Practical training and internships in engineering education: educational goals and assessment

Otto Rompelman
Faculty Information Technology and Systems
Delft University of Technology
Netherlands
E-mail: o.rompelman@its.tudelft.nl

Keywords: internationalisation, intercultural, engineering competences

SUMMARY: In many engineering curricula a period of practical training in industry is either compulsory or advised. Often the educational goals of such a period are defined as 'learning to put knowledge and skills into practice'. The assessment is usually based on a technical report of the activities during the period. In this paper it is discussed how the definition of educational objectives led to the introduction of practical training. These objectives are acquiring insight in the engineering profession, learning to ‘survive’ in a different culture and learning to apply as well as broadening technical knowledge and skills. Furthermore, an assessment procedure is introduced which allows for assessing whether the students have met the objectives.

1. INTRODUCTION
In many university engineering education programmes a period of practical training is incorporated: students are advised to take an internship in industry. Occasionally, this is even obligatory. Usually, the internship is focused on engineering aspects. The MSc-programme in electrical engineering at Delft University of Technology takes a somewhat different view: the practical training is a consequence of the explicit wish to include some aspects of internationalisation in the curriculum.

2. ASPECTS OF INTERNATIONALISATION OF ENGINEERING EDUCATION
Presently internationalisation of engineering education is an important issue. In a symposium of SEFI (the European Engineering Education Society) held in Berlin in 2000, the following points were made [1]:
- The borders between countries are disappearing, see the unification of Europe, the global economy etc.
- There is an increase of limited time contracts for employees; more engineers work as consultants
- Engineers in large companies work closely together with colleagues from different countries
- The customers of companies are not restricted to the home country: this holds for large, medium and small companies alike
- There is a trend towards 'Europe is the home market'
We have acknowledged these issues as being highly important. Consequently, educational objectives had to be defined. These objectives are formulated as:
- Learning to communicate and co-operate in international teams
- Acknowledge and appreciate different cultures
- Mastering at least one foreign language (either including or apart from English)
These objectives are supposed to be met by the practical training.
3. EDUCATIONAL OBJECTIVES OF PRACTICAL TRAINING

Apart from the objectives as far as internationalisation is concerned, it is envisaged that students will gain some insight in the engineering profession. The practical training gives a unique opportunity for students to learn about the roles and tasks of engineers. Finally, during a practical training period students will learn to apply their knowledge and skills in a real life situation. In conclusion, educational goals are related to the following aspects (in order of educational interest):
- Acquiring insight in the engineering profession
- Social/psychological goals: learning to ‘survive’ in a different culture
- Learning to apply as well as broadening technical knowledge and skills

Obviously, it is the responsibility of the university to assess whether the educational objectives are met. The second issue is particularly interesting when it comes down to the question how to make this operational. This will be discussed in somewhat more detail.

4. MAKING THE SOCIAL/PSYCHOLOGICAL GOALS OPERATIONAL

We decided to use the historical work of Geert Hofstede. Hofstede is well known for his work on four dimensions of cultural variability, commonly referred to as “Hofstede’s Cultural Dimensions.” These include: Uncertainty Avoidance, Power Distance, Masculinity-Femininity, Individualism-Collectivism. These dimensions were arrived at in his 1980 publication, "Culture’s consequences: International differences in work-related value" [2]. The study took existing survey data (sample size of 116,000) collected from a multinational corporation. The result was a score in each of the dimensions for 40 different countries. The cultural dimensions are briefly described below. The students have access to a summarizing paper (in Dutch) on Hofstede’s work [3] and are supposed to study this paper prior to their practical training period. Before discussing the way Hofstede's work is used in the assessment, the cultural dimensions as introduced by him are briefly reviewed.

4.1. Brief review of Hofstede's cultural dimensions

The cultural dimensions can be considered as continuous variables. On the basis of the aforementioned survey, Hofstede arrived at quantitative figures of each country for each cultural dimension. Consequently, he normalised the figures such, that they led to indices (scores) being in the range between 0 and 100. The four dimensions are shortly reviewed and the extremes are elucidated with tables. Obviously, the character of any culture is somewhere in between these extremes.

