisciplinary	Directional supervision
II		Complex, structured, involves application of familiar methods in dynamic situations	Familiar; complex, monodisciplinary, professional practice with supervision	Supervision if necessary
III		Complex, unstructured, involves improving methods and adapting standards to the circumstances	Unfamiliar; complex, multidisciplinary, professional practice	Independent

The guideline for reaching a certain competence level is that at least two out three factors should be at that level, for instance 'type of task' and 'degree of independence.

Figure 1: Competence web for Industrial Engineering & Management



[*] Senior General Secondary Education
[†] Senior Secondary Vocational Education

For every Engineering programme the minimum level for each of the eight competences has been set. The sum of all competence level must be at least 18. Furthermore it is not allowed to leave a competence out: the minimum level is 1. Comprehensive competence profiles (in Dutch) can be found at www.hbo-Engineering.nl. Table 3 gives an overview in summary.

Table 3: A summary of competence profiles

	Analysis	Design	Realisation	Control	Management	Consultation	Research	Professionalisation	Total
Automotive	3	2	2	2	2	2	2	3	*18*
Aviation	3	3	2	2	2	2	2	3	*19*
Electrical and Electronic Engineering	3	3	3	2	2	1	2	2	*18*
Engineering	2	2	2	2	2	2	2	2	*16 +2*
Industrial Product Design Engineering	3	3	3	1	2	2	2	2	*18*
Logistics Engineering	3	3	1	1	2	3	3	2	*18*
Aeronautical Engineering	3	3	2	2	2	2	2	3	*19*
Mechatronics	3	3	2	2	2	2	2	2	*18*
Health Technology	3	2	2	1	2	2	3	3	*18*
Maritime Technology	3	3	2	2	2	2	2	3	*19*
Industrial Engineering & Management	3	2	2	2	2	2	2	3	*18*
Mathematic Engineering	3	3	2	1	1	2	3	3	*18*
Mechanical Engineering	3	3	2	2	1	2	2	3	*18*

Defining competences

This paragraph specifies for each competence how it relates to specific Engineering activities and the accompanying attitudes.

1. Analysis

Analysing an Engineering task entails identifying the problem or client needs, choosing the right design strategy or solution and conclusively charting the possible demands, objectives or conditions. For this a range of methods is employed, such as mathematical analysis, computer modelling, simulation and experimenting. Conditions in fields as (business) economy, commerce, society, health, safety and sustainability are also taken into account.

In analysing, the engineer displays the following attitudes:

a. deciding what aspects are relevant for the question;
b. indicating what economic, societal and technical aspects may be affected;
c. formulating a clear-cut problem definition, objective and assignment, based on the client's demands;
d. drafting and documenting a programme of requirements;
e. modelling an existing product, process of service.

2. Design

Realising an Engineering design requires working together with both engineers and non-engineers. The design can be a machine, process or method and may be more than technical, requiring the engineer to understand the impact his design may have on society, public health, the environment, natural resources, public safety and commerce. The engineer draws on his methodological knowledge in realising a design. The design itself is a full and correct implementation of the programme of requirements.

In designing, the engineer displays the following attitudes:

a. choosing a concept solution (architecture), based on the requirements;
b. drawing detailed designs from the concept solution (architecture);
c. taking into account the design's feasibility and testability;
d. checking the design against the programme of requirements;
e. selecting the right design tools;
f. drawing up documentation for the product, service or process.

3. Realisation

For the realisation and delivery of a product, service or process that meets the requirements set, the engineer must develop practical skills to solve Engineering issues through research and experiments. These skills include knowledge of material use and limitations, computer simulation models, Engineering processes, machines, technical literature and information sources. The graduate is also capable of recognising the (often non-technical) impact of his activities, with respect to ethics, the social environment and sustainability.

In realising, the engineer displays the following attitudes:

a. the right use of materials, processes, methods, norms and standards;
b. assembling components into an integral product, service or process;

c. verifying and validating a product, service or process against the requirements;
d. documenting the realisation process.

4. Control

The engineer allows a product, service or process to function at optimum level in its application context or working environment, while taking into account aspects as safety, environment and technical and economic life.

In managing, the engineer displays the following attitudes:

a. implementing, testing, integrating and commissioning a new product, service or process;
b. contributing to management systems and/or maintenance plans, by monitoring, flagging and optimising (corrective measures) and anticipating (preventive measures);
c. checking the performance of a product, service or process against quality standards;
d. referring back changes in circumstances and/or performance of a product, service or process.

