



MICKEY MOUSE AND A GIANT: COMPARISON OF AERONAUTICS EDUCATION IN FINLAND AND CHINA

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Abstract

New education technologies and global availability of study materials and fluent exchanges of students offer new alternative ways to educate for aeronautics and form international study programmes. Aeronautics is a field of technology where fundamental basis is similar independent of local industry and size of the field. However, the size of the industry and education organizations can affect the teaching environment and culture of students. This study focuses on comparing the size and structure of aeronautics education in two different universities: Tampere University in Finland and Tsinghua University in China. Parametric data is collected and analyzed. The results reveal interesting differences and similarities between the universities.

Keywords: education, aeronautics, teaching methods, higher education

1. Introduction

Education of technical topics at the highest, university level is facing changes with pros and cons. The teaching of aeronautics greatly relies on advanced mathematics, physics and various numerical methods. The use of online tools (e.g., Hyppönen and Lindén, 2009) has already long carved its shape on the aeronautics education – among various team working and challenge or problem-based learning (PBL) methods (e.g. Brodeur, 2002) typical in aeronautics education. The big current trends are the easy reach of studies all over the world (via web), the use of tools of artificial intelligence (AI), and various harmonizations between countries and continents. All of the recent trends and changes allow easier transfer of students via exchange programmes between universities, easy reach of various study materials, as well as common education between universities over country borders. The pros of this development should be harnessed to the education of aeronautics and boosting of the level of aeronautics through students in different countries. Due to the easy flow of people between companies in different nations, the recent development improves the field of aeronautics globally and from different perspectives of viewing the field's future.

The cons of the increased transparency and transfer (exchange) of students can be the loss of students in certain locations or regions, loss of potential workers from certain locations, or – on the other hand – increased workload towards teaching staff or universities in general. Sometimes the switch of teaching language can harm the knowledge of national terminology (of aeronautics) among students. These effects can be overcome with a high quality of teaching and good marketing of study programmes and is important in improving the quality via global 'competition' (e.g., Dill et al., 2006). Recently, Tampere University has emphasized the importance of well-being of students and teachers to improve the timely progress of students' learning, education. It is possible to create activities and structures that foster a sense of participation among teachers and students and engage in closer collaboration (Vanhanen-Nuutinen and Aura, 2023; Erkkilä and Perunka, 2021; Soini et al., 2010).

Also the cultural effects during the long learning process for undergraduate and graduate students can affect the ability to learn, i.e. individual learning process (Packer and Goicoechea, 2000).

An interesting topic of aeronautics education is the effect of industry size on joint studies. The courses and other teaching activities (e.g. assignments, theses) of aeronautics are often tied to local industry so that the size and capabilities of the industry can bring interesting views to the collaboration in education. On the other hand, the student-teacher ratio can be different in different countries and offer new ways of studies for exchange students. Eventually, as a third point of view, to become a global expert, a students needs to widen their academic and generic expertise in specific field of technology and beyond field or socio-cultural boundaries (e.g. OECD, 2024).

This study focuses on looking at the aeronautics education in two countries with very different sizes of aeronautics industry. The study does not deal with the comparison of the industries or the strategy for the size of study programmes in universities but strictly focus on the numeric sizes of education structures in two example universities. The data of the study is collected over three-to-five-year periods. Finally, ideas for potential advantages of the collaboration between the nations are discussed.

2. Methods

The quantitative data of the work is based on non-personal data representing total annual rates, as shown in Table 1. The data was used to estimate annual rates and capacities per programme and university. The term ‘aeronautics’ is not strictly defined and was the requirement of programme title but instead the content of the studies was considered. Therefore, fields of ‘mechanics’, ‘astronautics’ and ‘thermodynamics’ related programmes were also considered when they comprised typical (local, at a university) appearance of students targeting to aeronautical courses and modules. The data is analyzed by comparing the numbers and discussing possible reasons and harmony of the parameters compared. The example universities are the Tampere University (Tampere, Finland) (TAU in the following) and Tsinghua University (Beijing, China) (THU in the following). These two example universities were representing universities of approximately small and large aeronautics nation by industry size, respectively.

Table 1 – quantitative parameters for data collection in this study

Parameter	TAU	THU
Programme size	-	Graduated students
Module size	5-year average	-
Course size	Typical total credits earned, students active	-
Education size	Teaching staff, Department staff	Faculty staff, current number of students

3. Results

3.1 Aircraft Engineering education, Tampere University

At Tampere University (TAU), the term ‘programme’ is for an extensive number of studies – for example, a programme can cover overall (all) materials science majors. The typical ‘fields of technologies’ are represented more specifically by the content of so-called ‘modules’. The B.Sc. level of education (undergraduate level) is a common entity for a wide range of technical fields at TAU. This education entity leads to – in the event of student continuing up to M.Sc. level – the educational basis on top of which the more specific M.Sc. level (graduate) of programs are built on. This means that certain technical field, such as ‘aeronautics’ is represented by students selecting so-called ‘modules’ that include courses in the field of aeronautics. These modules have sizes of 20 and 30 credits (ECTS). The modules divide into undergraduate and graduate level courses. A credit stands

for European Credit Transfer and Accumulation System (ECTS) and, at TAU, means 27 h of course-related activities by the student. The typical course size is 5 ECTS.