*Power Distance (PDI)*

Power distance is the answer of a culture to the fundamental problem of inequality of human beings. This implies that people in a culture with large power distance easily accept that the fact that the power in society is unequally distributed. This applies to both the powerful and the powerless. In other words: people in high power distance cultures are much more comfortable with a larger status differential than low power distance cultures. In Table 1 the extremes are shown.

<table>
<thead>
<tr>
<th>LARGE PDI</th>
<th>SMALL PDI</th>
</tr>
</thead>
<tbody>
<tr>
<td>High dependence needs</td>
<td>Low dependence needs</td>
</tr>
<tr>
<td>Inequality accepted</td>
<td>Inequality minimized</td>
</tr>
<tr>
<td>Hierarchy needed</td>
<td>Hierarchy for convenience</td>
</tr>
<tr>
<td>Superiors often inaccessible</td>
<td>Superiors accessible</td>
</tr>
<tr>
<td>Power-holders have privileges</td>
<td>All have equal rights</td>
</tr>
<tr>
<td>Change by revolution</td>
<td>Change by evolution</td>
</tr>
</tbody>
</table>

Table 1. Differences between high and low power distance cultures
Uncertainty Avoidance (UAI)

Uncertainty avoidance indicates to what extent people feel threatened by uncertain or unknown situations. This feeling is expressed by nervous tension and a need for predictability and formal or informal rules. In other words: this dimension refers to how comfortable people feel towards ambiguity. Cultures which ranked low (compared to other cultures), feel much more comfortable with the unknown. As a result, high uncertainty avoidance cultures prefer formal rules and any uncertainty can express itself in higher anxiety than those from low uncertainty avoidance cultures. Important characteristics of very high and very low uncertainty avoidance cultures are shown in Table 2.

<table>
<thead>
<tr>
<th>HIGH UAI</th>
<th>LOW UAI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anxiety, higher stress</td>
<td>Relaxed, lower stress</td>
</tr>
<tr>
<td>Inner urge to work hard</td>
<td>Hard work not a virtue per se</td>
</tr>
<tr>
<td>Showing emotions accepted</td>
<td>Emotions not shown</td>
</tr>
<tr>
<td>Conflict is threatening</td>
<td>Conflict &amp; competition seen as fair play</td>
</tr>
<tr>
<td>Need for consensus</td>
<td>Acceptance of dissent</td>
</tr>
<tr>
<td>Need to avoid failure</td>
<td>Willingness to take risks</td>
</tr>
<tr>
<td>Need for laws and rules</td>
<td>There should be few rules</td>
</tr>
</tbody>
</table>

Table 2. Differences between high and low uncertainty avoidance cultures

Masculinity-Femininity (MAS)

Masculinity is related to the dominant value of fixed and sex related allocation of tasks: the man as the hunter, the woman as the careful and considerate person. Femininity implies that dominant values are attention for other people and the quality of life. A society is masculine if men are supposed to be assertive and hard and oriented towards material success; women are supposed to be modest and particularly oriented towards the quality of life. A society is feminine if social sex roles are overlapping: both men and women are supposed to be care taking and oriented towards the quality of life. Some characteristics of masculinity and femininity are shown in Table 3. High masculinity leads to a high MAS-score, whereas high femininity leads to a low MAS-score.

<table>
<thead>
<tr>
<th>MASCULINITY</th>
<th>FEMININITY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ambitious and a need to excel</td>
<td>Quality of life-serving others</td>
</tr>
<tr>
<td>Tendency to polarize</td>
<td>Striving for consensus</td>
</tr>
<tr>
<td>Live in order to work</td>
<td>Work in order to live</td>
</tr>
<tr>
<td>Big and fast are beautiful</td>
<td>Small and slow are beautiful</td>
</tr>
<tr>
<td>Admiration for the achiever</td>
<td>Sympathy for the unfortunate</td>
</tr>
<tr>
<td>Decisiveness</td>
<td>Intuition</td>
</tr>
</tbody>
</table>

Table 3. Some features of masculinity and femininity

Individualism-Collectivism (IDV)

A society is individualistic if the mutual relations between individuals are rather loose: everybody is assumed to exclusively take care of his/herself and, possibly, his/her nearest relatives. In a collectivistic society, on the other hand, individuals are assimilated in strong and close-knit communities. These communities offer a lifelong protection in exchange for unconditional loyalty. Some features of individualism and collectivism are shown in Table 4.
Individualistic cultures are characterized by a high IDV-score whereas collectivistic cultures are characterized by a low IDV-score.

