



## **Creating an International Profile of a Degree Program in Mechanical Engineering**

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# Creating an International Profile of a Degree Program in Mechanical Engineering

## Abstract

At the Royal Institute of Technology in Stockholm, Sweden (KTH), Mechanical engineering has been taught since the middle of the 19<sup>th</sup> century. Today, the degree program in Mechanical Engineering is a five year program, based on a three years BSc program and a two year MSc program. The program enrolls about 160 students every year.

Starting in 2012, an international profile of the program was established. Students of the degree program choose during the first year to apply to an international profile based on one of three languages: Spanish, German or French. Acceptance criteria include good performance during the first year and language skills from prior studies.

If accepted, these students are following a modified curriculum for their second and third year of studies. For the second year, language courses spans the entire academic year and constitute 25% of the entire curriculum that year. The third year includes a mandatory exchange semester abroad, with engineering studies in the local language (Spanish, German or French).

To facilitate for the exchange semester, KTH has made agreements with a number of partner universities. In particular, exchange semester curricula have been established at each key partner university, so that a prior agreement of the list of courses to be taken at each university is predetermined.

This paper presents results from a first run of the program with the exchange semester. For the first year, a total 24 out of 160 students were accepted to the international profile. Considerably more students applied but did not qualify. Of these 24 students, 19 choose Spanish, three choose German and two choose French. These 24 students were divided between three Spanish universities, two German universities, one French university and one Swiss.

## Background – KTH and internationalization

KTH, the Royal Institute of Technology, is the largest, oldest and most international technical university in Sweden. KTH accounts for about a third of all technical research and higher engineering education in Sweden. Currently, about 14000 students are enrolled in one of the programs that lead to a Bachelor, Master or a PhD degree.

Most engineering education in Sweden is balancing between traditional national degrees and the European standards (like most universities in Europe). The traditional engineering programs are divided between three year programs and five year programs, where the three

year programs are more applied and the five year programs more theoretically oriented. To comply with the European standard, the five year programs are divided into a three year BSc program followed by a two year MSc program, but the national degree (in Swedish: “civilingenjörsexamen”, also translates to Master of Science) is only awarded if the full five year program is taken. At the moment, the five year national degree is the prioritized degree, and the students get the additional to degrees (BSc and MSc) as a bonus and to facilitate international careers. The trend is however to move towards the European degrees and reduce the importance of the five year degree. For the rest of this paper, the five year programs are referred to as the “national engineering programs”.

A student that starts at KTH therefore chooses between nine three year engineering programs and seventeen five year national engineering programs. All programs (except one) are given in Swedish for the first three years and in English for the last, meaning that all BSc programs (except one) are in Swedish and all MSc programs are in English.

### KTH and Europe

Similar systems exist in several of the European countries. Spain and France keeps their national engineering degrees while still complying with the European standards, very similar to Sweden. Germany also have the same setup with basically two kinds of BSc programs (applied and theoretical), paving way for either a BSc degree (the applied program) or acceptance to a MSc program (prepared for by a theoretically oriented BSc degree). In Spain and France, just like in Sweden, the national degrees (five years or more) are recognized by the industry as a professional degree and not the combination of any BSc and MSc degrees.

In this perspective, internationalization of the engineering programs can be done in two ways, either by exchange periods or by recruitment, but the main difference is that, the local national degrees can typically only be awarded to local students since they require the full five year program. If a KTH student takes a BSc at KTH and a MSc degree somewhere else, the student is neither awarded with the Swedish five year degree nor the local degree in the other country. And, since the importance of the European BSc and MSc degrees still is to be recognized by Swedish industry, the above is not an option for most Swedish students.

### International exchange programs at KTH

KTH currently has student exchange agreements with approximately 200 universities in Europe and 100 universities in the rest of the world. In 2012, KTH welcomed in total 1372 new exchange students while in total 509 KTH students started studies abroad. Of these 509, 288 students (56%) studied outside Europe. In total, 651 KTH students studied abroad during 2012 and 1895 exchange students studied at KTH. Of these 1895, 1459 (77%) students came from countries belonging to the European Union [1].

