# Wanted: super(wo)man

## A study to define professional roles for future engineers by distinctive professional competences.

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### INTRODUCTION

Excellent communication skills, work independently, a big team player, fluent in English … This is just a selection of professional competences mentioned in vacancies addressed to young engineers. Unless they are super(wo)man, it is impossible for engineering students to acquire a mastery level in all professional skills [1].

Different types of jobs are associated with different demands. The professional role is relevant for explaining the importance of competences [2]. For example, some competences are more relevant for an engineer working in maintenance than for one working with customer relations. Students who can identify their strengths, become more specialized and more confident in a professional role, will increase their employability [2–4].

Cech et al. (2011) identify two dimensions of professional role confidence [3]. (1) Expertise confidence refers to the confidence students have in a set of competences required in a kind of profession. (2) Career-fit confidence encompasses the confidence that a professional role will suit the students' particular interests, needs and values. Where career fit is more about students' alignment with a certain profession, the expertise fit is about students' assessment of their own abilities and competences.

Both dimensions are addressed in the PREFER project (Professional Roles and Employability for Future EngineeRs). This European project aims to reduce the skills mismatch in the field of engineering by increasing students' awareness of their strengths, weaknesses and interests by offering them opportunities to actively explore the different engineering roles [5]. Not only do we want to provide students a better understanding of what it is to be an engineer, we also want to provide students a better understanding of what kind of engineer they want to be.

Hence, the aim is to design a validated Professional Roles Framework for Future Engineers. The framework consists of three roles, independent of domain or sector and described by typical professional competences [5].

This paper focuses on the performed research about the key competences per role. In a two hour round table discussion, 12 expert panels of engineers and HR managers reflected on the key competences of the three roles. The result is a list of competences per role that picture the specific competences industry and business organizations require from young engineers to be successful in that professional role.

## 1 PROFESSIONAL ROLES FOR FUTURE ENGINEERS

### 1.1 Professional competences

Many studies focus on the essential professional competences in the field of engineering, but it is often presumed that all engineering careers require the same balance of technical and professional skills [6]. However, some studies demonstrate that different engineering roles require different skill sets. Brunhaver et al. (2013) asked alumni to rate the importance of a set of 20 professional competences in their job. Results indicate that for example problem solving and analytical skills were deemed equally important in all engineering sub-occupations, but communication was less important in some and more in others [6]. Male et al. (2011) identified competences were inter-related and their importance varied across job tasks and work contexts. They question the assumption that professional competences are the same for all jobs [7].

### 1.2 Professional roles

A Professional Roles Framework for young engineers was designed with three roles, based on the value disciplines of Treacy & Wiersema [8]: operational excellence (engineers who focus on process optimization), product leadership (engineers who focus on radical innovation) and customer intimacy (engineers who focus on tailored solutions). Previous research by Hofland (2015) and De Norre (2016) tested whether the model was recognized by the different stakeholders (industry and higher education). More specifically, 92% of the HR representatives and engineers that filled in the questionnaire of Hofland (N=122) confirmed they recognized these roles within their company [9]. De Norre mapped the roles to the learning outcomes of the KU Leuven Faculty of Engineering Technology and investigated how the roles could be implemented in the curriculum. Students were able to indicate a preference for one of these roles [4].

### 1.3 Competency profiles

Based on the previous research, the professional roles will be optimized by developing competency profiles for each role. A competency profile pictures the essential and typical professional competences required in a particular role.

The raised research question in this paper is the following:

*“Which professional competences do engineering students need to possess in order to be successful in one of the professional roles?”*

## 2 METHOD

A **modified Delphi method** was used to develop competency profiles. The Delphi method is widely used across numerous disciplines as a method to seek expert opinion in an iterative structured manner [10]. The methodology was chosen for its potential to simultaneously explore similarities and differences of opinions.

The Delphi technique is a consensus development technique with the following characteristics: anonymity, iteration and controlled feedback [11]. We modified this technique to a mixed method that combines a collection of quantitative data with the qualitative methodology of a group discussion in a face-to-face round table setting.

### 2.1 Participants of the expert panels

Experts were identified as engineers and HR managers or recruiters with expertise in hiring engineers. Both parties can make a good estimate of the required competences for a certain role.

We set up 12 expert panels. 11 panels were organised in companies from different sectors: construction, nuclear & energy, telecommunication, automotive, 3D printing in manufacturing and biomedical technology, automation, (micro-) electronics & IT, chemical and nutrition. A 12th mixed panel was organized with experts from different

sectors and from companies with different sizes (start-up, SME, large company, independent entrepreneur).

