
AC 2012-3667: A DETAILED LOOK AT THE GERMAN UNIVERSITIES OF APPLIED SCIENCES

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A Detailed Look at the German Universities of Applied Sciences

Abstract

The California Polytechnic State University and the Munich University of Applied Sciences in Germany have had a strong partnership for many years and realize several activities based on this partnership for mutual advantage. These include exchange of students and professors, the organization of a common summer school, and work on common projects. The authors of this paper have personal teaching experience in both Germany and in the US. The paper describes the German type of 'University of Applied Sciences' and tries to give the reader a detailed insight into this system; it is assumed that the reader is familiar with the US system. The differences are described from different perspectives: the university, the ME program, the professors and the students.

Universities of Applied Sciences

Germany has a higher education system based on two different types of universities. On one side, the research oriented traditional universities (in German 'Universität') have a very long tradition and a strong research orientation in their programs. On the other side there are 'Universities of Applied Sciences' (in German 'Fachhochschule') doing less research compared to the Universität, but having a strong focus on teaching professional skills. The Fachhochschulen were founded in 1969 to satisfy the requirements for employees in the growing industries to have an academic background and the ability to apply theoretical knowledge to practical problems. A report¹ from the German Council of Science and Humanities gives a good overview of the current situation and further development of the Fachhochschulen. Based on the Bologna process (from 2000) Fachhochschulen award Bachelor's and Master's degrees equivalent to Universitäten, but still no doctoral degrees. The programs of the Fachhochschulen cover a wide area of professional skills like engineering, computer science, business and management, arts and design, communication studies, social service and other professional areas. In Germany there are about 15 Universitäten and about 70 Fachhochschulen in the technical areas, mostly driven by the state. Due to this high number of Fachhochschule, they are often small and get most of their students from the local region in contrast to the Universitäten, which have a more trans-regional profile. Munich is exceptional, because it offers a wide range of different universities, among them the Munich University of Applied Sciences (Fachhochschule) with about 15,000 students and the Technical University of Munich (Universität) with about 26,000 students.

Until the start of the Bologna Process (about 2000) the Universitäten offered 5 year programs with the degree 'Diplom (univ)', the Fachhochschulen offered 4 year programs with the degree 'Diplom (FH)'. The Bologna Process², with the goal of introducing comparable and compatible academic degree and quality assurance standards in Europe, forced the universities to move towards a two step program with Bachelor and Master's degrees. The engineering programs at Universitäten usually were remodelled from the former 10 semesters to a 6 Semester (Bachelor) plus 4 semester (Master) model. The Fachhochschulen did either 7+3 or 6+4. One semester

usually covers 30 European credits (one credit is equivalent to approximately 30 hours of work); the lecture time per student each semester is between 200 and 300 hours.

Until now the mechanical engineering department at Munich University of Applied Sciences did not remodel its program due to very high acceptance of the old Diplom in industry. Even so, a first Master program (automotive engineering) was established in 2005.

Until about 2005 the universities in Germany did not charge any fees to students. Until that time, attending universities was financed 100% by the states of Germany. Due to a successful lawsuit of some of the German states against a law prohibiting these fees, they were introduced in some of the German states. Currently two states out of 16 in Germany allow the universities to charge students with fees. At Munich University of Applied Sciences the amount is about € 430 (1.1.2012: 1€ corresponds to 1.3\$) per semester.

The ME Department at Munich University of Applied Sciences has approximately 60 full time professors, 40 staff, and 2000 students; the average number of students starting the 4 year program in the first semester is about 500 to 600 per year, the average output of students is about 300 per year. The ME department also has about 90 lecturers, mostly doing this teaching job in addition to a full time industry job. They usually cover a teaching load of 2 to 4 hours a week.

Internationalization is an important value for the entire German higher education system. The Munich University of Applied Sciences maintains a high number of collaborations with universities all over the world, and even offers counselling to help students to choose an appropriate international experience. The same service is available for students coming from a university abroad to the Munich University of Applied Sciences. Also, a program of ‘lectures in English’ is offered to give German students the opportunity to increase their language skills and also to enable foreign students without sufficient German language knowledge to hear lectures in English. Some of these lectures are given by native English speakers who are guest lecturers. The Munich University of Applied Science is part of the UAS⁷, a strategic alliance of seven leading German universities of applied sciences committed to excellence in teaching and research especially founded to provide services for North American students and scholars interested in study and internship in Germany. An example of a successful professor exchange is described in our companion paper⁴.

