Stocktaking of Engineering Education in Germany: has there been a cultural shift?

Professor Dr Hans Jürgen Prömel
Vice-President HRK
1. Stocktaking of Engineering Education in Germany
2. Initiatives and Activities to Enhance Teaching and Learning
3. Engineering Education and Projekt KIVA at TU Darmstadt
4. Conclusion
## Engineering Study Programs*

<table>
<thead>
<tr>
<th>Winter term</th>
<th>total</th>
<th>Bachelor</th>
<th>Master</th>
<th>together</th>
<th>Percent of total</th>
</tr>
</thead>
<tbody>
<tr>
<td>2005/2006</td>
<td>2.109</td>
<td>553</td>
<td>456</td>
<td>1.009</td>
<td>48</td>
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<tr>
<td>2006/2007</td>
<td>2.244</td>
<td>818</td>
<td>554</td>
<td>1.372</td>
<td>61</td>
</tr>
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<td>2007/2008</td>
<td>2.223</td>
<td>1.058</td>
<td>691</td>
<td>1.749</td>
<td>79</td>
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<tr>
<td>2008/2009</td>
<td>2.454</td>
<td>1.325</td>
<td>878</td>
<td>2.203</td>
<td>90</td>
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<tr>
<td>2009/2010</td>
<td>2.632</td>
<td>1.443</td>
<td>1.002</td>
<td>2.445</td>
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<tr>
<td>2010/2011</td>
<td>2.792</td>
<td>1.540</td>
<td>1.098</td>
<td>2.638</td>
<td>95</td>
</tr>
<tr>
<td>2011/2012</td>
<td>2.987</td>
<td>1.643</td>
<td>1.222</td>
<td>2.865</td>
<td>96</td>
</tr>
<tr>
<td>2012/2013</td>
<td>3.150</td>
<td>1.709</td>
<td>1.332</td>
<td>3.041</td>
<td>97</td>
</tr>
</tbody>
</table>

* A study program may be associated with two or more subject groups.
Source: HRK-Higher Education Compass, 2012
# Bachelor and Master Graduates in Engineering Study Programs

<table>
<thead>
<tr>
<th>Winter term</th>
<th>Engineering Graduates</th>
<th>Bachelor</th>
<th>Master</th>
<th>Bachelor and Master</th>
<th>Percent of total</th>
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</thead>
<tbody>
<tr>
<td>2005</td>
<td>37.071</td>
<td>1.089</td>
<td>2.597</td>
<td>3.686</td>
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<tr>
<td>2006</td>
<td>38.708</td>
<td>1.648</td>
<td>3.181</td>
<td>4.829</td>
<td>13</td>
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<tr>
<td>2007</td>
<td>41.803</td>
<td>2.582</td>
<td>3.861</td>
<td>6.443</td>
<td>15</td>
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<tr>
<td>2008</td>
<td>46.210</td>
<td>5.426</td>
<td>4.057</td>
<td>9.483</td>
<td>21</td>
</tr>
<tr>
<td>2010</td>
<td>59.249</td>
<td>20.326</td>
<td>5.912</td>
<td>26.238</td>
<td>44</td>
</tr>
<tr>
<td>2011</td>
<td>66.904</td>
<td>31.272</td>
<td>10.079</td>
<td>41.351</td>
<td>62</td>
</tr>
</tbody>
</table>

# Students’ Dropout and Attrition Rate in Engineering Study Programs*

*Graduates of the year 2010


<table>
<thead>
<tr>
<th></th>
<th>Dropout</th>
<th>Change of subject or degree</th>
<th>Attrition rate</th>
<th>Student gain</th>
<th>Attrition balance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bachelor University</td>
<td>48</td>
<td>+</td>
<td>8</td>
<td>56</td>
<td>-</td>
</tr>
<tr>
<td>Bachelor University of Applied Sciences</td>
<td>30</td>
<td>+</td>
<td>1</td>
<td>31</td>
<td>-</td>
</tr>
</tbody>
</table>
Students’ Drop-out in Specific Engineering Study Programs and by sex*

<table>
<thead>
<tr>
<th>Drop-out</th>
<th>total</th>
<th>mechanical engineering</th>
<th>electrical engineering</th>
<th>civil engineering</th>
<th>female</th>
<th>male</th>
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</thead>
<tbody>
<tr>
<td>Bachelor University</td>
<td>48</td>
<td>53</td>
<td>53</td>
<td>51</td>
<td>42</td>
<td>49</td>
</tr>
<tr>
<td>Bachelor University of Applied Sciences</td>
<td>30</td>
<td>32</td>
<td>36</td>
<td>36</td>
<td>28</td>
<td>31</td>
</tr>
</tbody>
</table>