During a preliminary meeting that took place before the expert panel, we presented the research project to our liaison in the company. The liaison selected the experts within his or her company according to the following criteria:

1. 6 to 8 engineers from different professional roles, preferably of different age and experience;
2. 1 or 2 recruiters or HR managers with expertise in hiring engineers;
3. male and female experts.

Eight participants (min. 6, max. 10) are considered a good panel size to provide enough input for the discussion and encourage a good group conversation [12].

| Expert | Female | Male | Total |
|---|---|---|---|
| Engineer | 8 | 61 | 69 |
| Engineer with HR expertise | 0 | 3 | 3 |
| HR | 8 | 7 | 15 |
| **Total** | **16** | **71** | **87** |

*Table 1*. Participants of the 12 expert panels

## 2.2 Panel structure

The expert panels were led by the researcher-observer and the moderator. The moderator, an expert in talent management and HR screening tools, led the actual expert panel without bias (Figure 1, phase 2 and 3). The next paragraphs will describe the different steps of the panel.

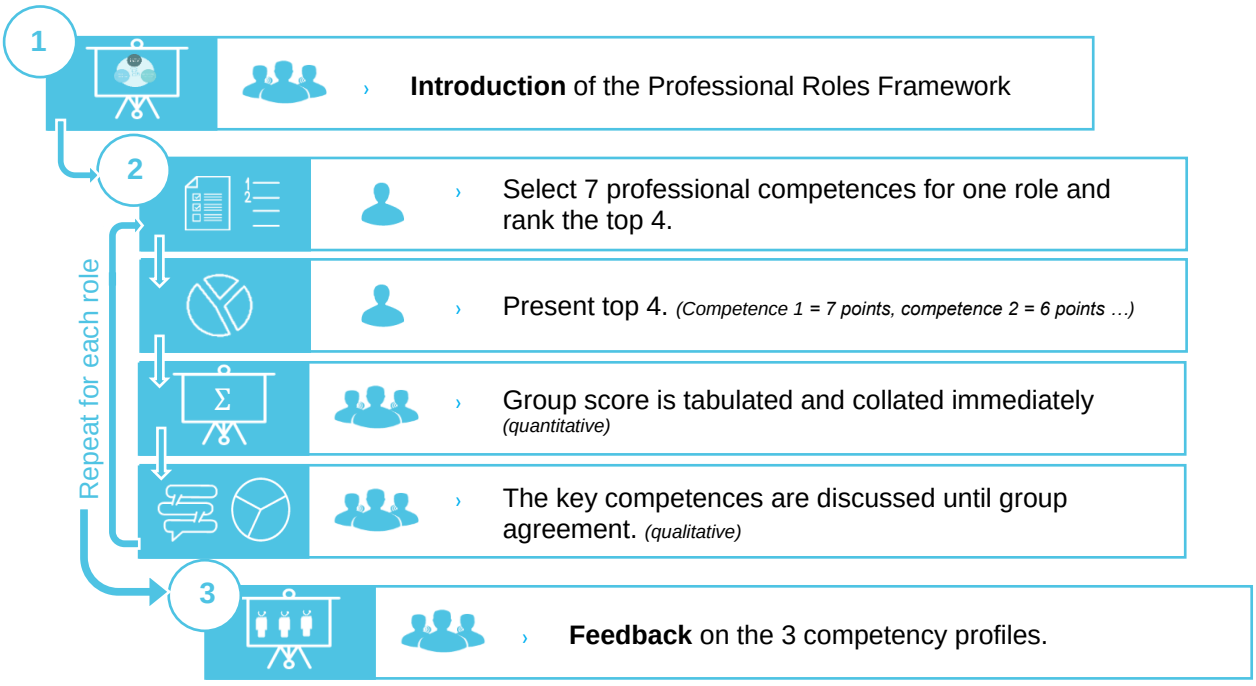


*Figure 1.* Different steps of an expert panel

## 2.3 Phase 1 : introduction of the professional roles

The researcher explained the model to the experts using the overview of the different roles in table 2. Competences were not mentioned to define the roles. The participants were allowed to give feedback to the model or ask questions to clarify the roles.