5. Management

The engineer directs organisational processes and manages the employees involved towards the objectives of the business unit or project.

In managing, the engineer displays the following attitudes:

a. starting up a project: quantifying the required time and budget, assessing and weighing risks, setting up the project documentation and organising resources;
b. monitoring and managing activities with regard to budget, time, quality, information and organisation;
c. task and process oriented communication;
d. supervising employees, stimulating collaboration and delegating tasks;
e. communicating and collaborating with others in a multicultural, international and/or multidisciplinary environment.

6. Consultation

The engineer provides well substantiated advice on designing, improving or applying products, services or processes, and brings about profitable transactions involving goods or services.

In advising, the engineer displays the following attitudes:

a. understanding the needs of internal and external customers;
b. clarifying what de client requires;
c. translating the customer needs into technically and financially viable solutions;
d. substantiating an advice to convince the customer;
e. maintaining good relationships with customer.

7. Research

The engineer has a critical stance and an investigative attitude. He uses the appropriate methods and techniques for gathering and assessing information, in doing applied research. Examples of such methodology are literature research, designing and executing experiments, and interpreting data and computer simulations, which requires consulting data sets, standards and safety norms.

In researching, the engineer displays the following attitudes:

a. translating hypotheses into research objectives;
b. independently selecting, validating and obtaining (scientific) literature and other information sources in order to understand the hypothesis fully;
c. summarising, arranging and interpreting results and drawing conclusions regarding the research question;
d. reporting results according to the relevant professional standard;
e. using the obtained results to critically evaluate the approach chosen and provide recommendations for future research.

8. Professionalisation

The engineer gains and maintains the skills necessary for performing the competence effectively. These skills may be relevant in a broader setting. Among other things, this encompasses having an international orientation and a perspective on new developments, social norms and ethical dilemmas.

In professionalising, the engineer displays the following attitudes:

a. choosing a learning outcome and strategy independently, and using the result to reflect on the learning outcome;
b. being flexible in all kinds of professional situations;
c. taking shared norms and values into account when weighing a decision in professional and ethical dilemmas;

d. being constructive in giving and receiving feedback;
e. being able to reflect on his behaviour, thinking and results;
f. being able to use various forms and means to communicate in Dutch and English.

The body of knowledge and skills

In this document the body of knowledge and skills is defined as the cluster of knowledge and skills covered in an Engineering programme. Students must master this to become competent professionals. Each programme has defined its own body of knowledge and skills. Universities coach students in mastering the skills and knowledge and assesses whether they command them at the level required for the profession. The body of knowledge and skills can be split into roughly three parts:

Basics : the elementary knowledge, laws, skills and methods, that form the fundamentals for every graduate within his professional field. These basics are the most obvious parts of the body of knowledge to synchronise at the national level.

Visions : the most important theory and methodology in Engineering practice, that builds upon the basics.

Trends : the current and future developments and movements in practice and science. This allows the student to understand the developments at the cutting edge of Engineering and science.

These above parts have not been decisive in how a body of knowledge and skills is structured, but they have been helpful in identifying its components. Due to the rapid developments in the field, the body of knowledge and skills allows for more variation than the Engineering competences. Universities and programmes have the freedom to make their own choices in visions and trends.

The relation between competences and the body of knowledge and skills

Together with the body of knowledge and skills, the domain competences make up the programme profile. The knowledge and skills described in the body of knowledge and skills are helpful in mastering the competences. Which components of the body of knowledge and skills assist in reaching what competence level – and how – can be further specified in the programme profile.

Table 4 presents an elaboration of the body of knowledge and skills for a randomly chosen programme. It should be stressed that the description is incomplete and presented solely as an example. All body of knowledge and skills components defined here should be viewed from that perspective.

