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A Proposal for Ensuring the Quality of Aerospace Engineering Higher Education in Europe

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Abstract

The paper presents a possible roadmap for the definition of a European quality label for aerospace related higher education degrees. The proposal is the result of a two-years long Horizon 2020 project that has involved a great portion of the European stakeholders in aerospace: Universities, research centres, industries (both small and large) networks, associations and accreditation agencies. The core concept established is that it is possible to establish a sector-specific, content based, quality system, that can complement the existing national or European accreditation systems, providing added value to the internal and/or external quality assurance processes that are in place in most EU countries. The tools and processes proposed are sufficiently simple to be manageable by Universities in addition to their national accreditation processes or as stand-alone assessment. The main goal of the proposed process is the evaluation of the quality of the aerospace curricula in the European context, whereas the accreditation of the programme can be seen as an optional extension of the process, subject to further national regulations. The process is proposed in view of the awarding of a sector-specific, content based, quality label, to be issued by an appropriate legally recognized and qualified institution. A set of 8 field tests with volunteering universities throughout Europe has been performed. They experienced the method as very practical and to the point.

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Keywords: aerospace higher education ; quality in education ; learning outcomes

1. Motivations and objectives

Europe has successfully managed, during the past decades, to ensure a world-leading position in the global civil Aeronautics and Air Transport (AAT) market. A substantial portion of this accomplishment should irrefutably be

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attributed to the excellently-trained human potential ensured through a number of world class European Universities offering aeronautics education. It has been realized, nonetheless, that during the recent years, both the European Aeronautics and Air Transport sectors have been facing tremendous societal, environmental and competitiveness challenges, as well as, concurrently, it has been noticed that aviation related studies are not considered as “prestigious” as other scientific fields such as medicine, law, etc. As a result, the number and quality of aviation engineering students is at risk of not keeping up with the evolving and increasing demand of the sector, to the point where the European Aviation industry might have a shortage of highly skilled engineers. Consequently, in order to reinforce and corroborate the global competitiveness of Europe in the dynamic global market, it is imperative that the European aviation sector (i.e. Industry, Research Establishments, Academia, etc.) improves the quantity, as well as the quality and skills of its engineers and researchers.

The aforementioned eminent necessity of providing the European aviation sector access to a greater, highly-skilled, excellently educated, experienced and motivated workforce has been commonly recognized by all AAT stakeholders as well as, most importantly, by the European Union (EU).

Within this context, the AIRQUAL project, a TEMPUS project funded by the EU Commission described in Gola and Tobaldo (2011), attempted to develop a common qualifications language for Aerospace Engineering academic courses as well as to ensure international comparability among the Russian Federation and three West European countries (France, Italy and Sweden) all represented by academic institutions belonging to the PEGASUS Network. In doing this AIRQUAL provided a benchmark for the application in a broader geographical context of a Quality Assurance method based on the comparison of functions / competences and learning outcomes.

In addition, the Advisory Council for Aviation Research and Innovation in Europe (ACARE) has, already since 2004, recognized the problem of the declining magnitude and deftness of the European aviation engineering and scientific workforce, and accordingly instigated the publication of two relevant studies: an “Education Study” in ACARE (2004) and an “Accreditation Study” in ACARE (2006). Amongst the foremost conclusions of these studies was the acknowledgement of the need to take a concrete action towards the establishment of a platform where university representatives or networks and the demand side (e.g. Industry, Research Establishments) could meet at regular intervals to exchange views on the requested developments of the curricula at universities. In addition, issues such as the importance of identifying and implementing appropriate mechanisms to measure the quality of education through accreditation and student qualification, as well as, of improving the image of a potential career in the Air Transport sector, were also underlined.