These numbers show a large imbalance, with 2.7 incoming students per outgoing. For universities outside Europe, the numbers give 1.5 incoming student per outgoing, and for European students, KTH sees 6.6 incoming per outgoing student.

Tables 1 and 2 show the ranking of countries for incoming and outgoing students.

<b>European country</b>	<b>Rank, incoming</b>	<b>Rank, outgoing</b>
France	1	1
Germany	2	2
Spain	3	4
Italy	4	5
Switzerland	5	3

Table 1 – Ranking of countries for incoming and outgoing students, for European countries

<b>Non-European country</b>	<b>Rank, incoming</b>	<b>Rank, outgoing</b>
Singapore	1	1
US	2	3
China	3	4
Australia	4	2

Table 2 – Ranking of countries for incoming and outgoing students, for non-European countries

In 2012, KTH accepted about 325 incoming students from France, compared with about 40 KTH students studying in France.

### Mechanical Engineering at KTH

In this paper, one (of the seventeen) national engineering program is studied in particular, Mechanical Engineering. Mechanical Engineering is one of the oldest programs at KTH and enrolls 160 students every year. As described earlier, the first three years (the BSc program) is taught in Swedish and the last two years in English. Currently twelve KTH MSc programs are mapped toward the Mechanical Engineering programs, meaning that the national engineering degree (of five years) is awarded to students choosing one of these twelve specializations. The third year of the curriculum the students choose specialization and study preparatory courses for one of the twelve specializations.

Figure 1 shows the outline of the curriculum. Note that the choice for MSc program is made during the second year of studies.

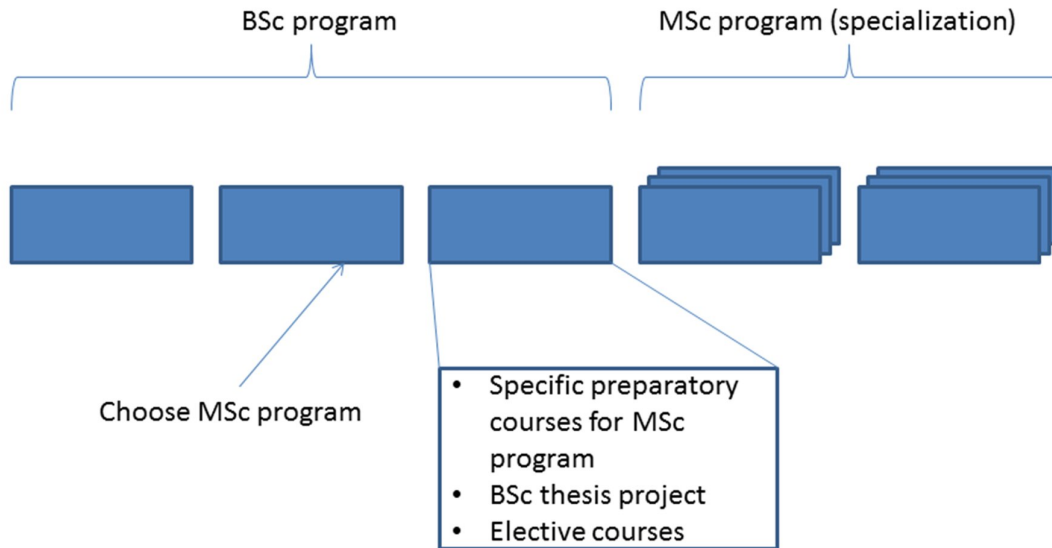


Figure 1 – Outline of curriculum for the five year degree program in Mechanical Engineering

#### Enhancing the balance by creating an international profile

Starting in 2012, students of the Mechanical Engineering program were offered an international profile. According to the earlier presented statistics, the key to create a better balance between incoming and outgoing students, KTH had identified a need to increase outgoing students to European countries. Utilizing the transferability of the European BSc and MSc system was not an option, as described earlier, since this did not enable students to receive the national degree. The basic idea with the new concept was to enable students to travel in the third year of studies, and to study in the local language.

Figure 2 shows the additions of the international profile of the curriculum, as introduced in 2012.

