BSc Final Qualifications

TU Delft Aerospace Engineering

summary

The currently used set of BSc Final Qualifications has evolved from the set that was established for the 5-year programme. Over the past years it has only been changed on some details to reflect the BaMa structure, the expansion of the faculty's disciplines and the impact of the major-minor structure in the 3rd year. It neither reflects a systematic framework of the curriculum nor a consolidated view on academic competences. The BSc Final Qualifications have therefore to be updated, also in view of the upcoming accreditation in 2007.

The BSc Final Qualifications for Aerospace Engineering have been redefined as competences, as detailed and specific as possible so that they can serve as generic learning targets for the individual courses, and in future for reconsiderations about the structure of the BSc curriculum. The booklet "Criteria for Academic Bachelor's and Master's Curricula" has been used as the prime outline, since the systematic framework described herein provides a clear breakdown of the academic competences. Also the equal way the design and research competences are addressed is of importance. This framework has recently been adopted by the Delft University of Technology. It was already presented to the chairholders of the faculty of Aerospace Engineering by Michel van Tooren at the Chairholders' Conference on 29 November 2004. A 3-member taskforce (Maartje van den Bogaard, Vincent Brügemann and Aldert Kamp) have sharpened the competences from the booklet, using "Qualification Profile of the Aeronautical Engineer in the IDEA League", and tailored to the faculty's (desired) situation using the "Study Guide BSc/MSc Aerospace Engineering 2005-2006" and some other information. This approach enables an appropriate benchmarking with aerospace curricula on national and international universities. On April 21st, 06 the BSc Final Qualifications were reviewed by the BSc Curriculum Committee. This issue reflects the results from this review.

This new set of BSc Final Qualifications is defined for the major part of the bachelor programme. The minor part in the 5th semester of the BSc programme adds enrichment to a subset of these competences. This subset is different for each minor. After agreement of the final qualifications the individual courses have to be mapped onto these objectives. The last step in the loop will be the matching of the individual course objectives with the BSc Final Qualifications. This process will identify any overlaps, unbalances and deficiencies in our curriculum, or reveal a need for changes in the educational approach to teach and train both the knowledge ánd skill ánd attitude aspects.

A.Kamp
BSc Programme Director
24 April 2006

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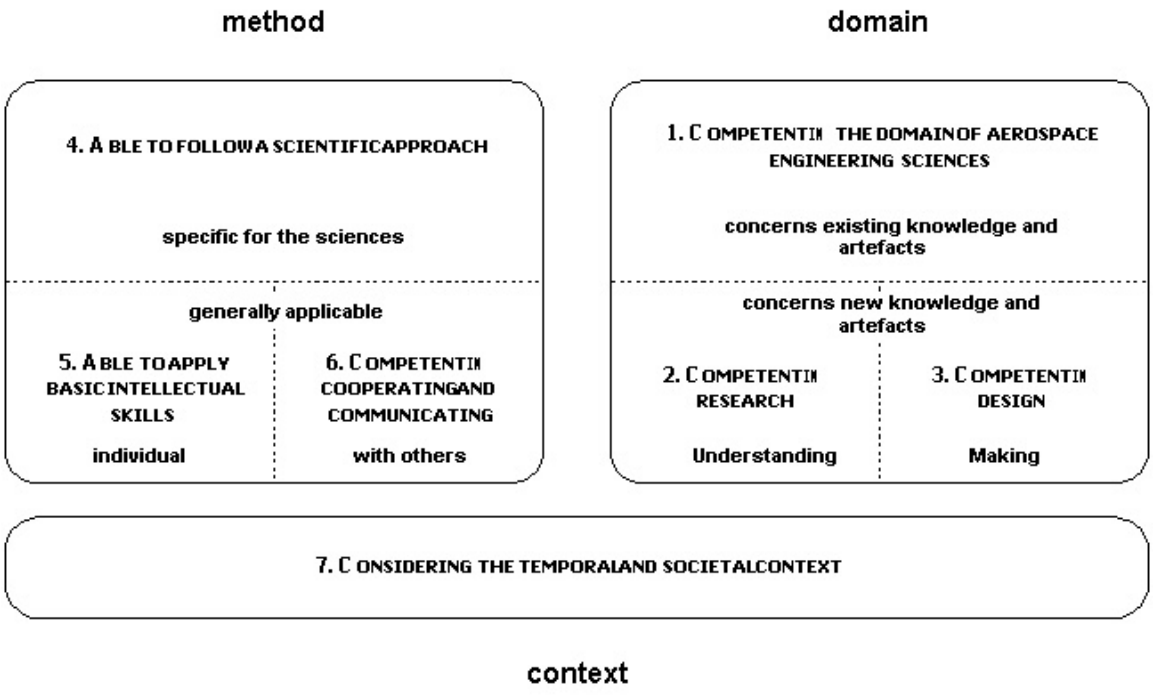
The areas of competence of a BSc graduate

The compentence areas of a BSc university graduate are represented in the figure below, that was taken from"Criteria for Academic Bachelor's and Master's Curricula".