Equivalent conclusions and suggestions have been outlined by ACARE Working Group 5 (i.e. Prioritizing research, test capabilities and education) which had the responsibility to provide input to the Strategic Research and Innovation Agenda (SRIA), related to the educational needs of Europe towards the ambitious strategic goals of Flightpath 2050. In particular, ACARE WG5 in ACARE (2012) has intensely and very keenly stressed the prominent need to establish a fully integrated European aviation education system capable to deliver the required high-quality workforce.

The European aerospace sector is not only the most integrated one with regard to industry, but probably it is also the most advanced one when its perspectives of integration in the educational domain are considered. Indeed, not only academia, in this specific case within the PEGASUS Network (2017), but also other structures (e.g. ACARE) have already established some sound bases on which a real harmonization of the aerospace engineering education in Europe may be designed. Leveraging on these past activities, the PERSEUS project has been conducted in order to define a clear methodology for the evaluation of aviation related higher education programmes and evaluate a series of Universities on the basis of their aerospace curriculum in order to check whether they can be approved by the Industry, hence ensuring that the typical engineer graduate is compliant with their expectations (required learning outcomes, competence profiles for aero-engineering curricula, etc.).

2. The quality systems of EU aerospace education curricula

An analysis of accreditation schemes has been carried out for those 25 member states of the European Higher Education Area (EHEA) were aerospace-related programmes are on offer. The analysis focused on the questions to which extent degree programmes have to follow requirements stemming from external quality assurance regulations which would have an impact on the design and delivery of aerospace programmes. The analysis has highlighted those aspects which are of direct relevance to those designing and offering programmes. Thereby, the distinction between evaluation, assessment or accreditation does not have a significant influence on programme design and implementation. Where in evaluation and assessment an emphasis is typically put on enhancement and self-reflection, the main difference to accreditation is that in the latter an additional yes-no decision is taken at the end of the process. For a glossary of terms, see Vlãsceanu et al. (2007). The general question to which the following analysis shall answer is: to which requirements drawn from external quality assurance do aerospace engineering programmes have to adhere to?

In a first step, the general distinction between an institutional and programme-based approach to external quality assurance is made. In the case of the former, criteria only exist on the level of the higher education institution as a whole and typically not for specific programmes. Where programme level criteria exit, the analysis will as a next step detail whether these are input based or learning-outcome oriented. Based on this, the analysis will furthermore establish whether specific subject-specific criteria exist or whether criteria apply to all programmes irrespective of their subject area.

The following table is intended to provide examples of the different external quality assurance approaches in use in the EHEA countries where aerospace degree programmes are offered. However, it should be noted that in most countries, a combination of approaches exists, sometimes with interdependencies between them, or differencing between types of institutions, or depending on whether or not educational programmes are new or being externally reviewed for the first time. The table thus should be read with caution. For a more detailed analysis, please refer to PERSEUS Consortium (2016).

The main results of the analysis can be summarized as follows:

- A form of external quality assurance, either on the level of institutions or of programmes, is mandatory in all relevant countries, often in a combination of both approaches. While accreditation, i.e. procedures leading to a yes/no decision, is the most common, other schemes such as evaluation are also in use.
- Only a few countries (e.g. Poland, Lithuania, Romania, and Belgium) allow higher education institutions to choose an agency other than the national one to carry out the mandatory external evaluation. Nevertheless, the accreditation decision itself normally remains the exclusive right of the national accreditation agency. Only in one country, Germany, there is competition among nationally recognized agencies.
- An outcome-oriented approach, i.e. focusing on the achievement of intended learning outcomes by students during the course of study, forms the underpinning principle of all but a few agencies. Where there is currently not a strong focus on learning outcomes, change processes are already in place to adopt one.
- The vast majority of accreditation agencies do not stipulate any subject-specific criteria for degree programmes. Where such criteria exist, they do on the level of broad fields of a subject, e.g. engineering, but do not go beyond this into specific branches within the subject area. Notable exception is the German agency ASIIN which provides subject-specific criteria for a number of engineering disciplines, albeit not in the field of aerospace.

Table 1. National approaches to Quality Assurance in the EHEA.