<table>
<thead>
<tr>
<th>INDIVIDUALISM</th>
<th>COLLECTIVISM</th>
</tr>
</thead>
<tbody>
<tr>
<td>&quot;I&quot; conscious</td>
<td>&quot;We&quot; conscious</td>
</tr>
<tr>
<td>Private options</td>
<td>Relationships over tasks</td>
</tr>
<tr>
<td>Fulfil obligations to self</td>
<td>Fulfil obligations to group</td>
</tr>
<tr>
<td>Loss of self-respect, guilt</td>
<td>Loss of &quot;face&quot;, shame</td>
</tr>
</tbody>
</table>

Table 4. Some features of individualism and collectivism

4.2 Some results of Hofstede’s work

Hofstede carried out his research using questionnaires in some 50 countries. An example of the results is shown in Table 5. The fact one number is outside the range of 1 - 100 is due to the fact that the data of some countries were included after normalisation.

<table>
<thead>
<tr>
<th>Country</th>
<th>PDI</th>
<th>UAI</th>
<th>MAS</th>
<th>IDV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Austria</td>
<td>11</td>
<td>70</td>
<td>79</td>
<td>55</td>
</tr>
<tr>
<td>France</td>
<td>68</td>
<td>86</td>
<td>43</td>
<td>71</td>
</tr>
<tr>
<td>Germany</td>
<td>35</td>
<td>65</td>
<td>66</td>
<td>67</td>
</tr>
<tr>
<td>Greece</td>
<td>60</td>
<td>112</td>
<td>57</td>
<td>35</td>
</tr>
<tr>
<td>Italy</td>
<td>50</td>
<td>75</td>
<td>70</td>
<td>76</td>
</tr>
<tr>
<td>Japan</td>
<td>54</td>
<td>88</td>
<td>95</td>
<td>46</td>
</tr>
<tr>
<td>Netherlands</td>
<td>38</td>
<td>53</td>
<td>14</td>
<td>80</td>
</tr>
<tr>
<td>Sweden</td>
<td>31</td>
<td>29</td>
<td>5</td>
<td>71</td>
</tr>
<tr>
<td>Turkey</td>
<td>66</td>
<td>85</td>
<td>45</td>
<td>37</td>
</tr>
<tr>
<td>UK</td>
<td>35</td>
<td>35</td>
<td>66</td>
<td>89</td>
</tr>
<tr>
<td>USA</td>
<td>40</td>
<td>46</td>
<td>62</td>
<td>91</td>
</tr>
<tr>
<td>West Africa</td>
<td>77</td>
<td>54</td>
<td>46</td>
<td>20</td>
</tr>
<tr>
<td>Arab countries</td>
<td>80</td>
<td>68</td>
<td>53</td>
<td>38</td>
</tr>
</tbody>
</table>

Table 5. The values of Hofstede’s cultural dimensions for some (groups of) countries

5. ASSESSMENT

In order to find out whether the objectives are met the students have to produce a short report (2 - 4 pages) comprising a self-evaluation. In this self-evaluation a number of issues have to be addressed. These issues are (according to the instructions for the students):

I. Aspects related to the engineering profession (questions related to the company)
   - Which positions do engineers hold?
   - Which tasks and responsibilities do engineers have in the company?
   - To whom are engineers responsible and about what?
   - Which employees are responsible to engineers and about what?

II. Social-psychological aspects
   - What were your expectations before you left?
   - What did you do in order to get acquainted with the country and its culture?
   - Give at least four differences in culture between the company and the TU-Delft.
   - Discuss whether to your opinion, these differences are due to company (is different from the TU-Delft) or the country (is different from the Netherlands)
   - Which differences raised most problems for you and how did you try to overcome these difficulties?
III. According to Hofstede cultures can be characterised by their scores in four cultural dimensions.

- What are the scores Hofstede found for the country you visited?
- Discuss how these scores are related to your own experience.

The report is submitted to the teacher in charge of the practical training assessment within one month after completing the internship. The actual assessment is a half hour discussion between this teacher and the student based on this report. If the report and the result of this discussion are satisfactory, the student is granted the credit points related to the practical training.

