TECHNICAL EDUCATION ON AEROSPACE AND REMOTE SENSING IN THE ITALIAN UNIVERSITY SYSTEM - A BRIEF OVERVIEW

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ABSTRACT

The aim of this research is to depict a rough, synthetic description of what technical education in aerospace and remote sensing means to Italian Universities. This work was done in the framework of the activities of the "Education" Working Group of the Lombardy Aerospace Industry Cluster, and this paper briefly summarizes some of the findings. A similar, but more in-depth and extensive work is in progress at the European and global level.

Index Terms— Aerospace engineering; Aerospace industry; Educational institutions; Europe; Italy; Remote sensing.

1. INTRODUCTION

Among the other activities that are being carried out by the recently founded Lombardy Aerospace Industry Cluster, an important item consists of an in-depth review (a *"picture"*) of Aerospace activities at the regional, national, and supranational level to help steering the future Strategic Plan of the Cluster towards sensible goals. This review is being carried out through mostly volunteered contributions from both Industry and Academia, and it includes education-related aspects of the "Aerospace System", in addition to production, research, and others. The present paper reports some of the preliminary findings that emerged from a survey of post-graduate education in Italy. The next chapter will depict the context of the work, while chapter 3 will report the main facts that emerged from our investigation. Chapter 4 will close the paper with some conclusions.

2. THE CONTEXT: ITALIAN AEROSPACE CLUSTERS

2.1. The Lombardy Aerospace Industry Cluster

The Lombardy Aerospace Industry Cluster [1] (*Distretto Aerospaziale Lombardo* in Italian) was born in February 2010 as an initiative of some of the biggest aerospace industries in the Italian Region of Lombardy. It is an integrated system of enterprises, universities, research centers, holding advanced technological know-how and scientific knowledge in the aerospace sector. In the same year, this latter was declared to be a "strategic sector" by the Regional Council (Regional Decree # 1134, 23^{rd} December 2010), hence the Cluster was officially recognized as the contact point between the Regional institution and the regional productive system (Regional Decree # IX/1817, 8^{th} June 2011).

2.2. Italian Cluster for Aerospace Technology

Several others Regional Aerospace Clusters characterized the Italian scenario, which the Italian Ministry of Education and Research encouraged to organize and link at the national level by issuing an ad-hoc call for National Clusters in 2012 (at the time of writing, an additional call for supporting the setting up of suitable legal persons out of the organized Clusters is open). The Italian Cluster for Aerospace Technology [2] (*Cluster Tecnologico Nazionale Aerospazio* in Italian) was then activated later in the same year as a result of a joint proposal by several regional clusters including Lombardy Cluster. Currently, the details for implementing the Strategic Plan of the National Cluster are being set up and the operation of the plan is expected to start later in 2014.

3. TECHNICAL EDUCATION AND CLUSTERS

In its initial operational arrangement, the Cluster activated 10 Working Groups (WGs), whose first assigned task was to review the current situation in the Region and beyond, as a base for the Technological and Strategic Plan to be written at a successive stage. A specific "Education WG" was defined among the 10 WGs, chaired by the author of this manuscript, whose work, lasting several months, led to a fairly complete picture of all educational activities relevant to aerospace in the Italian Region of Lombardy. The output was integrated into the Cluster Strategic Plan as the state-of-art from which to start in determining the Cluster actions, envisaging an effective link between the education system and the production system. Later, the confluence of the Regional Cluster into the National Cluster prompted the "Education WG" to expand the scope of the review to a national level, hence the work summarized in this manuscript.

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3.1. The analysis

The background of the investigation is naturally the concept of higher education as defined by the Bologna process [4], including the related, shared definition of educational levels. The perspective of the investigation obviously also looks at the European integration among educational systems, or the building of the European Higher Education Area (EHEA) [5]. The work was carried out in February and March 2013, considering the 20 most relevant Italian Universities where aerospace and remote sensing courses are offered. About 60 curricula were examined and inventoried, to retain only the 25 ones related in some way with aerospace and remote sensing. The most important selection criterion was the presence of courses, laboratories and research activities related to aerospace and remote sensing. These latter characteristics were inferred from their official web sites, while the subsequent analysis was carried out by examining the web-published curricula of the selected universities. Within them, we observed the subjects and the main topics of each course, to understand how and to what extent they were actually related to aerospace. The main focus of the search was on the master (MSc) degree because at that level we expected to find a sufficient level of specialization to definitely tell aerospace from non-aerospace. Generally, undergraduate (BSc) degrees of the different examined curricula turned out to be pretty similar to each other, and to include generic and grassroots courses about mathematics, physics, informatics and electronics. It is only in the final year that students happen to find some aerospace-related items. Since less specialized BSc aerospace-related courses are usually made available where MSc aerospace-related courses are also found, the BSc level will not add much new information to MSc level investigation. For this reason, our attention was focused on graduate degrees. We started from analyzing the larger universities, which offer a wide choice of curricula and courses, and then continued to the universities of medium size, and finally to small-sized universities. The purpose was to try and sort out the common lines in Italian education in this field.