Approach	institutional	programme	accreditation	evaluation	Subject-specific
Austria	✓ Δ	✓ *	✓ *	✓ Δ	✗
Belgium (French community)		✓		✓	✗
Croatia		✓		✓	✗
Czech Republic	✓ Δ	✓ Δ	✓ Δ	✓ Δ	✗
Denmark		✓	✓		✗
Estonia	✓ °	✓ °	✓ °	✓ °	✗
Finland		✓		✓	No further than EUR-ACE criteria
France	✓ ×	✓ ×	✓ ×	✓ ×	No further than EUR-ACE criteria
Germany	✓ =	✓ =	✓ =		✓
Greece	✓ Δ	✓ Δ	✓ Δ	✓ Δ	✗
Hungary	✓ Δ	✓ Δ	✓ Δ	✓ Δ	✗

Ireland	✓	✓ ×*	✓ ×*	✓	No further than EUR-ACE criteria
Italy	✓ ×	✓ ×	✓		No further than EUR-ACE criteria
Lithuania	✓	✓ ’		✓ ’	✗
Netherlands / Belgium (Flemish community)	✓ Δ	✓ Δ	✓ Δ	✓ Δ	✗
Norway	✓	✓ *	✓ *		✗
Poland	✓ ×	✓ ×		✓ ×	✗
Portugal	✓ ’	✓	✓	✓ ’	No further than EUR-ACE criteria
Romania	✓	✓	✓		No further than EUR-ACE criteria
Serbia	✓	✓	✓		✗
Slovak Republic	✓ *	✓ *	✓ *		✗
Slovenia	✓ Δ	✓ Δ	✓ Δ	✓ Δ	✗
Spain	✓ ’	✓	✓		No further than EUR-ACE criteria
Sweden		✓		✓	✗
UK	✓ ×Δ	✓ ×Δ	✓ ×Δ	✓ ×Δ	✗

* restrictions apply depending on type of institution/programme
× different agencies
Δ institutional evaluation/programme accreditation
° HEIs can choose between programme and institutional accreditation
’ complementary

3. Proposal for standards for aerospace curricula

The main aim of engineering education is to prepare graduates and make them competitive in the European job market. Moreover, graduates from aerospace engineering programs find also jobs in other engineering fields in industry. Therefore, the aim of any aerospace engineering degree should be to prepare a graduate with wider engineering knowledge, good adaptability to different engineering fields and awareness of the importance of life-long learning. One can become a professional engineer only through execution of engineering profession and a continual professional development.

According to the vision that Quality Assurance of the aerospace engineering degree programs should be in compliance with the European Quality Assurance Framework, that is EUR-ACE quality standards, it is emphasized that these quality standards are outcome oriented and are defined separately for both Bachelor and Master Degree Programs. However, focusing the quality assessment only on learning outcomes might be misleading, at least from the perspective of a University professor. In fact, learning outcomes are connected by “conditio sine qua non” with learning inputs. So, the number of ECs delivered in particular subjects in the program curricula is also one of indicators of the quality, but by far not the only one.

3.1. Recommended learning outcomes at Master level

Taking into consideration the introductory analysis, it is not recommended to formulate any standard requirement in terms of one or more specific profiles linked to one particular job orientation, but rather provide some general guidelines on what is expected from high-standard aerospace curricula at master level.

Considering the many different options to achieve a Master degree, in terms of semesters of study and division between Bachelor and Master, the following recommendations apply to the combination of Bachelor and Master. When a Master degree is designed as a postgraduate course, following a Bachelor, admission requirements must be defined in order to comply with the overall recommendations.

The following curriculum requirements specify subject areas appropriate to aero-engineering degrees but do not prescribe specific courses. The faculty must ensure that the program curriculum devotes adequate attention and time to each component, consistent with the outcomes and objectives of the program.