Specific module selection also defines ‘major’ and ‘minor’ topics in the study plan of a student. There are modules of aeronautics that are eligible for a ‘major’ or ‘minor’ of aeronautics at TAU. The different modules are given in Table 2.

Table 2 – sizes of different modules of aeronautics at TAU

Module	Size (ECTS)	Module level
Long major	80	M.Sc. major eligible
Short major	60	M.Sc. major eligible
Long minor	30	B.Sc. eligible or M.Sc. minor
Short minor	20	B.Sc. eligible or M.Sc. minor

The modules (Table 2) include courses of different depth of knowledge. The modules of Long minor and Short minor contain basically courses that have knowledge on the level of ‘introduction’. The modules Long major and Short major contain courses that have knowledge on the level of ‘intermediate’ and ‘advanced’. The advanced level, basically, refers to type of education that prepares for doctoral studies. In the study programmes throughout TAU, the modules typically have certain amount of eligibility. Additionally, the B.Sc. and M.Sc. education overall contains number of courses that students are essentially free to choose from a selection of courses. This selection is free, as long as the student can fulfil possible pre-requirements of a course and finish the course in a normal way. Therefore, many of the aeronautics courses can be selected by students completely outside the ‘field of aeronautics’ and carry out these courses as part of B.Sc. or M.Sc. education.

The averaged number of students on the aeronautics courses of different depth of knowledge are given in Table 3.

Table 3 – the sizes for aeronautics courses of different level (depth) at TAU

Course level	Size in terms of credits (ECTS)	Size in terms of 5-year average (students, accuracy ± 5 students)
Introduction	5	50
Intermediate	5	30
Advanced	5	5

A more detailed divisions of students participated to various courses are introduced in Table 4. The data in the table shows the typical variation in the numbers of students for selected courses of aeronautics. The numbers represent active students per course per year.

Table 4 – the variation of students (st.) on selected aeronautics and materials courses at TAU

Course	Course level	2018 (st.)	2019 (st.)	2020 (st.)	2021 (st.)	2022 (st.)	2023 (st.)	3-5 year-average size (st.)
Introduction to Aircraft Engineering	Introduction	n/a	n/a	n/a	38	55	45	46
Aerodynamics and Flight Mechanics	Intermediate	n/a	n/a	15	24	36	26	25.3
Avionics	Intermediate	n/a	n/a	n/a	36	35	39	36.7
Composite Structures	Intermediate	(launched 2019)	16	16	18	26	23	19.8
Advanced Composites	Advanced	29	12	46	20	19	10	22.7

3.2 Aerospace Engineering education, Tsinghua University

At THU, Aerospace Engineering education includes programmes and those divide into undergraduate and graduate programmes. The education of doctoral studies are differently organized. The undergraduate students have to gain at least 156 credits to get the B.Sc. degree. In this, a credit means one lecture of 45 minutes a week, and in total 16 weeks per semester. Most of the courses related to aeronautics are 2...4 credits in size (in a semester). The students graduated from undergraduate programmes over 2018-2023 are given in Table 5. In addition to the Aerospace Engineering programme, the numbers for the Mechanics programme are given.

Table 5 – the number of students on selected aeronautics programmes for undergraduate level

Programme	2018	2019	2020	2021	2022	2023
Mechanics	41	41	48	47	60	39
Aerospace Engineering	44	47	41	41	36	47

The students graduated from graduate programs over 2018-2023 are given in Table 6. In addition to the Aerospace Engineering programme, the numbers for the Mechanics, Thermodynamics, and Aeronautical and Astronautical Science and Technology programme are given.

Table 6 - number of students on selected aeronautics programmes of graduate level

Programme	2018		2019	2020	2021	2022	2023
Mechanics	13		17	11	9	9	8
Thermodynamics	4		4	5	4	5	7
Aeronautical and Astronautical Science and Technology	25		10	11	6	10	8
Aerospace Engineering	14		10	9	9	10	17

The students graduated from doctoral programs over 2018-2023 are given in Table 7. The numbers for the Mechanics, Thermodynamics, and Aeronautical and Astronautical Science and Technology programmes are given as representative for the doctoral level of education for aeronautics.

Table 7 – number of students on selected aeronautics programmes of doctoral level

Programme	2018	2019	2020	2021	2022	2023
Mechanics	43	27	33	50	45	47
Thermodynamics	7	9	4	13	13	9
Aeronautical and Astronautical Science and Technology	23	17	22	21	31	28

4. Discussion

4.1 Structure of education

The data collection from the two universities revealed that there are different ways to structure aeronautics education. Both – TAU and THU – implicitly divide education into undergraduate and graduate education. However, TAU has a structure where courses are collected into modular packages and these modules can form the studies of undergraduate and graduate levels for a student. Further, the modules are divided into major and minor modules depending on the size (depth of substance) of the module's content. THU has programme(s) that are related to the field of aeronautics. As is typical for aeronautics education, there is overlapping content with the education of mechanics and astronautics. Both universities have different structures for doctoral education compared to the arrangements for offering B.Sc. and M.Sc. degrees. When discussing the focus of this work, the different structures can make potential exchange students feel overwhelmed. Therefore, it is suggested that student advisors at the faculties or departments form an important feature to enable any type of collaboration related to aeronautics education between (any) two very different universities.