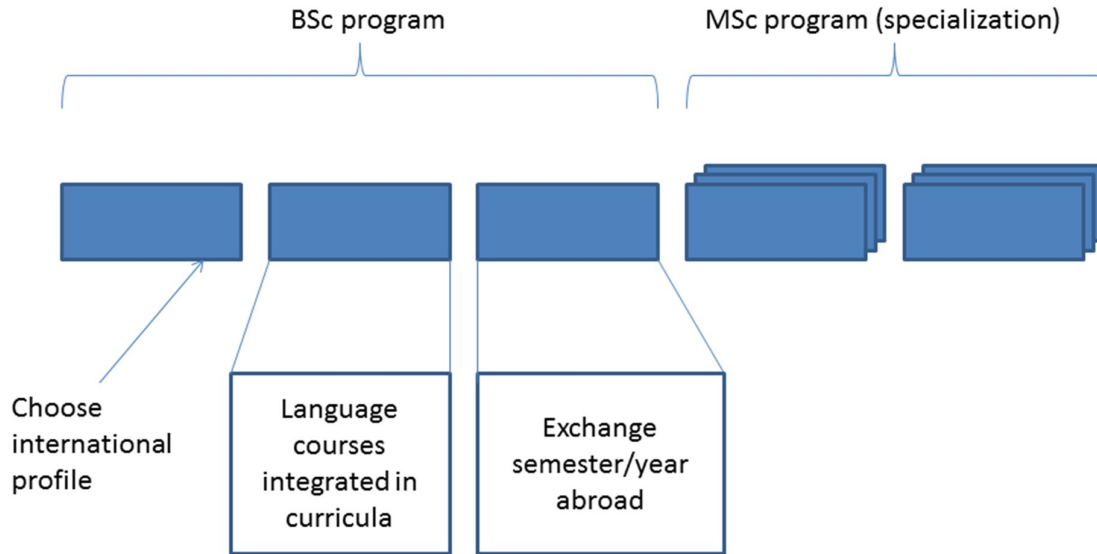


Figure 2 – Outline of curriculum for the international profile of the five year degree program in Mechanical Engineering

The curriculum of the first year is same to all students, regardless of specialization (MSc program) or international focus. The second year is divided between international focus and non-international focus. The third year is both divided between international and non-international, as well as according to the chosen MSc program. The fourth and fifth year is divided between twelve MSc programs (meaning that there exist 24 variations of the third year curriculum).

The implementation of the international profile

Figure 3 shows the curriculum for year 1-3 for the non-international profile. Figure 4 shows the curriculum for the international profile. The main difference is that voluntary courses in the non-international profile has been replaced by language courses in the international profile, and that courses have been shuffled around to facilitate international exchange during the third year.