| CORE PROCESSES | OPERATIONAL EXCELLENCE | PRODUCT LEADERSHIP | CUSTOMER INTIMACY |
|---|---|---|---|
| | PROCESS OPTIMIZATION | RADICAL INNOVATION | TAILORED SOLUTIONS |
| | ▪ Focus on increasing efficiency & reliability | ▪ Focus on new cutting edge products or processes | ▪ Focus on customer satisfaction |
| | › Cost, logistics & resource efficiency<br>› Quality assurance: high reliability<br>› Sustainable maintenance<br>› Subcomponent analysis & priorities<br>› Standardization & flow optimization: process (re-)design<br>› … | › Research: high level of specialised knowledge<br>› Fast development<br>› Commercial exploitation<br>› Market exploration (internal + external market)<br>› Superior branding<br>› … | › Individual customer needs analysis<br>› Client-centred customized solutions<br>› Client acquisition & establishing long-term client relations<br>› Integration and implementation in client systems<br>› Follow-up support service & training<br>› … |

*Table 2.* Three roles for young engineers, defined by core processes

## 2.4 Phase 2 : Individual assessment & group discussion

### Principles and guidelines

The moderator explained the principles and guidelines to the experts:

- One exercise consists of 2 rounds: (1) individual assessment and (2) group discussion
- The exercise is finalized when the experts reach consensus about the competency profile or decide that no consensus can be reached.
- Consensus is reached when the experts agree on 6 to 10 competences that define the role.
- The exercise will be repeated for each of the three roles, with a final feedback moment at the end (phase 3).

### Selecting competences individually

The participants received an extensive list of 64 professional competences, based on the Big Eight Competences, described by Bartram (2005) as a model of performance in the workplace. The framework is often used to develop diagnostics tests in recruitment [13]. The competence list is available on request.

The experts selected individually seven competences that seemed to be the most crucial ones for each particular role. Afterwards, they were asked to rank them from most important to least important.

### Feedback on individual outcomes

The experts presented the top four of the selected competences in order of importance. No discussion was allowed to avoid that participants would feel limited to express their opinion. The competences were tabulated and scored simultaneously by the researcher. Competence 1 got seven points, competence 2 got six points etc. When all the experts had presented their top 4 competences, the researcher could easily calculate the final group score.

### Group discussion

The group score was presented to the panel. The moderator indicated certain particularities, e.g. a clearly defined top 3 or a less distinctive top 5. The top 5 (or more in the case of equally scored competences) was highlighted and presented as the key competences that picture the role. Based on this information, the group discussion started. Experts could add competences that were mentioned but did (not) make it to the top or decide a competence was ranked too high. They also had the opportunity to add competences that were not mentioned in the individual outcomes.

The group score fed the discussion. The scores will not be used for further analysis as the ranking changed through the group discussion. The discussion ended when consensus was reached on six to ten competences or when the panel decided they could not reach consensus.

### 2.5 Phase 3 : feedback on group outcomes

When phase 2 was repeated for the three roles, the competency profiles were presented again to the panel. The experts had the opportunity to confirm the consensus or to make adjustments after comparing the three profiles.

## 3 RESULTS

All the panels reached **consensus** on the competency profiles. As the panels were organised in-company, the company culture and strategy might have facilitated the consent between the experts. The mixed panel also reached consensus, but the experts had to argue more profound and illustrate with more examples why a competence was more or less relevant.

One panel managed to describe the roles by five competences. The other panels pictured the roles by six to ten competences (**average eight competences per role**). After a few panels, clear patterns appeared in the competency profiles. The point of data saturation was reached in the 12$^{th}$ panel: no new elements were added in the group discussions that were not mentioned in one of the previous panels.

The competency profile of the operational excellence role seemed the most difficult to construct. In all panels, the individual outcomes resulted in a longer list of essential competences than the lists of product leadership or customer intimacy. The top scores were less distinct (see also table 3) and the discussion was more intense. Nonetheless, the experts recognised the importance of this role and declined to advice a redefinition

of the role or to scale the framework with a fourth role. The more extensive outcome is likely typical for the role of operational excellence, which can include various functions, tasks and responsibilities.

Although the competence list provided a brief and comprehensive definition per competence, the experts identified **similar competences** (competences labelled differently but with a comparable meaning): networking & relation building and stress tolerance & stress resistance. We combined these competences in the final data analysis.

**The outcomes of the twelve expert panels resulted in a collection of:**

- 29 competences associated with operational excellence
- 28 competences associated with product leadership
- 22 competences associated with customer intimacy

Out of the 64 initial competences, a list of 41 competences was drawn when combining the outcomes of the three roles. Fifteen **competences overlapped** in the three roles: clear communication, client focus, coping with criticism, creativity, focus on results, initiative, negotiation, networking & relation building, perseverance, persuasiveness, planning & organisation, realism, solution oriented, stress resistance and team spirit / team player. A few competences overlapped only in two roles, for example responsibility appeared to be even more important for engineers in the role of operational excellence and customer intimacy.