3.2. Indicative input criteria

The main curriculum in aeronautical / aerospace engineering should include a mix of fundamental sciences, general engineering sciences, specific aero-engineering sciences and general (non-engineering) courses. Indicatively, considering the average teaching and learning capacity, the following division among the 4 groups can be identified as a preliminary indication in terms of input: Fundamental Sciences (recommended minimum 15%), that corresponds approximately to one year of a combination of University level mathematics and basic sciences, eventually with experimental experience. Basic sciences are defined as chemical and physical sciences; Engineering Sciences (recommended minimum 40%), having their roots in mathematics and basic sciences but carrying knowledge further toward creative application; at least 50% of the Engineering Sciences should be Aero-Engineering Sciences (that is, minimum 20% of the overall program or 60 ECs for a 5-year programme); General Courses, including foreign languages, sustainability and ethics, which complement the technical content of the curriculum.

3.3. Specific aerospace learning outcomes

The specific Aero-Engineering Sciences should provide the graduates with learning outcomes in 15 knowledge areas, with each knowledge area expanded into two broad learning outcomes as detailed in PERSEUS Consortium (2016) and shown in table 2.

To provide additional flexibility in the characterization of the programme, each University can include other specialized fields, which might be of interest for evaluation.

Table 2. Learning outcomes.

1. Aircraft design, avionics and subsystems design / integration	
	1.1 Understanding the successive phases of airplane design, knowledge of essential parameters affecting airplane performance and handling qualities, knowledge of aerospace fundamentals to design specific airplane parts and systems
	1.2 Knowledge of systems, avionics, instruments and aids to navigation systems, their design, performance and integration, data processing and fusion, systems modelling, simulation and electronics implementation, special electronic trials, signal processing and ASICs
2. Flight dynamics, performances, flight operations and flight testing	
	2.1 Knowledge of the aircraft load distribution, typical manoeuvres and aircraft longitudinal and lateral derivatives, understanding the main parameters influencing the aircraft performances
	2.2 Knowledge of the aircraft certification flight testing, flight log preparation, instrumentation calibration, in-flight data acquisition and flight data reduction, ability to correlate experimental results with numerical-theoretical computations.
3. Fluid dynamics, aerodynamics	
	3.1 Understanding the principles & theory of fluid dynamics, specifically aerodynamics, compressibility, viscosity, aeroacoustics …
	3.2 Modelling of complex internal and external flows, handling of numerical and experimental methods
4. Structures, materials	
	4.1 Having knowledge of the fabrication of lightweight structures, the choice of appropriate materials, the link between structural properties and mechanical behavior
	4.2 Knowledge of experimental and numerical methods for prediction of deformation, stress, fatigue, damage, …
5. Propulsion systems design	
	5.1 Knowledge of the principles, theory of operation and state-of-the-art analysis and design tools of propulsion systems.
	5.2 Knowledge of complex and coupled phenomena associated with reactive flows
6. Aerospace telecoms / CNS / ATM systems engineering	
	6.1 Understanding the fundamentals of telecommunications and their applications to aeronautics and/or space systems, in particular for air-ground communications, navigation, surveillance, positioning, air traffic control systems, etc...…
	6.2 Knowledge of design and test equipment / software for aeronautical / space communications purposes
7. Airworthiness/Aviation safety, A/C Ops & Product Life Cycle	