The ME Program at Munich University of Applied Sciences

The primary school system in Germany is different from the US system. It is inhomogeneous over the 16 states of Germany, and even in single states there can be a wide variety of different curricula offering access to the higher education system. The general ‘Abitur’ gives access to every program at a Universität or Fachhochschule, the ‘Fachabitur’ gives just access to a Fachhochschule. The main difference between Abitur and Fachabitur is the missing second foreign language at the Fachabitur. Current statistics about the situation at Munich University of Applied Sciences show that about 33% of the freshman in the ME programs have the general Abitur, the rest have different types of Fachabitur. A certain amount of the student did not start a program at a university directly after their graduation from school; often they do 2 or 3 years of professional training before enrolling, or even try another program at a university. Exact statistics are not available, but the authors estimate that 10% to 20% of the freshman students do

not directly come from primary school and are somewhat older than 18. Consequently the maturity and the knowledge of the students can vary greatly within a class. Usually the amount of applications of students for the ME program is 2 to 4 times higher than the amount of places available, and admittance in undergraduate program is usually based on the final grade of Abitur or Fachabitur. For graduate programs, additional tests like interviews are used to assess the abilities of the students.

The ME department at the Munich University of Applied Sciences still uses programs based on an 8 semester Diplom (see above). The available programs are Mechanical Engineering, Automotive Engineering and Aerospace Engineering. The programs have six theoretical semesters, two obligatory 20 week internships in industry (called practical semesters) in semester 3 and 6 and an obligatory 5 month thesis at the end of the program, usually also done in industry. Table 1 shows a typical schedule of one academic year; table 2 gives an overview of the mechanical engineering program.

Table 1: Typical semester schedule

	15 Weeks of Instruction	Exams	Holidays
Winter Semester	1st Week of Oct to 3rd Week of January	4th Week of Jan. to 1st Week of Feb.	3rd Week of Feb. to 2nd Week of March
Summer Semester	3rd Week of March to 1st Week of July	2nd Week of July to 3rd Week of July	August to September

The lectures are usually done in 90 minutes blocks without a break; many of them have hands-on labs as well. The ME Department has labs for Aerodynamics, Aero Acoustics, Fluid Mechanics, Controls, Hydraulics, Pneumatics, Systems Engineering, Material Science, Corrosion and Wear, Thermal Turbo Machinery, Process Engineering, Heat Technologies, Renewable Energies, CAD and Simulation, Rapid Prototyping, Automotive Mechatronics (see Figure 1), Electronics and Electrical Drives, Dynamics of Machines, Mechanisms, Automotive Technologies, Measurement Technologies, Quality, Chemistry, Synthetic Material Science, Smart Composites, Manufacturing and Combustion Engines. The program also covers two projects, the first one focused on design, the second usually on some more general topics. With some exceptions (Design classes, Projects, Labs) the classes do not have obligatory attendance, homework or midterms. The size of the lecture-based classes has an average value of 50, (may be more, if necessary); the classes with labs or projects have a smaller number of students adapted to individual needs. Usually the students prove their abilities just once at the end of the term by a 90 minute final exam. The drop out rates for these exams in the first semesters reach values of more than 50%. Students may only retake the final exam of a single class twice, and there is also a limit to the total number of exams a student can retake.

As can be seen in Table 2, the majority of classes are technical in nature – there is no large general education requirement in German higher education. Students take a total of three free

Classes:	Semester:	1	2	3	4	5	6	7	8
Math		6	6						
Chemistry		2	2						
Physics		2	2						
Statics and Dynamics		4	4						
Strength of Materials		4	4						
Geometry		2							
Material Science		2	3						
Machine Parts I		2	2						
Machine Parts II					4	2			
Design I		3	2						
Design II					3	3			
Design Project								4	
Electrical Engineering		2	2						
Electronics / Microprocessor					4				
Electrical Drives								2	
Computer Science I		2							
Computer Science II					3				
Finite elements									4
Fluid Mechanics						4			
Heat Transfer								3	
Thermodynamics					4	2			
Dynamics of Machines, Mechanisms					4	3			
Synthetic Material Science					2	2			
Non Cutting Manufacturing					2	2			
Cutting Manufacturing						3			
Measurement Engineering					2	2			
Control					3	3			
Machines Lab									2
Thesis									4
Seminar on Industry Internship				2			2		
Business Organization				2					
Industrial Safety				2					
Economics							2		
Law							2		
Internship in Industry (20 weeks)				X			X		
General Electives		2				2		2	
Technical Electives									12
Specialization (General/Energy/Manufacturing/Design/ Mechatronics/Process Engineering)									16

Table 2: Program with amount of 45 minutes per unit per week



Figure 1. Hands-on laboratories at the Munich University of Applied Sciences.

electives, one each in the 2nd, 5th and 7th semesters. Students are allowed to choose freely from a wide variety of different topics.

The variety of job opportunities is wide: the graduates find positions in Research, Simulation, Design, Product Development, Testing, Quality Management and Manufacturing, Sales and Marketing or even in areas not directly related to technology. Usually the graduates from traditional Universities are stronger in the areas of Research and Simulation; however the gap in the starting salaries between graduate engineers from Fachhochschulen and traditional Universities is quite small. Due to the close ties to industry based on the internships, the thesis, students working part-time in industry, and also the background of the professors (see below), the students typically do not have trouble finding their first jobs.