The different structures of aeronautics education make a direct (quantitative) comparison of the size of content and education in the two universities difficult. Estimative comparisons can be made in terms of number of students (see Results) on courses and programmes and in terms of 'core courses' as well as number of staff members.

In terms of the skills and competence of students performing studies, the courses and their contents are important. At TAU, the aircraft engineering courses and some nearly related courses of technical fields (e.g. Composite Structures) are given in Appendix. These courses count 9 entities (2018-2023) and they form the core of the minor and major modules of aeronautics at TAU. For the unit (comparable to e.g. department or study entity) of School of Aerospace Engineering (SAE) at THU, the education covers in total 87 courses and they are taught by professors of SAE in the case of undergraduate students. Most of the courses are elective. The aeronautical core is formed by 10 'core courses' which are compulsory (see in Appendix). These above numbers indicate that the sizes of the programmes in terms of the core courses is comparable – this is natural due to the fact that the fundamental skills necessary for aeronautics skills are essentially the same in the two nations. This also tends to indicate that the substance contents of aeronautical teaching could be easily matched for exchange students on undergraduate and graduate levels.

4.2 Teaching environment for individual students

The modules (related to aeronautics) at TAU are not given an 'intake' (limit). However, in practice,

the courses can have limits for maximum number students in order to fit classroom spaces and other services or teaching tech. Therefore, the learning environment for students from the point of view of total amount of aeronautics students is better represented by the students *active* on a course (see Results). The intake for incoming students at SAE of THU is 40 students (per each year) – this makes around 0.4 students per teacher (per year) based on the total 95 faculty members. The intake of doctoral students is around 95 annually. The students (estimated by the current numbers) cover 342 undergraduate students and 122 master students. The current number of doctoral students is 533 of which the minority (76) is part-time students. The direct student-teacher interaction depends much on the level of studies. Especially for doctoral students, group meetings are a typical form of interaction and available weekly (SAE & TAU). For each student, there is around 15-30 minutes of advising defined available each week (SAE, THU).

At TAU, specific study advisors, as a part of faculty staff, are available to students. The number of this type of advisors is approximately 1-2 persons per programme. For course-related questions (competence advises), the teachers are advising students and, for the nine core courses of aeronautics, there are four teachers. This means 1.3-12.5 students per teacher depending on the level of course (introduction – advanced). In terms of department (Automation Technology and Mechanical Engineering at TAU) and its staff (160 department staff members), there are 0.3-0.03 students per faculty member.

The resources at the faculty or department per student (undergraduate and graduate students), according to the numbers above, tend to be surprisingly similar. The resources per doctoral students are not discussed here because of the challenge of comparison. The habits per professor can be very different and the numbers of doctoral students related to the field of aeronautics are very different at the two studied universities in this work. This could indicate that collaboration related to exchange of doctoral students is necessary to be adjust between individual professors.

5. Conclusions

This work compared sizes of the aeronautics education of two universities, namely Tampere University and Tsinghua University. Quantitative parameters were selected and data was collected over periods of three to five years. The size-related differences and equalities were discussed, and conclusive suggestions were formed. The results and the discussion suggest the following conclusions of the study: i) The education structures are different in the two universities so that direct numerical comparison of sizes is difficult; ii) the core courses form the fundamental backbone of aeronautical education in both universities and the number of core courses is comparable; iii) the teaching and advising resources per (M.Sc., B.Sc.) student tend to be similar in the two universities; iv) doctoral education in the aeronautics-related topics differs greatly from undergraduate and graduate education in both universities.

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Appendix

The core courses of Aircraft Engineering (with teaching language) at TAU are (2018-2023):

- Introduction to Aircraft Engineering
- Aerodynamics and Flight Mechanics (English & Finnish)
- Aircraft Loads and Structures (English & Finnish)
- Composite Structures (Finnish)
- Aircraft Engines and Systems (English & Finnish)
- Aircraft Avionics and Situational Awareness (English & Finnish)
- Aerodynamic Modeling (English & Finnish)
- Advanced Course in Flight Mechanics (English & Finnish)
- Reliability and Maintenance of Technical Systems (English & Finnish)
- Condition Monitoring and Diagnostics of Machine Systems (English & Finnish)

The core courses of Aerospace Engineering (with teaching language) of SAE at THU are (2018-2023):

- Theoretical Mechanics
- Fluid mechanics
- Strength of Materials
- Engineering Thermodynamics
- Aerodynamics

- Dynamics and Control of Flight
- Aircraft Preliminary Design
- Numerical Computation for Aerospace Engineering
- Propulsion Principle and Technology
- Automatic Control Theory