5. THE PROFESSIONAL PROFILE OF THE ENGINEER

5.1 INTRODUCTION

This chapter lists and explains the domain competences for Engineering. The context within which these domain competences apply is that of the industrial manufacturing process for products based on technological knowledge. Together with these domain competences, there are two other important standards with which the starting professional practitioner at higher professional education level must comply:

- Dublin descriptors (see appendix I);
- Higher professional education standard (see appendix II).

The domain competences defined in this chapter are linked in chapter 6 to these and other (national and international) standards.

The profile for the Domain Engineering consists of eight domain competences:

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

Each of these domain competences is defined and further elaborated in the following paragraphs according to behaviour characteristics, and then linked to a Body of Knowledge & Skills (BoKS). The behaviour characteristics are formulated in such a way that they apply to start-competent professional practitioners.

Before further elaborating these competence levels and the domain competences (see § 5.3 and § 5.4 respectively), a structure for the entire competence profile is first elaborated (see § 5.2). After all, this profile will determine any interaction and relationships between the competences, behaviour characteristics, competence levels and the BoKS components

5.2 STRUCTURE FOR THE COMPETENCE PROFILE FOR ENGINEERING

The competence profile comprises a uniform structure that makes it possible to introduce changes at various levels of aggregation:

National Bachelor of Engineering level: all engineering study programmes in the Netherlands;
National level per study programme / CROHO:
all study programmes with the same CROHO;
Study programmes/CROHO from a single specific university of applied sciences.

At national level, the eight domain competences are already laid down (see § 5.1). These domain competences form the starting point for all affiliated higher professional education engineering study programmes.

Each domain competence consists of one or more behaviour characteristics. These behaviour characteristics are also defined in this national Bachelor of Engineering profile. Each behaviour characteristic specifically describes a single competence: a student shows that he masters a competence by acting/performing in a specific manner.

Also at national level, but then in respect of each study programme, (minimum) competence levels are linked to the domain competences, and a Body of Knowledge & Skills (BoKS) can be defined. The result then forms the national study programme profile. One possibility for achieving full agreement on this profile is to initiate national study programme consultation. The national profiles from two different engineering study programmes share the same domain competences, but as a rule are linked to other competence levels and other BoKS.

Finally, a study programme within a specific university of applied sciences can establish an individual profile by allocating specific focus. This can be achieved both by raising the level of competence or by allocating a specific structure to a BoKS.

In this document, a BoKS should be taken to be the grouping of knowledge and skills covered in an engineering study programme. This knowledge and these skills must be acquired by students in order to make them competent in the profession. This means that every study programme can define its own BoKS (for example in the study programme profile), but also that a number of BoKS components can be harmonised at national level.

The study programme assists the students to acquire this knowledge and these skills. The study programme also examines whether the knowledge and skills have reached the final attainment level considered desirable by the profession. The knowledge and skills can broadly be split into three components:
Basics: elementary knowledge, basic laws and basic skills/methods, essential as a foundation for any graduate within the subject area. These basics are the most obvious BoKS components for a harmonisation agreement at national level.
Visions: the most important theories and methods for engineering practice and science, and as such the next level built on the basics.
Trends: the current and future-oriented developments & schools of thought in professional practice and science. According to these trends, at the very cutting edge of engineering and science, the student is able to follow developments in the subject area.

Although these components are not decisive in the structuring of a BoKS, they can assist in identifying the BoKS components.

Given the rapid developments in the various specialist fields, the BoKS is more in a state of flux than the engineering competences. This offers space to universities of applied sciences and to individual study programmes to make choices in specific visions and trends, in examples and (cited) sources.

Chapter 7 provides an example of a BoKS and the way in which the BoKS can be linked to the domain competences. In its study programme profile, a study programme can further elaborate the BoKS, and clarify which and how many BoKS components are necessary in order to raise a competence to a specific level.

5.3 DEFINITION OF COMPETENCE LEVELS

Alongside the final attainment level of a recently graduated bachelor (level III), a number of other lower levels have been formulated, namely 0, 1 and II, of which level 0 refers to pre-higher professional education level (also known as intake level). In table 5.3, these levels are further explained. The following factors influence these levels[4]:

a. Scale/scope and complexity of the task
b. Complexity of the professional situation
c. Degree of independence and responsibility.