For each competence an indication is given whether it is knowledge, skill or attitude related:

[k] = knowledge

[s] = skill

[a] = attitude

References used

1. Criteria for Academic Bachelor's and Master's Curricula, ISBN: 90-386-2217-1, issued by TU Delft, TU/e and University of Twente, 2005
2. Study Guide BSc/MSc Aerospace Engineering 2005-2006
3. Qualification Profile of the Aeronautical Engineer in the IDEA League, issued by IDEA League 27 September 2005

1. BSc-I Competent in the domain of aerospace engineering sciences

The fields of major subjects in aerospace engineering sciences (subject to review)

A	Mathematics	calculus, differential equations, linear algebra, vector calculus, numerical methods, statistics, probability and observation theory.
B	Thermodynamics	equations of state, entropy, constant pressure, volume temperature; 1st & 2nd laws, energy, exergy, efficiencies, power and cooling cycles, heat transfer.
C	Electromagnetism and optics[1]	electricity, magnetism, optics
D	Fluid Mechanics	Conservation of mass, energy, momentum, boundary layer, laminar and turbulent flow, Bernoulli, Navier-Stokes, dimensionless analysis, compressible flow
E	Aerodynamics	aircraft aerodynamics, airfoil and wing theory, incompressible flow, compressible aerodynamics propeller theory, sub- and supersonic flow, Mach effects,
F	Solid Mechanics	statics, kinematics, dynamics, stress analysis, strength and vibrations, finite-element methods.
G	Flight Mechanics	stability, control, performance of aircraft, helicopters and hovers, flight performance optimisation.
H	Propulsion	gas turbine, rocket
I	Materials Science / Aircraft Structures	relation between structure and properties for metals, plastics, ceramics, composites; failure, fracture, fatigue, wear, manufacture, production; buckling, shear panels, thin-walled structures.
J	Systems & Control Engineering	modelling, simulating, automation control, system identification, tools, avionics, fundamental and instrumental electronics, sensors and actuators, positioning, guidance and navigation.
K	Design of aircraft, spacecraft and rockets	Design methodologies, systems engineering, aircraft and spacecraft systems, vehicle engineering, reliability, safety, inspection and quality control, testing, engineering design standards, maintenance and (mission) operations, product life cycle
L	Astrodynamics	orbits and orbit dynamics, ascent, re-entry, interplanetary flight trajectories, space environment, space mission design
M	Space Science	observation requirements, measurement techniques, Earth and planetary space research, physical phenomena and principles
N	Information Technology	fundamentals, software architecture, programming techniques, tools for design, analysis and simulation.
O	Management, economics & communications	management and organisation, economics, aerospace business marketing, air and space law, sustainability

[1] This subject will be made part of the new bachelor curricum but is not contained inthe current curriculum of 2006-2007.

The BSc graduate has a consolidated body of knowledge in the fields of basic and engineering sciences, and aerospace engineering sciences in particular, and has the competence to increase and develop this through study.

a. 1 - Understands the knowledge base of the critical fields to the extent that the student can apply it in basic physical and mathematical models that adequately simulate reality. [k]
   2 - Is able to validate models following an accepted scientific approach. [ks]

b. Is able to relate and apply general engineering sciences to disciplines using appropriate methods and tools.[ks]

c. 1 - Has basic knowledge and skills in assessing theories and models in the field of aerospace engineering sciences. [ks]
   2 – Has basic knowledge and skills in applying theories and developing models in the field of aerospace engineering sciences. [ks]

d. Has basic knowledge and skills in conducting experiments and simulations and gathering data in the relevant fields of aerospace engineering sciences. [ks]

e. Has basic knowledge and skills in deducting knowledge from data, text, problems and results in the field of aerospace engineering sciences. [ks]

f. Has basic knowledge and skills of accepted criteria on which decisions are based within the specific fields of aerospace engineering sciences. [ks]

g. Is aware of the limits of usability of standard methods and procedures used in aerospace engineering sciences. [ksa]

2. BSc-II Competent in research

The BSc graduate has an understanding at an introductory level of the most important research issues in the aerospace related sciences, and is aware of the connections with other disciplines. He or she has the competence to acquire new scientific knowledge through research. For this purpose, research means: the development of new knowledge and new insights in a purposeful and methodical way.

a. Is able to spot deficiencies in a problem statement, to indicate how to reformulate the problem and to justify his choices. [ksa]
b. Is observant, and has the creativity and the capacity to discover connections and views from different perspectives. [ksa]
c. Is able to contribute to the execution of the research plan according. [ks]
d. Is able to work at different levels of abstraction, in relation to the research question at hand [ks].
e. Is aware of the importance of other disciplines. [ka]