	7.1 Understanding the principles of airworthiness / aviation safety, its importance from upstream project design throughout the entire aviation product life cycle
	7.2 Knowledge of state-of-the-art software / methods in aircraft operations planning and aircraft use, regular and special operations, air traffic management
8. Aeronautical production and A/C maintenance	
	8.1 Knowledge and understanding of operating standards, criteria for reliability and safety. Knowledge and understanding of the systemic criteria for reliability, maintainability and safety. Understanding reliability and safety requirements at system level. Signals procedures, special electronic trials.
	8.2 Knowledge and understanding of production techniques for aerospace vehicles and of manufacturing plans for an aircraft or spacecraft, quality control
9. Non-conventional / Rotary wing aircraft design	
	9.1 Knowledge of the principles & theory of operation of non-conventional / rotary wing aircraft and their specific subsystems (e.g. helicopter rotor).
	9.2 Knowledge of state-of-the-art analysis and design tools specific for non-conventional / rotary wing aircraft.
10. Space technology	
	10.1 Knowledge of the space segment characteristics and design methods (satellites and their subsystems, orbital mechanics, orbital controls, scientific data, human spaceflight…)
	10.2 Knowledge of launchers characteristics and design methods (launcher technology, launch sites, orbital mechanics …), ground segment (tracking stations…)
11. Space applications	
	11.1 Knowledge of telecommunications (spectrum management, regulations like ITU, modulation, use of bandwidth, internet via space etc.)
	11.2 Knowledge of Earth observation and navigation techniques and applications such as traffic control, climate change, meteo, disaster management, telemedicine
12. Economic / Financial aspects of aerospace projects, Air Transport Economics	
	12.1 Knowledge of the economic environment of aviation / air transport worldwide, analysis of the air transport market structure, regulatory structure and competitive characteristics of the air transport markets
	12.2 Knowledge in modelling of air traffic and estimation of air traffic forecasts. Have knowledge about costs and financial practice of airlines.
13. Environmental aspects / Sustainable development of aerospace projects	
	13.1 Have knowledge of the environmental impact of aviation and space, both on the local scale (e.g. airport level: noise and local air quality) and the global level, as well as the life cycle analysis of air- and spacecraft.
	13.2 PDM (Product Data Management), PLM (Product Lifecycle Management), LEAN/ Process management
14. Configuration Management in Design and production	
	14.1 Understanding of the principles to breakdown the product in configurable elements.
	14.2 Product changes: master the product development across the complete life cycle. Configuration tracking models: past, present and future for the whole aircraft life cycle
15. Integrated and complex technical environment	
	15.1 Capability to integrate complex technical environment (multi technical dimensions, multi stakeholders customers/supplier..) with timescale constraints
	15.2 Supply chain management (all external stakeholder, technical aspects, financial/legal aspects,…)

It is expected that the learning outcomes will in most part cover the areas listed from 1 to 12, which represent core aerospace knowledge areas, while knowledge areas 13, 14 and 15 are complementary aerospace knowledge areas. Furthermore, it is expected that learning outcomes of a high quality Master will cover at least 3 or 4 of the above listed core knowledge areas.

Students must be prepared for engineering practice through a curriculum culminating in a major individual work (design project, internship and/or thesis) based on the knowledge and skills acquired in earlier course work and incorporating appropriate engineering standards and multiple realistic constraints. The individual work should also incorporate the latest knowledge and eventually prepare the graduates for further studies and research.

3.4. Skills and abilities

Aerospace graduates should possess skills and abilities suited for a typical international technical employment in a multicultural and multidisciplinary team. This is detailed by table 3.

Table 3. Skills and abilities.

A) Technical
Simulation and software proficiency / CAD-CAE-CAM / Writing technical specifications / Conducting a technical or economical study
B) Methodological

Analysing and solving a technical problem / Managing a technical meeting / Managing a technical project or programme / Writing a synthetic report, final project report or technical document to be used as a reference by others
C) Interpersonal
Team working, team management / Working in a multicultural environment / Proficiency in English / Oral communication skills
D) Complementary
Proficiency in a (second) foreign language other than English / Industrial experience / Ability to integrate non-technical parameters (economical, juridical, environmental…) in proposed technical solutions / Personal skills / Behaviours (Independent working, autonomy, Well-being, stress management, Analytical skills, Time management, Intercultural, open mind set, capability to work in different countries/business environment) / Management skills (Business acumen, Leadership / decision making, Influencing / negotiating skills)

3.5. Suggested learning outcomes assessment

The assessment of the learning outcomes will be based on a peer evaluation process and on a matching between the programme outcomes and the industry needs.