Table 5.3 further elaborates these factors, whereby it should be commented that level I in higher professional education (hbo) exceeds the final attainment level of a senior secondary vocational education programme (mbo) (see also appendix VI)[5].

By means of classification according to competence levels, study programmes can make a choice to place specific accents in their study programme profile. A study programme focused heavily on product design will probably opt to train its higher professional education bachelors to level III for the competences 'Analysis' and 'Design'. National consultation for each study programme could for example also consider agreeing on a higher minimum level for a domain competence (for example 'Research')

Table 5.3 Definition of competence levels

Level	
0	Intake level (senior general secondary education (havo) 5 / senior secondary vocational education (mbo) 4 final attainment level
I	**Nature of the task:** simple, structured, applies known methods directly according to fixed standards. **Nature of the context:** known, simple, monodisciplinary **Degree of independence:** supervision and guidance
II	**Nature of the task:** complex, structured, adapts known methods to changing situations. **Nature of the context:** known, complex, monodisciplinary, in practice under supervision **Degree of independence:** supervision if necessary
III	**Nature of the task:** complex, unstructured, improves methods and adapts standards to situations **Nature of the context:** unknown; complex, multidisciplinary in practice **Degree of independence:** independent

[4] Source: HvA (2005). Cahier 1 – competence-oriented education
[5] Source: Hogeschool Rotterdam (Sept. 2011). Guide to drawing up examinable final qualifications

The guideline for demonstrating achievement of a level is that two of the three factors must be at that level, e.g. ‘nature of the task’ and ‘degree of independence’.

In linking the competence levels to the eight domain competences, the following suggestions are made[6]:

The sum of the eight competence levels should be at least 18;
A domain competence cannot be left out (minimum level is level I).

This document primarily describes the bachelor level (EQF level 6, see § 6.3). The domain competences described here and the competence levels are all ideal for the description of other qualification levels such as

Associate Degree (AD): an AD study programme is in principle part of a bachelor study programme, but offers a lower final attainment level (EQF level 5).
Professional Master: this term refers to a higher professional education master (EQF level 7). To this end, a fourth competence level could be defined.

5.4 DEFINITION OF DOMAIN COMPETENCES

In this paragraph, for each competence, an indication is given of the relevance of each competence for the type of work of an engineer, and the accompanying behaviour characteristics.

1. ANALYSIS

The analysis of an engineering question/issue comprises the identification of the problem or customer need, the consideration/balancing of possible design strategies / proposed solutions and the unambiguous charting out of the requirements / objectives / parameters. In this process, a whole range of methods are used, including mathematical analyses, computer models, simulations and experiments. Parameters relating to (commercial) economics & commerce, man & society, health, safety, environment & sustainability, etc. are also considered.

The start-competent professional demonstrates this competence according to the following behaviour characteristics:

a. selection of relevant aspects in respect of the question/issue;
b. indication of the possible influence on commercial, social and specialist subject-related aspects;
c. formulating a clear problem outline, objective and assignment according to the wishes of the customer;
d. drawing up a schedule of (technical and non-technical) requirements and laying down those requirements;
e. modelling an existing product, process or service.

[6] These suggestions are the result of a number of workshops held with participants during the national consultation session ‘Higher Professional Education Engineering’ (HvA, 18-11-2011; HU, 15-02-2012; Hogeschool Windesheim 20-04-2012)

2. DESIGN

Implementing an engineering design and in that process being able to collaborate with engineers and non-engineers. The design to be realised may be for a device, a process or a method, and may consist of more than simply the technical design, whereby the engineer has a sense of the impact of his design on the social environment, health, safety, the environment, sustainability (e.g. cradle-to-cradle) and commercial considerations. In drawing up his design, the engineer makes use of his knowledge of design methods, and is able to successfully apply that knowledge. The design to be realised is based on the schedule of requirements and forms a complete and correct implementation of all requirements imposed.

The start-competent engineer demonstrates this competence according to the following behaviour characteristics:

a. on the basis of the requirements imposed, is the ability to elaborate and select a concept solution (architecture);
b. producing detailed designs according to the selected concept solution (architecture);
c. the ability to take account of the makability and testability of the design;
d. verifying the design according to the schedule of requirements;
e. selecting the correct design tools;
f. drawing up the documentation for the product, service or process.