Students

Due to the lack of obligatory homework, quizzes and midterms, the students usually have lots of freedom in using their time and structuring their learning process. According to Table 2 the students have about 30 classes of 45 minute per week (usually taught in 90 minute blocks), but mostly these classes are not obligatory. Depending on their own abilities and time, students can create their own learning style without attending the classes (we estimate about 10-20% of students do this). Often students have close ties to a company due to professional training they did before being a student at Munich University of Applied Sciences, or develop these close ties during the obligatory internships or by working for industry during the holidays (see Table 1). The flexibility in the learning gives them the opportunity to do professional work even during the semester. In addition Munich has a huge variety of companies, giving students the opportunity to get good part-time jobs with a technical background.

Unfortunately, providing the students this freedom to be responsible for their own learning can cause serious problems. Especially in the first semesters, the students are often not able to cope with this responsibility; the dropout rates in some exams are enormous (over 50%) and the pressure on the students is very high. In particular the students of the first semesters often do not

have the ability to learn consistently and to structure their learning process on their own. The final exams are just offered twice a year, causing a serious delay by waiting until the next trial.

The professors are required to offer one office hour (45 minutes) per week (see below), but often, the amount of students trying to get help does not require these 45 minutes! Obviously the distance between students and professors is so high that students do not think about using this opportunity to get help on the material they try to learn. It seems to the author that the students accept that learning is a process that they predominantly organize by themselves. However the cooperation between students is quite high, and there seems to be an enormous amount of material and information organized by the students themselves.

In addition, the students do usually not feel such close ties to their university: the universities in Germany often do not have a closed campus, and they offer neither housing nor sporting activities. The efforts done to build a corporate identity are very small. From a German point of view, having a university football (soccer) team or even a stadium would be seen as waste of money.

Professors

The main prerequisites to become a professor at a Fachhochschule are to have a doctoral degree (this provides the scientific background) and to have worked a minimum for 2 years in industry (this provides the professional background and is a main difference from the Universitäten). Actually most of the professors spend much more time than the required 2 years; often they have 10 or more years of experience in areas with supervisory responsibility. This requirement provides a close link between the ME program and the real needs in industry. The hiring process is based on the application material of the candidates, a couple of interviews and two lectures evaluated by a committee consisting of professors from the ME Department, the Munich University of Applied Sciences and other Fachhochschulen. Mostly the new professors get a lifetime position from the first day and have no need to demonstrate their abilities to the department or to the management of the university. The possibilities to improve the salary paid by the university are very limited and are not a means of motivation for professors.

The salaries for the professors are smaller compared to jobs in industry requiring a doctoral degree and certain job experience. Consequently the strategy of the universities to get good professors is not based on money but on offering personal freedom. This is, for example, the right to do work independent from the university. Lots of professors use this possibility to improve their income, to have fun with non-educational work, to keep their knowledge up to date and consequently to keep close ties to industry. This is very useful for the students and for the program in general. Since the Bologna Process started in 2000, the Fachhochschulen have also tried to encourage research work by giving their Professors the possibility to reduce the teaching workload and to do industry or government funded projects.

Student evaluations are done, but they are not used to put pressure on professors. It is common sense that a drop out rate of 50% or even more may cause a negative student evaluation and that any relationship between the salary of a professor and the student evaluation may have a serious impact on the quality of the achieved level of education. The thinking is that a student evaluation is a very valuable aid, to give professors feedback for their teaching work and to show how

improvements can be made. It is assumed that the professors bring enough motivation and knowledge on their own to be able to do good teaching, good work for the department and the university and also –if they want– good research work. Compared to Cal Poly, the professors act more like specialists in their field than like teachers teaching lots of different classes.

The teaching load is 19 times 45 minutes per week, over two 15 week semesters. The class sizes for usual lectures are about 50 students, if necessary this may increase to 100 or even more. Every professor has to offer one office hour per week and it is assumed that every professor helps to cover a small part of the administrative work in the department. Some of these jobs –if they are very extensive- are linked with a reduction of the teaching workload, but usually this reduction is far from covering the real additional work load.

Conclusions

From the point of view of the authors the professor at a German Fachhochschule is less involved in the learning process of students; the responsibility of the student for the learning process is much higher compared to the situation at Cal Poly (and most other US institutions). The missing or very small student fees do not support thinking about the students like customers who are entitled to certain benefits or instructional qualities. It seems that the focus on teaching in Germany is not so pronounced compared to the US; organizations like the ASEE that give a platform for educational development are missing. Personally the authors think that even the interest of professors in modern teaching techniques is less developed compared to the US.

The close ties to industry form a core element of the German Fachhochschule. They are mainly based on the obligatory professional background of the professors, the obligatory internships of the students in industry, the thesis usually done in industry and also on a huge amount of lecturers working in parallel on a full time industry job. In addition many of the professors do part time work in industry. These close ties help to keep the professional knowledge of the professors up to date and give them the ability to teach skills really needed for an industry career. And sometimes they even help the students to find the right jobs.

References

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