Table 4: Example of a body of knowledge and skills

BoKS item	**Associated engineering competences**
Mathematics: algebra, differentiation, geometry, integration	1) Analysis; 2) Design; 7) Research; 8) Professionalisation
Mechanics: dynamics, statics	-
Design methodologies	-
Statistics: distributions, testing	-
Literature study	-
Systems engineering	-
Result publication: publication standards, publication methods	-
Communication: presentation, reporting, conferencing	-

6. A new development: learning outcomes

Educating Engineering Bachelor students is not a static business. The domain competences recorded in this Bachelor profile form a durable and validated basis for safeguarding the attainment targets. That also applies to universities that are increasing the flexibility of part-time education in response to the trend of life-long learning. Course-independent teaching and examination requires working with learning outcomes. A learning outcome is what a student knows, understands and can do after completing a learning process. Whereas competences are a more general classification of the qualification level of the starting engineer, learning outcomes are more concrete and relate to the learning results that students achieve through university education. Learning outcomes are explicitly related to attainment targets, because the sum of learning outcomes leads to certification. It is up to each programme to formulate their own learning outcomes in cooperation with the professional field. This must be done within a framework, to ensure that the learning outcomes are compatible and can be recognised nationally. Two examples to clarify the relation between a particular learning outcome and the domain competences:

Example A

The student can design an electronic interface from a technical specification, build it as a prototype and demonstrate it satisfies all demands.

Contributes to the development of the competences Analysis, Realise and Research.

Example B

The student can make a technical risk analysis for an electronic problem and consequently formulate a concrete recommendation.

Contributes to the development of the competences Analysis, Consultation and Research.

References

- *Naar 4 op de 10. Meer technologietalent voor Nederland*. *Masterplan Bèta en Technologie*. Commissie Van Pernis, 2012.
- *Profiel van de Bachelor of Engineering, generieke competenties voor sturende, voortbrengende en ondersteunende processen in het domein van de Bachelor of Engineering*, 2006.
- *Bachelor of Applied Science, een competentiegerichte profielbeschrijving*, 2008.
- *Bachelor of ICT, domeinbeschrijving,* 2009.
- *Cahier 1 – competentiegericht opleiden*, Hogeschool van Amsterdam, 2005.
- *Handreiking opstellen van toetsbare eindkwalificaties*, Hogeschool Rotterdam, 2011.
- *Procedure op- en vaststelling landelijke opleidingsprofielen Bacheloropleidingen hogescholen*. Online: http://www.vereniginghogescholen.nl/profielenbank.
- *Kwaliteit als opdracht*, HBO-raad, 2009.
- EUR-ACE: Framework standard for the Accreditation of Engineering Programmes, 2008.
- *The European Qualifications framework for lifelong learning.* Online: http://ec.europa.eu/dgs/education_culture.
- *A Tuning Guide to Formulating Degree Programme Profiles - Including Programme Competences and Programme Learning Outcomes,* 2010. Online: http://nvao.com/page/downloads/A_Tuning_Guide_to_Formulating_Degree_Programme_Profiles_2010.pdf.

Appendices

I. (Inter)national educational standards

I.a Dublin descriptors

The attainment targets for Bachelor graduates have been described in general terms as the Dublin descriptors by the Bologna Group on Qualifications Frameworks.

Knowledge and understanding
Have demonstrated knowledge and understanding in a field of study that builds upon their general secondary education, and is typically at a level that, whilst supported by advanced textbooks, includes some aspects that will be informed by knowledge of the forefront of their field of study.

Applying knowledge and understanding
Can apply their knowledge and understanding in a manner that indicates a professional approach to their work or vocation, and have competences typically demonstrated through devising and sustaining arguments and solving problems within their field of study.

Making judgements
Have the ability to gather and interpret relevant data (usually within their field of study) to inform judgements that include reflection on relevant social, scientific or ethical issues.

Communication
Can communicate information, ideas, problems and solutions to both specialist and non-specialist audiences.

Learning skills
Have developed those learning skills that are necessary for them to continue to undertake further study with a high degree of autonomy.

I.b The Dutch Bachelor standard

In 2009 The Netherlands Association of Universities of Applied Sciences ('Vereniging Hogescholen') put forth its own educational standard, which is quoted in full below.

A thorough theoretical basis
A certain amount of basic knowledge is part of any standard. For new students a proficiency in Dutch, English, calculus and maths is a prerequisite. This knowledge is expected to broaden and deepen during the programme. But foremost it is about technical knowledge that is specific to the chosen discipline. Determining and maintaining this knowledge is a crucial task for universities of applied science. Competence-based learning has been an important innovation in higher education, but the implementation sometimes brought along an underestimation of knowledge. Integrating knowledge, skills and attitudes is part of educating qualified professionals. A stronger focus on knowledge will

change the direction of competence-based learning from what it was a couple of years ago. It is vital that students have the theoretical baggage to engage with their discipline critically and creatively. As such, this knowledge base is intrinsically linked with the Bachelor level.