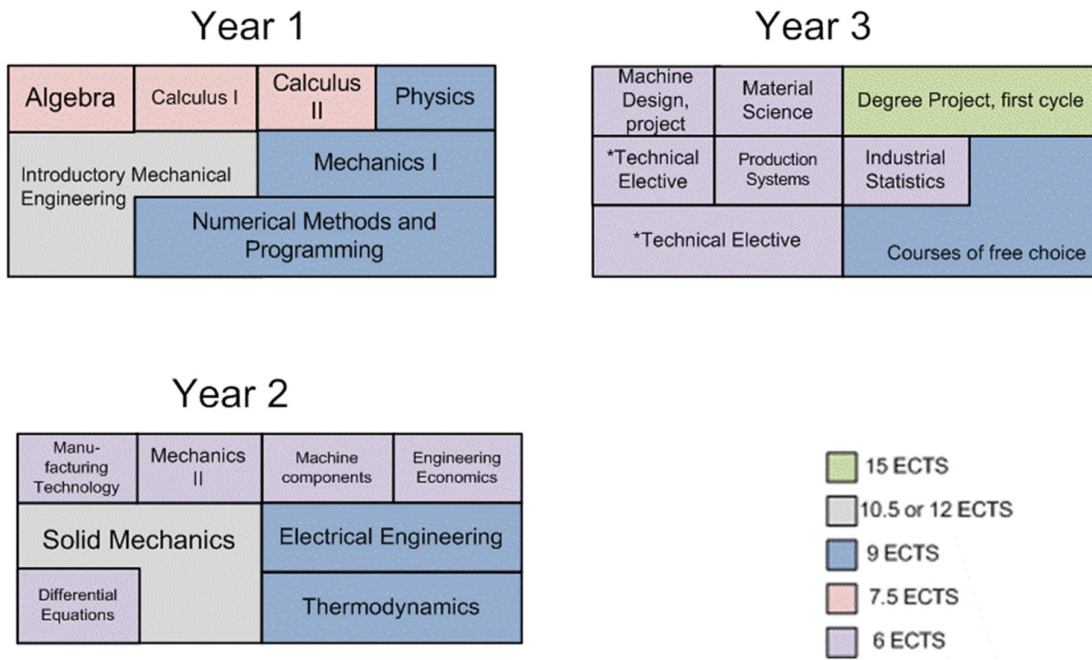


Figure 3 – curriculum for non-international profile, year 1-3

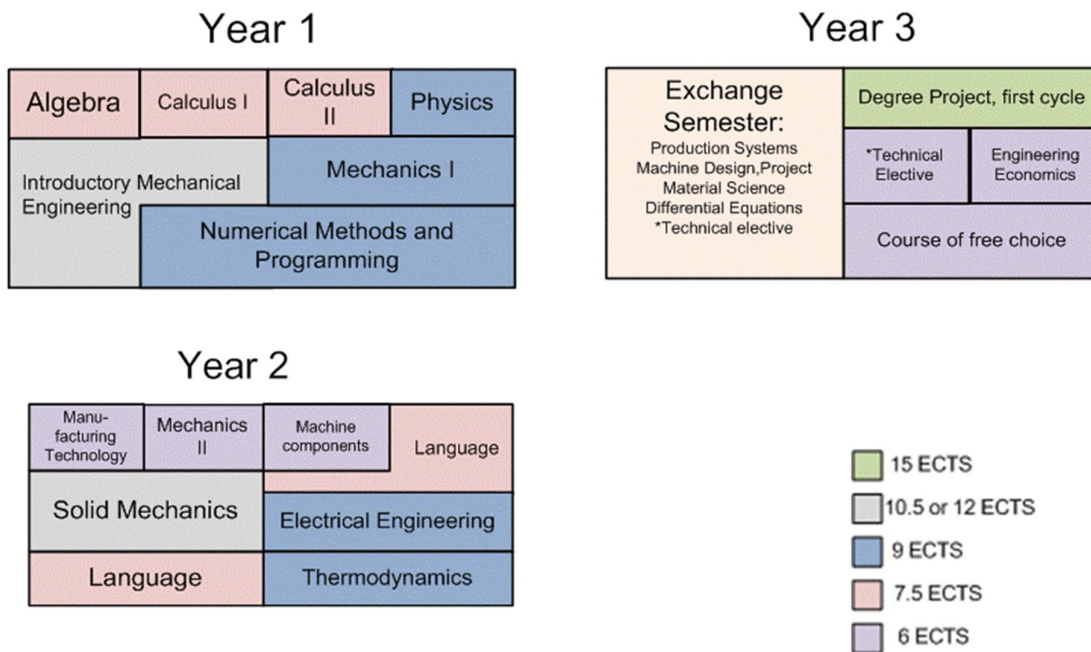


Figure 4 – curriculum for international profile, year 1-3

Students are eligible for the international profile if they have studied the language previously, and have acquired at least basic knowledge. At the moment, three language tracks are available: German, French and Spanish. Students are subjected to a placement test in the first year of studies, and, passing this test accepted to language courses in the second year. The

language courses run for the entire second year, spanning about 25% of full time, and after completion students are expected to be able to study in the country of their choice, in the local language.

#### Partner universities

In time for this paper, agreements have been made with seven partner universities (see table 3). With all seven partner universities, exchange curricula have been established and agreed upon for the third year of studies. As mentioned above, KTH students follow one of 24 possible curricula during the third year. Besides this, students can choose whether staying abroad one or two semesters, and if one semester – whether exchanging the fall or spring semester. In a first step, structural differences in terms of semesters and calendars made certain combinations impossible. See table 4.