* Graduates of the year 2010
Mobility in Engineering Study Programs

Percentage of German Engineering Students with a study relevant stay abroad

<table>
<thead>
<tr>
<th></th>
<th>2007</th>
<th>2009</th>
<th>2011</th>
</tr>
</thead>
<tbody>
<tr>
<td>Engineering students</td>
<td>16</td>
<td>16</td>
<td>17</td>
</tr>
<tr>
<td>All students</td>
<td>23</td>
<td>26</td>
<td>25</td>
</tr>
</tbody>
</table>

## Employability and Career Satisfaction of Engineering Bachelors one Year after Graduation

<table>
<thead>
<tr>
<th></th>
<th>Unemployment (%)</th>
<th>Inadequate employment (%)</th>
<th>Satisfaction with career situation (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bachelor University</td>
<td>1</td>
<td>23</td>
<td>71</td>
</tr>
<tr>
<td>Bachelor University of Applied Sciences</td>
<td>3</td>
<td>10</td>
<td>66</td>
</tr>
</tbody>
</table>

* Regarding University Bachelors data is only available for the group of STEM subjects
** very high satisfaction and satisfaction
*** Regarding University Bachelors data is only available for the group of STEM subjects

Findings

- 97% of engineering study programs are bachelor or master programs
- 62% of the engineering graduates complete bachelors or masters
  38% complete „Diplom-Ingenieur“ degrees
- Student drop-out is high in engineering education (48% resp. 30%)
- The mobility of engineering students is low (17%)
- Most of the engineering graduates find adequate employments (77% resp. 90%)
- Young professionals are mostly satisfied with their career (71% resp. 66%)

→ Reduce drop-out rates!
→ Enhance mobility!
Engineering Specifics

• Engineering studies are known as difficult and stressful
• Prerequisites (mathematics, chemistry, physics, technical understanding) are indespensible
• Engineering studies are demanding from the beginning on
• Engineers are in demand in the labour market
Initiatives to Enhance Teaching and Learning in (Engineering) Study Programs

- Plenty and diverse initiatives by Universities
- Initiatives by employers’ foundations and by federal and state governments

Objectives of the Initiatives

• Strengthen the importance of teaching and learning
• Foster active, student-centered and outcome-oriented learning methods
• Push design and testing of innovative teaching methods
• Attract more (non-traditional) students for STEM subjects
• Decrease student drop-out
Activities and Tools to Improve Engineering Education and Reduce Drop-out

- Improve counselling for first semester students,
- Offer preparatory courses & supporting courses
- Improve support for students by tutors and mentors (first semester),
- Offer courses to train how to study (learning styles, time management),
- Install warning systems and monitoring systems to recognize threatened students,
- Develop problem-oriented and problem-based learning methods for engineers,
- Develop project-based learning methods to strengthen employability,
- Use new media and train teachers to use these in courses and for distant learning,
- Qualify staff for teaching, counselling and support,
- Recruit additional staff to improve the faculty-student ratio.
Profile of TU Darmstadt

25,000 Students
4,300 Foreign Students (included)
2,800 Graduates
320 Doctorates awarded
286 Professors

100 Degree programs
13 Departments
4 Fields of studies

HRK German Rectors’ Conference
Project nexus
Concepts and good practice in Higher Education
# TU Darmstadt, Facts and Figures I

## Number of Engineering Degree Programs

<table>
<thead>
<tr>
<th>Winter term</th>
<th>total</th>
<th>Bachelor</th>
<th>Master</th>
<th>together</th>
<th>% of total</th>
</tr>
</thead>
<tbody>
<tr>
<td>2005/2006</td>
<td>32</td>
<td>11</td>
<td>11</td>
<td>22</td>
<td>69</td>
</tr>
<tr>
<td>2006/2007</td>
<td>32</td>
<td>16</td>
<td>12</td>
<td>28</td>
<td>88</td>
</tr>
<tr>
<td>2007/2008</td>
<td>33</td>
<td>16</td>
<td>14</td>
<td>30</td>
<td>91</td>
</tr>
<tr>
<td>2008/2009</td>
<td>33</td>
<td>18</td>
<td>14</td>
<td>32</td>
<td>97</td>
</tr>
<tr>
<td>2009/2010</td>
<td>41</td>
<td>19</td>
<td>21</td>
<td>40</td>
<td>98</td>
</tr>
<tr>
<td>2010/2011</td>
<td>46</td>
<td>19</td>
<td>26</td>
<td>45</td>
<td>98</td>
</tr>
<tr>
<td>2011/2012</td>
<td>46</td>
<td>19</td>
<td>26</td>
<td>45</td>
<td>98</td>
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<tr>
<td>2012/2013</td>
<td>47</td>
<td>19</td>
<td>27</td>
<td>46</td>
<td>98</td>
</tr>
</tbody>
</table>
## TU Darmstadt, Facts and Figures II
### Number of Engineering Students