3. REALISATION

The realisation and handover of a product or service or the implementation of a process that fulfils the requirements imposed. In this connection, the engineer develops practical skills for solving engineering problems and with that in mind carries out studies and tests. These skills include knowledge of the use and limitations of materials, computer simulation models, engineering processes, equipment, practical skills, technical literature and sources of information. The bachelor is also capable of overseeing the (often non-technical) consequences of his work, for example in respect of ethics, the social environment and sustainability.

The start-competent professional demonstrates this competence according to the following behaviour characteristics:

a. making suitable use of materials, processes, norms and standards;
b. assembling components into a complete product, service or process;
c. verifying and validating the product, service or process in respect of the requirements imposed;
d. documenting the realisation process.

4. CONTROL

Ensuring that a product, service or process operates ideally in its application, context or working environment, taking account of aspects relating to safety, the environment, technical and economic lifetime.

The start-competent engineer demonstrates this competence according to the following behaviour characteristics:

a. introducing, testing, integrating and commissioning a new product, service or process;
b. delivering a contribution to control systems and/or maintenance plans, both corrective (monitoring, identifying and optimising) and preventive (anticipating);
c. the ability to assess the performance of a product, service or process according to quality criteria;
d. the ability to provide feedback in response to changing circumstances and/or performance of a product, service or process.

5. MANAGEMENT

The engineer directs and orders organisation processes and the related staff with a view to achieving the objectives of the organisation component of the project of which he is in charge.

The start-competent engineer demonstrates this competence according to the following behaviour characteristics:

a. organising a (sub)project: quantifying time and money, assessing and quantifying risks, drawing up project documentation and organising resources (human and material);
b. monitoring and readjusting activities in terms of time, money, quality, information and organisation;
c. task and process-oriented communication;
d. supervising employees, encouraging cooperation and the ability to delegate;
e. communication and cooperation with others in a multicultural, international and/or multidisciplinary environment, and fulfilling the requirements imposed by participation in a labour organisation.

6. ADVICE

The engineer offers well-argued advice on the design, improvement or application of products, processes and methods, and establishes profitable transactions with goods or services.

The start-competent engineer demonstrates this competence according to the following behaviour characteristics:

a. empathy with the position of the (internal or external) customer;
b. clarifying the needs of the client;

c. in consultation with relevant parties, translating the customer requirements into technically & economically-viable solutions;
d. the ability to underpin advice with argument, and duly convince the client;
e. adequately maintaining relationships with clients.

7. RESEARCH

The engineer has a critical researching/investigative attitude and uses suitable methods and techniques for acquiring and assessing information to be able to undertake applied research. These methods can include: literature study, the design and execution of experiments, the interpretation of data and computer simulations. With this in mind, databases, standards and (safety) standards are consulted.

The start-competent engineer demonstrates this competence according to the following behaviour characteristics:

a. Drawing up the objectives for a specific study/research programme on the basis of the underlying question;
b. Independently selecting (scientific) literature and own / other information sources for acquiring further in-depth knowledge of the question, thereby demonstrating the ability to validate the reliability of the various information sources;
c. summarising, structuring and interpreting the results and drawing conclusions in relation to the study question;
d. reporting on the results according to the standards applicable in the professional field;
e. on the basis of the results obtained, critically analysing the selected approach and issuing recommendations for follow-up study.

8. PROFESSIONALISATION

Acquiring and maintaining the skills needed to be able to effectively implement the engineering competences. These skills can also be applicable in a broader context. This includes maintaining an international orientation and the ability to place the latest developments, for example in relation to social standards, values and ethical dilemmas.

The start-competent engineer demonstrates this competence according to the following behaviour characteristics:

a. independently defining and executing a learning target and learning strategy, and feeding the result back to the learning target;
b. adopting a flexible approach in a range of professional situations;
c. when faced with professional and ethical dilemmas, making sound considerations and taking a decision, taking account of accepted standards and values;
d. the ability to offer and receive constructive feedback in respect of both behaviour and content;
e. the ability to reflect on own actions, thoughts and outcomes;

f. the ability to use a range of forms of and tools for communication in order to be able to effectively communicate in Dutch and English.