When we limit the competences to those mentioned in at least four panels, the roles can be defined by eight to nine competences (table 3).

| OPERATIONAL EXCELLENCE | | PRODUCT LEADERSHIP | | CUSTOMER INITMACY | |
|---|---|---|---|---|---|
| **Competence** | **N** | **Competence** | **N** | **Competence** | **N** |
| Positive critical attitude | 10 | Creativity | 12 | Client focus | 12 |
| Solution-oriented | 10 | Innovation | 12 | Networking & relation building | 11 |
| Focus on results | 6 | Client focus | 7 | Clear communication | 10 |
| Planning and organisation | 6 | Initiative | 7 | Negotiation | 9 |
| Clear communication | 5 | Out of the box thinking | 7 | Capacity for empathy | 8 |
| Initiative | 5 | Persuasiveness | 6 | Focus on results | 8 |
| Creativity | 4 | Vision | 6 | Solution-oriented | 7 |
| Networking & relation building | 4 | Conceptualisation | 5 | Stress resistance | 5 |
| | | Perseverance | 5 | | |

*Table 3.* Competency profiles per role based on the outcomes of 12 expert panels.
*(N = number of panels that mentioned the competence)*

Also in the limited competency list, we observed overlapping competences, mainly between operational excellence and customer intimacy (4 overlapping). During the group discussion, experts **nuanced the overlapping competences**. For example, client focus: an engineer in the role of product leadership must be aware of the prospect client markets for new innovative technologies, while an engineer in the role

of customer intimacy must be able to attune his or her actions to the needs and wishes of a particular client.

A **mixed meta panel** will be organised to consolidate the results of the 12 panels by an all-decisive exercise. This panel will address the possible influence of company culture to the panel consensus and the nuances made in overlapping competences. The meta panel with experts from different sectors, SME's and large companies will be organised according to the same criteria as described in 2.2. The final outcomes will be the subject of another paper (in progress) in which the focus will also be on the practicability of the final framework.

## 4 CONCLUSION

Higher education programmes are expected to prepare students for future professional work experience. Students are expected to learn how to become effective professionals, ready to handle the demands associated with his or her job shortly after graduation to improve their employability [2]. Therefore, it is interesting to know what key competences are required for a fresh engineer entering the labour market [7].

This research identified different professional competences for professional roles for future engineers. Via a modified Delphi method, 12 expert panels mapped competences to the three professional roles that were described in the Professional Roles Framework: operational excellence, product leadership and customer intimacy.

This resulted in three competency profiles made up of eight to nine key professional competences. Some competences are overlapping, for example 'focus on results' and 'networking & relation building' seems to be crucial competences in both operational excellence and customer intimacy. A mixed meta-panel with experts from different sectors, SME's and large companies will be organised to validate the outcomes of the 12 expert panels. The outcome will be a competency profile per role consisting out of six to eight competences.

In essence, the competency profiles give a clear picture of the essential competences that are required to be successful in a particular role and allow us to finetune the Professional Roles Framework for Future Engineers.

## 5 DISCUSSION

Male et al. (2011) recommend that engineering educators design their **programmes** with an understanding that diverse programmes and diverse graduates are desirable because different jobs place different importance on the professional engineering competencies [7]. Such programmes can help students to develop a realistic understanding of engineering work and the different competencies required by different engineer roles [6].

The Professional Roles Framework for Future Engineers is a valuable instrument to adjust the curriculum in this regard. The competency profiles with an aspiration to career perspectives can be easily implemented in existing curricula, when framing

activities with industry, working on specific competences etc., but also extracurricular, for example extra activities including career guidance.

In future work of the PREFER project, the competency profiles will be used to develop a tool for students to help them reflect on their strengths and weaknesses and their future professional role(s). The outcomes of this research will be used to further investigate how acquaintance with the professional roles will increase students' professional awareness and align their expectations with the work field.

A nice edge effect of these expert panels is that the participants were triggered to reflect on the **company's recruitment policy**. Almost all the experts asked to receive the final outcomes. One company decided after the panel to revise their vacancies and make them more specific according to the competency profiles. These companies are no longer looking for super(wo)man. They prefer an engineer that fits the job.

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