The Coordinator of the programme under evaluation will have to complete a curriculum description table, called hereafter PERSEUS curriculum description table (CDT), where all the aero-engineering learning outcomes are collected. It is responsibility of the course Coordinator to provide a map of the learning outcomes of the degree assessed and to provide sufficient details to allow the peer evaluation.

Assuming the degree assessed is undergoing its national accreditation process, or the EUR-ACE process, the completed PERSEUS curriculum description table will be the only additional document required.

The PERSEUS curriculum description table will be also completed by an appropriate set of relevant employers of aero-engineering graduates, indicating the relative importance of the learning outcomes.

The programme learning outcomes will be then compared to the information provided by the employers, to understand how the programme fits the employers' needs. It is anticipated that a successful programme can in general fit the needs of one single employer, fit the average needs of a group of employers or fit the average needs of the employers.

Should the programme not undergo a national accreditation process or the EUR-ACE process, one additional document will be required, taking the role of the self-assessment reports of the EUR-ACE process. This document will be hereafter called Visiting Team Report (VTR). The VTR will have to include additional information regarding those activities which support an efficient teaching, particularly in the domain of aerospace: engineering workspaces and facilities, involvement of student teams in industrial projects, international relations and student exchange volumes, size of the classes and yearly number of degrees awarded.

4. Proposal for a procedure for the quality evaluation of aerospace curricula

The proposed procedure for the quality evaluation proposed for aerospace curricula is based on the following assumptions:

- The procedure should be as light as possible. The evaluation process should, whenever possible, be performed as a piggy-back of an existing national accreditation process, including in this also the EUR-ACE process. Piggy-backing is considered as a means of avoiding the duplication of efforts as well as economizing costs. In a piggy-backing procedure, only those subject-specific elements are added which have not yet been assessed in the basic procedure. These will be in most cases limited to learning outcome statements as all generic aspects of programme design, implementation and review are typically stipulated by the national criteria.
- In this case of piggy-backing, additional documents to be provided must be kept to a minimum and represent the sector-specific documents.
- Should the programme not undergo a national accreditation process or the EUR-ACE process, some complementary information should be provided, to include additional information regarding those activities which support an efficient teaching, particularly in the domain of aero-engineering.

The main goal of the PERSEUS process is the evaluation of the quality of the aerospace curricula in the European context, whereas the accreditation of the programme can be seen as an optional extension of the process, subject to further national regulations.

In the following, the process is proposed in view of the awarding of a sector-specific, content based, quality label, to be issued by an appropriate legally recognized and qualified institution.

4.1. Procedure for quality evaluation

The University under evaluation should prepare the PERSEUS curriculum description table and the PERSEUS visiting team report documentation. Upon completion of the documents, an audit team composed of at least 3 evaluators will be formed and a site visit will be performed to check the documents and discuss face-to-face with the curriculum managers, professors and students. The composition of the evaluating team should include at least 1 representative from the academic sector and at least 1 representative from non-academic sector (industry, research establishments, accreditation agencies, education institutions from a variety of EU countries). Considering the European perspective of the PERSEUS label, the documentation provided should be written in English.

The PERSEUS audit team will visit the University and the documents will be prepared before, during and after the visit in order to provide the final visiting team report. The final VTR will include the opinion of the audit team on the evaluated programme, including strengths, weaknesses and recommendations for minor or significant improvements. The evaluation should also include a comparison of the learning outcomes of the evaluated programme and the information provided by the employers, to understand how the programme fits the employers' needs. On the basis of the VTR, a decision can be taken as to the quality of the programme.