Inquisitive capability
A Bachelor's degree means more than being able to translate academic knowledge to real-life situations. In our modern society it is crucial that Bachelor graduates have an inquisitive capability that leads them to reflection, evidence based practice and innovation. The commission Abrahamsen proposes that: '… the abilities to analyse problems, to synthesize, to propose solutions and to communicate about various challenges (…), also in a multidisciplinary environment, are becoming more and more important. These abilities are not only important in research environments but also in industry and the society at large. This, in combination with the knowledge and the understanding of real life processes in industry, will give industry additional innovative power. Practical and professional experience of students, by preference from the start of their study in combination with applied research, will allow these competences to develop.'

Professional craftsmanship
Craftsmanship is an integral part of the programmes universities offer. For many Dutchmen the applied Bachelor is the highest received education. It means that our Bachelor programmes must teach the specific skills and knowledge needed for the role of professional in the field. That requires a relation between the university and the field. Teachers with recent practical experience and guest lectures can provide the right context for this. Internships offer students a confrontation between the acquired knowledge and the reality of the profession in practice. Having an international orientation is a part of craftsmanship, just as possessing an entrepreneurial attitude.

Professional ethics and social orientation
Bachelor graduates are not one-sided practitioners. They are professionals that must deal with social and sometimes ethical issues. They possess cultural baggage. They have had – in the true sense of the phrase – an academic training. It is becoming more important that health professionals reflect critically on the dignity of life, that economists ask questions about the relation between short-term profit maximization and long-term trust in the economic system, and that engineers are prepared for a world in which sustainability plays a more central role. We are talking about knowing the meaning of acquired knowledge and skills in their social context. Students may be expected to have the capability to critically evaluate knowledge by moral standards.

I.c European Qualifications Framework

The European Qualifications Framework (EQF) is a reference network that links national frameworks in a European context. It is non-mandatory and describes educational levels, but it is not a system for recognition or ratification. That is for national institutions. EQF is meant to compare and translate national educational systems. It also helps students and professional that move between universities in the EU. National and sectoral institutions are the main users.

EQF describes the regular educational levels in a European context. The framework distinguishes between eight levels, of which the following five are most relevant for higher vocational training:

- Level 5, 'higher education short cycle', corresponds with the Associate Degree level;
- Level 6, 'first cycle', corresponds with the Bachelor's Degree level;
- Level 7, 'second cycle', corresponds with the Master's Degree level;
- Level 8, corresponds with the PhD level.

For each EQF level typical expectations have been defined for the (learning) outcomes and achievements of graduates. The focus is on what someone knows and can do, and not on the length of the programme or other features. In EQF this is described in terms like knowledge, skills and competence. The description of the Bachelor level – the 'first cycle in the European Higher Education Area' – has been ratified by the joint European ministers for Education in Bergen in May 2005, as part of the Bologna Process. In table 5 is specified hoe EQF defines skills, knowledge and competence for the Bachelor level.

Table 5: Definition of skills, knowledge and competences for EQF level

Knowledge	Skills	Competence
In the context of EQF, knowledge is described as *theoretical and/or factual*	In the context of EQF, skills are described as *cognitive* (involving the use of logical, intuitive and creative thinking), and *practical* (involving manual dexterity and the use of methods, materials, tools and instruments)	In the context of EQF, competence is described in terms of *responsibility and autonomy*.
Advanced knowledge of a field of work or study, involving a critical understanding of theories and principles	Advanced skills, demonstrating mastery and innovation, required to solve complex and unpredictable problems in a specialised field of work or study	Manage complex technical or professional activities or projects, taking responsibility for decision-making in unpredictable work or study contexts; take responsibility for managing professional development of individuals and groups

The EQF definitions give an indication of the complexity and depth in knowledge, skills and competence. It corresponds to the competence levels 2 and 3, as defined in chapter 5. The way levels are defined in EQF – on the basis of complexity of the task and context, and the degree of independence in the execution.