<table>
<thead>
<tr>
<th>Winter term</th>
<th>Engineering Students</th>
<th>Bachelor</th>
<th>Master</th>
<th>Bachelor and Master</th>
<th>Percent of total</th>
</tr>
</thead>
<tbody>
<tr>
<td>2005</td>
<td>9.791</td>
<td>1.191</td>
<td>354</td>
<td>1.536</td>
<td>16</td>
</tr>
<tr>
<td>2006</td>
<td>9.209</td>
<td>2.003</td>
<td>331</td>
<td>2.334</td>
<td>25</td>
</tr>
<tr>
<td>2007</td>
<td>8.774</td>
<td>3.515</td>
<td>328</td>
<td>3.843</td>
<td>58</td>
</tr>
<tr>
<td>2008</td>
<td>10.332</td>
<td>5.401</td>
<td>564</td>
<td>5.965</td>
<td>69</td>
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<tr>
<td>2009</td>
<td>11.591</td>
<td>7.104</td>
<td>930</td>
<td>8.034</td>
<td>79</td>
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<tr>
<td>2010</td>
<td>12.685</td>
<td>8.534</td>
<td>1.453</td>
<td>9.987</td>
<td>86</td>
</tr>
</tbody>
</table>
Initiative “KIVA” at TU Darmstadt supported by Quality in Teaching Pact

KIVA – Kompetenzentwicklung durch interdisziplinäre Vernetzung von Anfang an:

• “Competence Development by Interdisciplinary Cooperation from the beginning”
• Successful project in the nationwide competition “Quality in Teaching Pact”: five years (2011-1016), 13 million Euro
• Objectives:
  (1) to intensify interdisciplinary cooperation in teaching,
  (2) to increase student commitment,
  (3) to encourage more young people to study the STEM disciplines (KIVA focuses on the introductory phase of students’ university careers).
KIVA Sub-Projects

Implementation in six sub-projects:

- **KIVA I**
  - Strengthening of mathematical skills

- **KIVA II**
  - Funds for Visiting Professorships

- **KIVA III**
  - Strengthening of Study Offices

- **KIVA IV**
  - Expansion of trainings for tutors

- **KIVA V**
  - Interdisciplinary First-Year Student Projects

- **KIVA VI**
  - Development of Interdisciplinarity

10/29/2012
KIVA V: Interdisciplinary projects in the introductory phase

Our goal: integration of interdisciplinary study projects in the curricula of all undergraduate programs at the TU Darmstadt

Concept: Students of Engineering, Sciences and Humanities work together in teams (Coaching is essential)

We want the students:
• to be introduced into one's own discipline
• experience a cooperation beyond its own borders
• solve complex and societally relevant tasks
• strengthen the bond with teachers and fellow students

Interdisciplinarity project work causes:
• strengthen the intrinsic motivation for study
• social issues are handled in the disciplinary context
• Networking between professors

Project work is hard but will forge students into long lasting study groups
„Meeting Point Mathematics“ at TU Darmstadt

- Optional offer of the department of mathematics
- Since 2009 offered to mechanical engineering students
- Expansion 2011: electrical engineering, civil engineering, computer science

- Supporting lectures and seminars through subject matter repetition and exercises
- Show fields of application and point out the relevance of the subject
- Supplemented by exam preparation classes
Conclusions

• There has been a strong structural change to the new bachelor and master programs in engineering.
• The structural change did not automatically lead to a better success rate.
• A lot of activities have started to reduce drop-out and improve teaching.

➔But:
• We need convenient solutions.
• We don’t yet know how successful our activities are.
• We need reliable financing.
Thank you!

Professor Dr Hans Jürgen Prömel