4.2. The Visiting Team Report

The Visiting Team Report should:

a) Provide a judgement on the fitness-for-purpose of the programme contents as seen by the aerospace stakeholders (industrial counterparts, aircraft manufacturers, airlines …)
b) Express, if appropriate, a criticism on the information provided by the PERSEUS Curriculum description table
c) Present an objective analysis of the strengths and weaknesses of the aerospace programme(s) offered by the University under evaluation.
d) Include and discuss relevant additional information gathered by the visiting team
e) Provide an evaluation of the programme together with a recommendation to support the decision on awarding the label.

4.3. The test of the procedure

The procedure identified has been implemented and tested on a group of 8 Universities across the EU. The Universities have been carefully selected and have cooperated on a voluntary basis, in order to evaluate the level of fulfilment of the required standards for aero-engineering curricula and the aerospace specific quality criteria defined.

The University of Žilina (and more precisely the Department of Air Transport) belongs to the group of Universities selected for testing the PERSEUS procedure.

The visiting team at Žilina has found that a problem lied in a common understanding of some important terms used in the PERSEUS questionnaire as well as in the template for the self-assessment report that led to discrepancy in some of declared levels of competences acquired by graduates in some disciplines. The visiting team discussed this issue with the program Tutor and explained him the principle of the assessment of the respective level of acquired knowledge, understanding and competence. In this regard the declared level of knowledge in some parts of questionnaire were corrected, but based only on a number of ETCS in relevant subjects.

The PERSEUS quality assessment procedure is based on a common European approach which is outcomes oriented, does not take into account just amount of credits, but by the evidence of competences of the student which are acquired by learning objectives and their practical application in a given problem solution. The proof of graduates practical applications was shown by the university by selected bachelor and master theses in English. Main topics of these theses were in the field of air traffic and airport operation. No presented theses supported the declared knowledge in Flight dynamics, fluid dynamics and also A/C design.

The overall perception of the quality of education at the Department of Air Transport is good. Some strong points have been identified: 1) avionics and CNS, 2) aircraft and airline operations and 3) finance and economy of air transport. They also benefit of strong flight training simulation facilities as well as a fleet of small aircraft available for practical flight experience and in-flight experiments (photogrammetric sampling for topography as an example).

The following weak points have been found: 1) insufficient amount of credits in fundamental sciences, 2) limited practical training and internships and 3) insufficient computer modelling techniques (such as hardware in the loop testing, use of CAD tools, FEM or multi-body models, ATM system simulation, …).

The following improvements were suggested by the visiting team: 1) enhance and structure relations with industry, appointing a person in charge of industry contacts, 2) update and balance of course programs in terms of contents (also increase the role of fundamental sciences), 3) reinforcing the image of the University of Zilina in Europe (increase the visibility at national and international level mainly with western Europe universities, also enforcing the real use of English for teaching at any level especially at Master level), 4) use of e-learning to be developed ex-novo.

5. The way forward

In order to build a sustainable European system of QA, one generally needs to have at least the following elements in place:

a) Sound Set of broadly accepted criteria/learning outcomes.

The PERSEUS project has accomplished a lot in as much as this is one of the few existing fields, where below the umbrella of the general engineering criteria more refined qualification profiles for sub disciplines were formulated/elaborated.

b) Sound procedural principles

c) Group of trained peers.

This PERSEUS project forms an important step in this direction. With the execution of all together 8 pilot evaluations, a first group of PERSEUS experts has been built which constitutes the nucleus of a future of qualified peers in the field of aerospace engineering

d) International Recognition

e) Legal Registration

The major line of thought is to cooperate with the Council of European Aerospace Societies (CEAS), which is currently the broadest representation of the aerospace engineering community. CEAS would have to associate the broad range of stakeholder participating in this project and beyond in order to guarantee the acceptance in the European aerospace community

What has been elaborated within PERSEUS over the past 2 years, can be used for multiple functions

a) For Internal Quality Assurance

The learning outcomes formulated could be used as a point of orientation when it comes to

- Revising or modernizing existing programs in the field of aerospace engineering
- Developing new curricula in this field
- Of special relevance is the PERSEUS methodology for the establishment of international joint degree programs in the field, as this is on top of the agenda of the European ministers of education and the Bologna process
- For benchmarking exercises, in the framework of which various aerospace engineering curricula strive to compare their educational outcomes
- For alignment exercises of curricula with national qualification frameworks in general

b) For External Quality Assurance

External quality assurance in Europe comes in various forms: evaluation, audit, accreditation decisions.