I.d EUR-ACE

The Standards for the Accreditation of Engineering Programmes (EUR-ACE) is specific to Engineering programmes. European Engineering associations have drawn up a standard by which curricula can be accredited. EUR-ACE does not guide the Bachelor profile discussed here, but it provides, for the sake of completeness, the European context from the sector's perspective. From the Framework Standards and Guidelines document we cite below the description of the six major themes for the first cycle.

The six Programme Outcomes of accredited Engineering degree programmes are:

- Knowledge and Understanding
- Engineering Analysis
- Engineering Design
- Investigations
- Engineering Practice
- Transferable Skills

Knowledge and Understanding

The underpinning knowledge and understanding of science, mathematics and Engineering fundamentals are essential to satisfying the other programme outcomes. Graduates should demonstrate their knowledge and understanding of their Engineering specialisation, and also of the wider context of Engineering.

First Cycle graduates should have:

- knowledge and understanding of the scientific and mathematical principles underlying their branch of Engineering;
- a systematic understanding of the key aspects and concepts of their branch of Engineering;
- coherent knowledge of their branch of Engineering including some at the forefront of the branch;
- awareness of the wider multidisciplinary context of Engineering.

Engineering Analysis

Graduates should be able to solve Engineering problems consistent with their level of knowledge and understanding, and which may involve considerations from outside their field of specialisation. Analysis can include the identification of the problem, clarification of the specification, consideration of possible methods of solution, selection of the most appropriate method, and correct implementation. Graduates should be able to use a variety of methods, including mathematical analysis, computational modelling, or practical experiments, and should be able to recognise the importance of societal, health and safety, environmental and commercial constraints.

First Cycle graduates should have:

- the ability to apply their knowledge and understanding to identify, formulate and solve Engineering problems using established methods;

- the ability to apply their knowledge and understanding to analyse Engineering products, processes and methods;
- the ability to select and apply relevant analytic and modelling methods.

Engineering Design
Graduates should be able to realise Engineering designs consistent with their level of knowledge and understanding, working in cooperation with engineers and non-engineers. The designs may be of devices, processes, methods or artefacts, and the specifications could be wider than technical, including an awareness of societal, health and safety, environmental and commercial considerations.

First Cycle graduates should have:
- the ability to apply their knowledge and understanding to develop and realise designs to meet defined and specified requirements;
- an understanding of design methodologies, and an ability to use them.

Investigations
Graduates should be able to use appropriate methods to pursue research or other detailed investigations of technical issues consistent with their level of knowledge and understanding. Investigations may involve literature searches, the design and execution of experiments, the interpretation of data, and computer simulation. They may require that databases, codes of practice and safety regulations are consulted.

First Cycle graduates should have:
- the ability to conduct searches of literature, and to use databases and other sources of information;
- the ability to design and conduct appropriate experiments, interpret the data and draw conclusions workshop and laboratory skills.

Engineering Practice
Graduates should be able to apply their knowledge and understanding to developing practical skills for solving problems, conducting investigations, and designing Engineering devices and processes. These skills may include the knowledge, use and limitations of materials, computer modelling, Engineering processes, equipment, workshop practice, and technical literature and information sources. They should also recognise the wider, non-technical implications of Engineering practice, ethical, environmental, commercial and industrial.

First Cycle graduates should have:
- the ability to select and use appropriate equipment, tools and methods;
- the ability to combine theory and practice to solve Engineering problems;
- an understanding of applicable techniques and methods, and of their limitations;
- an awareness of the non-technical implications of Engineering practice.

Transferable Skills
The skills necessary for the practice of Engineering, and which are applicable more widely, should be developed within the programme.

First Cycle graduates should be able to:
- function effectively as an individual and as a member of a team;
- use diverse methods to communicate effectively with the Engineering community and with society at large;

- demonstrate awareness of the health, safety and legal issues and responsibilities of Engineering practice, the impact of Engineering solutions in a societal and environmental context, and commit to professional ethics, responsibilities and norms of Engineering practice;
- demonstrate an awareness of project management and business practices, such as risk and change management, and understand their limitations;
- recognise the need for, and have the ability to engage in independent, life-long learning.

II. The relation between the domain competences and (inter)national standards

The domain competences correspond to the national standards and international references described in appendix I. The Dublin descriptors and the Dutch Bachelor standard have been the starting point for the Engineering profile: the first describes the internationally accepted level for the Bachelor, and the latter the national level. One of the requirements the Dutch government has set for accreditation, is that the level of Bachelor programmes complies with national and international standards.