3. BSc-III Competent in design

Designing is a synthetic activity aimed at the realisation of new or modified artefacts or systems, with the intention of creating value in accordance with predefined requirements. The BSc graduate aerospace engineering is able to recognize, formulate and analyse engineering problems independently and to offer one or more acceptable solutions.

a. Is able to spot deficiencies in a design problem definition, to indicate how to mitigate these and to justify his choices. [ksa]

b. 1 - Has sufficient creativity to come up with several solutions to a theoretical and/or practical design problem. [ka]
2. Has basic synthetic skills with respect to theoretical and practical design problems. [ks]

c. 1 – Is able to interpret a set of requirements and translate these into a design plan containing at least planning, work breakdown and activity flow. [ks]
2 –Is able to execute the design plan according to accepted standards [ks]

d. Is able to work at different levels of abstraction, including systems level. [ks]

e. 1 – Is aware of the importance of other disciplines [ks]
2 - Is able to synthesize disciplines in a design, such that a compliant (sub)system design is accomplished. [ks]

f. Is aware of the changeability of the design process through external circumstances or advancing insight and is able to keep the design process under control (working in a team under guidance of a professional). [ka]

g. Is able to integrate existing knowledge, information and numerical data from different sources in an efficient way into a design project. [ks]

h. Has the skill to take design decisions, and to justify and evaluate these in a systematic manner. [ks]

4. BSc-IV Able to follow a scientific approach

The BSc graduate has a systematic approach characterised by the development and use of theories, models and coherent interpretations, has a critical attitude, and has insight into the science and technology in the aerospace domain.

a. Is inquisitive and has an attitude of lifelong learning. [a]

b. Has a systematic approach characterised by applying theories and developing models and making interpretations. [ksa]

c. Has the knowledge and the skill to use, justify and assess as to their value models for research and design in the aerospace domain (model understood broadly: from mathematical model to scale-model). Is able to adapt and validate models for his or her own use. [ks]

d. Has insight into the aerospace related sciences and technology and has an appreciation of uncertainty, ambiguity and limitations of knowledge.[k]

e. Is able to report adequately the results of research and design. [ksa]

5. BSc-V Able to apply basic intellectual skills

The BSc graduate is competent in reasoning, reflecting, and forming a judgment. These are skills which are learned in the context of aerospace and which are generically applicable from then on.

a. Is able to critically reflect on his or her own thinking, decision-making, and acting and to adjust these on the basis of this reflection. [ks]

b. Is able to reason logically within the field and beyond; both 'why' and 'what-if' reasoning. [ks]

c. Is able to ask adequate questions, and has a critical yet constructive attitude towards analyzing and solving simple problems in the field. [ks]

d. Is able to form a well-reasoned opinion in the case of incomplete or irrelevant data. [ks]

e. Is able to comment meaningfully on a scientific argument in the field of aerospace engineering sciences. [ksa]

f. Possesses basic numerical skills, and has an understanding of orders of magnitude. [ks]

6. BSc-VI Competent in cooperating and communicating

The BSc graduate has the competence of being able to work with and for others. This requires not only adequate interaction, a sense of responsibility, and leadership, but also good communication with colleagues and non-colleagues. He or she is also able to follow a scientific or public debate.

a. Is able to communicate both verbally and in writing about the results of learning, thinking and decision making with colleagues and non-colleagues. [ks]

b. Is able to present verballythe solutions and conclusions of his or her work using state-of-the-art presentation techniques.

c. Is able to follow debates about the aerospace engineering sciences and its place in society. [ks]

d. Is characterised by professional behaviour. This includes: drive, integrity, reliability, commitment, accuracy, perseverance and independence. [ksa]

e. Is pragmatic and has a sense of responsibility; is able to deal with limited resources; is able to deal with risks; is able to compromise. [ksa]

f. Is able to work within an interdisciplinary team. [ks]

g. Has insight into, and is able to deal with team roles and social dynamics. [ks]

7. BSc-VII Considering the temporal and societal context

The aerospace engineering sciences are not isolated and always have a temporal and societal context. Beliefs and methods have their origins; decisions have societal consequences in time. The BSc graduate is aware of this and therefore has knowledge and understanding of the context in which aerospace engineering and utilization is practiced by industry, institutes and organizations. He or she has the competence to integrate these insights into his or her work.

a. Understands relevant (internal and external) developments in the history of aeronautics and spaceflight. This includes the interaction between the internal developments (of ideas) and the external (societal) developments, both national and international. [ks]

b. Is able to analyse the societal context of the aerospace industry (economic, social, cultural) and the consequences of new developments and applications in the domain of aerospace engineering sciences and to discuss these with colleagues and non-colleagues. [ks]

c. Is able to analyse and discuss the ethical, safety and sustainability consequences of professional acitivties in the domain of aerospace with colleagues and non-colleagues (both in research and in designing). [ks]

d. Has an eye for the different stakeholders in the fields of the aerospace engineering sciences. [ks]