Within the external QA logic, PERSEUS has privileged the form of evaluations leaving aside the accreditations, since in the former variation the enhancement concept is predominant, whereas in the accreditation a yes/no decision is being taken and the accountability/control aspect is prevalent.

The most appropriate application of the criteria and methodology developed during the PERSEUS project seem to be for internal quality assurance and for the evaluation aspect of the external quality assurance. In order to establish a EU-wide system of external quality assurance in aerospace, the PERSEUS project team has concluded that it is best to find an external well-established organisation to continue the work with the use of the procedures developed within the PERSEUS project. This organisation should also be the one that formally issues the labels. The most obvious organisation for this would be the Council of European Aerospace Societies (CEAS). CEAS is well established and has a complete overview of what is happening in the European aerospace sector. Furthermore, the Royal Aeronautical Society, which is a CEAS member, already has the authority to accredit British aerospace degree programs.

In principle, CEAS would be in charge of the quality assessment, eventually involving the already established pool of experts created during the PERSEUS project, and whenever required an established accreditation agency, like ASIIN, could be partner in the process if the University asks for accreditation. ASIIN could also take care of the operational details, even when only a quality label is to be issued. This would ease the work for CEAS, that in this case should not devote staff to manage also this process, so help from an experienced accreditation agency would be welcome.

6. Conclusions

The PERSEUS project has laid out the basis for the establishment of one European quality assessment system for aerospace related higher education. There are still some open issues that the PERSEUS project has been discussing, for which it has been felt that the solution should be identified once the proposed EU system is becoming operational. The major open issues are relative to the option of having one or more quality labels, creating a differentiated system, the establishment of clear and sound criteria, procedures and peers training, the definition of a time validity of the quality label, the frequency of update of the curriculum description table.

The PERSEUS project has stimulated discussions within the global EU aerospace community, having involved 15 EU Countries, 21 Universities, 4 research establishments, 25 EU companies (Large and SME), 2 accreditation agencies. The 8 visits to Universities have involved degree courses counting for approximately 6,500 students potentially involved. The outreach activities have reached all the EU Universities where higher education in the domain of aerospace engineering is offered. So far, good consensus on the methodologies proposed has been found.

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References

Gola, M., Tobaldo, I., 2011. Development of Qualification Framework for Cycles of Higher Education in Aerospace Engineering – AIRQUAL Project Final Report. aAcademia University Press, Torino, Italy.

ACARE, 2004. ACARE Education Study: “What changes are needed in European Aerospace Engineering Education to assure the Quality of the Future Engineering Workforce?”. Editor and Study Coordinator: J.L. van Ingen and A. de Graaff.

ACARE, 2006. ACARE Study Support in the frame of ASTERA2: “Developing a voluntary European accreditation system for higher education in aerospace engineering”. Final Report WP210_5. Editor J.L. van Ingen.

ACARE, 2012. ACARE WG5: “Strategic Research and Innovation Agenda (SRIA), Realizing Europe’s vision for aviation. Challenge 5: 5.6 Education and Workforce”. Vol. 1. ACARE, pp.132-137.

PEGASUS Network, 2017. https://www.pegasus-europe.org

Vlãsceanu, L., Grünberg, L., Pârlea, D., 2007. Quality Assurance and Accreditation: A Glossary of Basic Terms and Definitions. UNESCO-CEPES, Bucharest, Romania.

PERSEUS Consortium, 2016. PERSEUS Final Report. http://cordis.europa.eu/project/rcn/193699_en.html