The national programme profiles, that are derived from the professional profiles, encompass the Dublin descriptors and the Dutch Bachelor standard. As such, if the student satisfies the programme profile, he also satisfies both the national as the international level for the Bachelor.

This appendix also gives a global specification of how the domain competences relate to the European Qualifications Framework and EUR-ACE.

II.a Dublin descriptors

Table 6: Domain competences in relation to the Dublin descriptors

Engineering competences	Knowledge & understanding	Applying knowledge & understanding	Making judgements	Communication	Learning skills
1. Analysis	x‡	x	a, b	c, d	
2. Design	x	x	a, e	f	
3. Realisation	x	a, b§	c	d	
4. Control	x	x	c	d	

‡ A cross indicates that all behavioural characteristics of the engineering competence in question contribute to fulfilment of the Dublin descriptor.
§ A letter indicates that a particular behavioural characteristic of the engineering competence is related to the EUR-ACE theme.

5. Management	x	a	b	c, d, e	
6. Consultation	x	d	c	a, b, d, e	
7. Research	x	a	b	c, d, e	e
8. Professional-isation	x	x	a, b, c	d, f	x

II.b The Dutch Bachelor standard

Table 7: Domain competence in relation to The Dutch Bachelor standard

Engineering competence	Sound theoretical basis	Investigative ability	Professional skill	Professional ethics and community focus
1. Analysis	x	x	x	b
2. Design	x		x	x
3. Realisation	x		x	
4. Control	x	c, d	x	
5. Management	x		x	
6. Consultation	x	a, b, c, d	x	
7. Research	x	x		
8. Professionalisation	x		x	c, d, e

II.c European Qualifications Framework

Table 8: Domain competences in relation to the European Qualifications Framework

KNOWLEDGE	SKILLS	COMPETENCES
is described as theoretical and/or factual.	- *cognitive (involving the use of logical, intuitive and creative thinking);* - *practical (involving manual dexterity and the use of methods, materials, tools and instruments).*	*In the context of EQF, competence is described in terms of responsibility and autonomy.*
	Level 6:	
advanced knowledge of a field of work or study, involving a critical understanding of theories and principles	advanced skills, demonstrating mastery and innovation, required to solve complex and unpredictable problems in a specialized field of work or study	- manage complex technical or professional activities or projects, taking responsibility for decision making in unpredictable work or study contexts; - take responsibility for managing professional development of individuals and groups.

II.d EUR-ACE

Table 9: Domain competences in relation to EUR-ACE

Engineering competence	Knowledge & Understanding	Engineering Analysis	Engineering Design	Investigations	Engineering Practice	Transferable Skills
1. Analysis	x	x				
2. Design	x		x			
3. Realisation	x				x	
4. Control	x		b		a, c	d
5. Management	x					x
6. Consultation	x					
7. Research	x			x		
8. Professionalisation	x					x

III. An overview of Dutch Engineering programmes

This appendix gives an overview of all Engineering programmes taught at Dutch universities of applied science as of September 2016.

	Automotive	Aviation	Electrical Engineering	Engineering	Industrial Product Design	Logistics Engineering	Aviation Technology	Maritime Technology	Mechatronics	People and Technology	Industrial Engineering & Management	Applied Mathematics	Mechanical Engineering
Avans University of Applied Sciences			x						x	x	x		x
Windesheim Christian University of Applied Sciences			x	x	x	x					x		x
Fontys University of Applied Sciences	x		x		x	x			x	x	x	x	x
The Hague University of Applied Sciences			x		x				x	x	x	x	x
Hanze University of Applied Sciences			x		x						x		x
Inholland University of Applied Sciences			x				x				x	x	x
Rotterdam University of Applied Sciences	x		x		x	x		x		x	x		x
Utrecht University of Applied Sciences			x								x		x
Amsterdam University of Applied Sciences		x		x		x						x	
Arnhem and Nijmegen University of Applied Sciences	x		x		x						x		x
HZ University of Applied Sciences				x		x					x		
NHL University of Applied Sciences			x					x			x	x	x
Saxion University of Applied Sciences			x		x				x		x		x
Stenden University of Applied Sciences													x
Zuyd University of Applied Sciences				x						x			