Country	English name
Spain	Polytechnic University of Madrid (UPM)
	Polytechnic University of Valencia (UPV)
	University of Navarra, School of Engineering at San Sebastian (TECNUN)
Germany	Technical University of Munich (TUM)
	Karlsruhe Institute of Technology (KIT)
	RWTH Aachen University
France	Grenoble Institute of Technology (INP)

Table 3 – the seven partner universities

Country	Fall semester	Spring semester
Sweden	September to mid-January	Mid-January to June
Germany	October to end of March	April to August-September
Spain and France	Roughly beginning of September to January (varying from beginning of Jan to end of Jan)	Varying from mid-January to mid-February to June

Table 4 – major calendar differences between the partner universities

For exchange semesters with German universities, Swedish students cannot exchange only the fall semester since this overlaps with half of the Swedish spring semester. For German exchange studies, students need to either study a full year in Germany or exchange the spring semester.

For exchange with French and Spanish universities, students can choose to exchange either one or two semesters. With some universities there is a theoretical overlap of up to two weeks between the fall semester and the Swedish spring semester, which could be of some concern.



## Results

The international profile of the Mechanical Engineering program started in 2012 with the 160 students enrolled then. Of these 160 students, 24 got accepted into the international profile during spring 2013. Of these 24 students, 19 choose Spanish, three choose German and two choose French. These 24 students were divided between three Spanish universities, two German universities and one French university.

The acceptance criteria for the international profile included a language skill test and general academic performance during the first year of studies. These 24 students have during 2013 studied language courses in parallel with regular engineering courses. Starting in September 2014, all students will spend at least one semester at one of these seven partner universities.

The faculty has, together with representatives from the seven partner universities, established exchange curricula for all 24 students, based on their respective choice of MSc program at KTH upon their return.

It is impossible to say whether there is a broader impact yet, but everything points towards that. Prior to the international profile, only very few students studied abroad during their third year, never more than a handful. With the international profile, 24 students have made plans to study abroad the coming semester. Usually, students study abroad in their fourth and fifth (last year). Two factors further points towards an increase in international exchange. First, previous experience show that a student who has studied abroad is likely to study abroad once again. Second, the international profile enables students to study abroad earlier, which means that this cohort do have the opportunity to study abroad again, in their fourth or fifth year.

## Discussion

Similar programs exist at other universities, for example the GEARE program at Purdue University and the International Plan at Georgia Tech. Both the GEARE program and the International Plan include a full semester of studies abroad as well as preparatory activities before the exchange period. The GEARE program involves a local internship with minimum 10 weeks. Both these programs are recruiting students already enrolled into undergraduate programs. In a comparison between the KTH initiative and these two international programs, many similarities exist, but the main differences is that the US programs are more focused on international experience and a global career, the KTH program has so far been more focused on language skills and course exchange mainly, and to build on smaller incremental changes of the existing mechanical engineering curriculum. When comparing with these programs, it is clear that the next step in the development needs to focus more on international and global skills rather than language skills.

## Conclusions

In 2012, approximately one third of all KTH students had spent at least one semester studying abroad. KTH envisions that this number needs to increase and that, in the short term, at least half of all students should study at least one semester abroad to better prepare for a global career. There is a major imbalance between incoming and outgoing students which means that there is a huge potential to send more students abroad, particularly to Germany, France and Spain. This paper has presented an attempt made by the management of one of the engineering programs at KTH, the Mechanical Engineering program, which introduced an international profile in 2012. This attempt is to create a new window for exchange studies in a part of the curriculum not previously focused on exchange studies.

The absolute majority of exchange studies undertaken are done in English. Many universities teach MSc programs in English regardless of where in the world. The international profile of the KTH Mechanical Engineering program has shown that it is feasible to perform this exchange in French, Spanish and German as well.

## References

1. KTH Årsredovisning 2012 (KTH Annual Report 2012), KTH Royal Institute of Technology, Stockholm, Sweden, 2013.