6. RESULTS

The programme started in 1999. Up till September 2001 about 100 students have participated. Unfortunately, despite strong recommendation to go abroad, only 40% of the students did so. From the self-evaluation and assessment discussions we arrived at a number of interesting findings. Some of them will be summarised.

- It appeared that most students in general could describe and consequently discuss their experiences in relation to the cultural dimensions. All students tried to seriously answer the key questions (see above).
- Sometimes students told, that they found this difficult because of their limited experiences. Though the definitions of the cultural dimensions are very simple and concise, they become more understandable through a comprehensive list of characteristics. Checking their experiences with respect of this comprehensive list raised problems for these students. Those students, however, who indeed grasped the purport of the cultural dimensions, had less difficulties with the questions mentioned above.
- During the assessment some students even indicated that the results of Hofstede's work could be looked upon as a model with a predictive value concerning how people would respond to actions and circumstances.
- Incidentally there was some confusion whether some experiences had to be related to the UAI (Uncertainty Avoidance) or to PDI (Power Distance).
- In about 30% of the reports it appeared the students had difficulties with the Masculinity Index. These students argued that in the country they visited the MAS (Masculinity-Femininity) index was (much) lower than was found in Hofstede's work. Their argument was, that the number of females in technical jobs was much higher than in the Netherlands, a country with a very low MAS. This showed that they didn't quite grasp the purport of the MAS-index. Indeed, in countries with a low MAS-index women have more chances to take equal positions, but this doesn't always lead to the expected result. Particularly the Netherlands is a country with a relatively low number of female students in technical areas, which is reflected in the percentage of technical jobs taken by women. These facts therefore lead to confusion when interpreting the meaning of the MAS-index. This misinterpretation could be easily adjusted during the assessments.
- Apart from the discussion of the MAS-index, in a number of cases students disagreed with the findings of Hofstede. However, they always gave arguments for this and sometimes even possible explanations. As an example, one student worked in Antwerp (Belgium) and discussed that to his opinion both the UAI (Uncertainty Avoidance) and the PDI (Power Distance) were higher than in the Netherlands (as found by Hofstede) but he estimated these indices lower than the vales provided by Hofstede. In his opinion this could be due to the fact that Hofstede's values are average values for Belgium (i.e. both Flemish and French speaking Belgium), whereas his experiences were limited to Flemish
speaking city. It has indeed been discussed by Hofstede that Latin countries show higher values for the UAI and PDI.

- One student worked in Bolivia. Since in Hofstede's work Bolivia was not mentioned, he inserted his estimations of the values for the cultural dimensions in correlation plots of dimensions in pairs: these correlation plots, as derived from Hofstede's work, were taken from the introductory paper mentioned above [3]. He based his opinion on comparative experiences in Bolivia and neighbouring countries that he shortly visited.

- Some students identified the multi-cultural character of the company they worked in and discussed the cultural dimensions in relation to the different cultural backgrounds. In one case a student, who worked in Dubai (United Arab Emirates), discussed the differences between the original inhabitants (high UAI and low IDV) and the multicultural highly educated 'imported upper class' (low UAI and high IDV).

- All students appeared to be most careful not to show prejudices when discussing cultural differences.

- Some students mentioned the importance of some basis knowledge of the local language. As one student, who stayed in Portugal, stated: 'people appreciate that you take some pains to speak their language, which opens their hearts for you.'

All students were very positive about the practical training. A large majority declared, that they had indeed learned much more than expected. A number of repetitively made remarks were:

- this experience increased my self confidence: it turned out, that I can indeed 'survive' in a different environment
- I have now a much better view of what my future could be
- I have discovered that I am able to live and move around in another culture
- I found out that I am able to solve vaguely described problems in an area that I am not very familiar with.

7. CONCLUSIONS

The practical training as it has been given form in the Electrical Engineering programme of the TU-Delft has proven to meet the predefined educational objectives to a large extent. Furthermore, the reflection on Hofstede's cultural dimensions makes the educational goal 'learning to move in and appreciate different cultures' manageable. Finally, it is found that a discussion on the basis a written self-evaluation is an adequate method of assessment that is appreciated by both the students and the teacher in charge.

References:


Note: This paper was submitted in revised form to the European Journal of Engineering Education