3.2. Some findings: master-level degrees

As expected, the complete picture that emerged was pretty complex, also because the boundaries of what is vs. what is not aerospace and remote sensing education are sometimes pretty blurred. Though, some guidelines could be pointed out. From the analysis results we could note that educational programmes on aerospace and remote sensing in Italian master-level degrees may be roughly organized into three main categories, listed below:

- **Degree in Aerospace/Space/Aeronautical Engineering**: this type of degree courses explores the aircraft or satellite structure in great detail. The main objective is the study of the construction, the propulsion, the motion, the aerodynamics and the flight mechanics of the platform. In these degree programs one typically finds courses related to fluid dynamics, gas dynamics, design of aircrafts, techniques and technologies of propulsion, aerodynamics, flight dynamics and design or modeling of spatial structures. Usually, these degrees are proposed by medium- to large-sized universities, such as the Polytechnic of Milan and Turin, the Third University of Rome, University of Naples "Federico II, Pisa and Padua.

- **Degree in Telecommunication Engineering**: usually, this type of degree offers quite diverse curricula in telecommunications and thereabouts, and is mentioned because the curricula often entail remote sensing / Earth Observation topics. Classical courses are always found on networks, systems and telecommunication protocols, signal theory, digital communications, etc.; but there are also hints, more or less marked, to photonics, microelectronics, automation (robotics and process control) in addition to more general courses in mathematics or economics. Regarding aerospace, there are about one to two courses of Remote Sensing (optical and / or radar), analysis of remotely sensed images and data; there are also (two to three) courses in the context of microwaves, regarding antennas, propagation, RF systems or electromagnetic compatibility. Specific topics covered in each of this courses are probably mostly chosen by the teacher, as a consequence of his/her own research interests. We usually find this type of educational offer in small- to medium-sized universities, such as Pavia, Trento, Genoa, Florence, Brescia, Trieste, Parma, Naples "Parthenope, Polytechnic of Bari and Siena. Pavia recently switched from a Telecommunication track taught in Italian to a Space Communication and Sensing track taught in English and focussed on signal transmission and processing (largely including processing of remotely sensed data) and electronic aspects of space technology and environment.

- **High-specialization degree in Telecommunication Engineering**: In large-sized universities, often students can choose between several specialization paths within the master degree in Telecommunications Engineering. In general the choice is among three or four specific topics that may cover different fields, such as Internet and traffic theory, networking and radio transmissions and multimedia processing. Often only a few courses are shared among the specialized paths; in fact each option intends to provide an excellent preparation for the students in the selected area, providing a large number of courses in the specific context by removing more generic courses. It is evident how this type of preparation is highly specialized to a specific field only.

Some optical and radar remote sensing tests are usually found in one option with a name as "processing of multimedia data", while courses in electromagnetism are more concentrated in the option called "radio transmissions". Only few universities offer specializations that include remote sensing courses, but when they do, generally there is at least a pair of such course. Obviously, also in this case, the main topics can change from one university to the other. This type of offer is provided in big-sized universities, such as the Polytechnic of Milan and Turin, Pisa, Rome "La Sapienza" and Rome "Tor Vergata".

Space exploration/observation is instead a niche topic in Italian academic education. Pretty rarely it can be found in physics curricula, but it is usually dealt with extensively in specific PhD courses.

Finally it should be emphasized that in many universities, courses in remote sensing are offered within the degree programs of geological and environmental sciences, but such courses are generally designed around the use of satellite data for environmental monitoring and thus very specific.

3.3. Some findings: 2^{nd} level masters

Currently in Italy only few universities offer a specializing Master in the aerospace field. One is the Technical University of Bari, with the collaboration of University of Naples "Parthenope, which organizes a Master called "Tecnologie per il Telerilevamento Spaziale" (Technologies for spaceborne remote sensing). The purpose is to give students skills to operate in the area of new space technologies for the management of the territory and the environment. One can find other Masters concerning Remote Sensing at IUAV University of Venice and University of Siena. They share the name ("Sistemi informativi territoriali e telerilevamento" GIS and remote sensing) and, as the previous one, they mainly focus on the use of Remote Sensing for environmental monitoring. Others are focused on financial, management and policy aspects of aerospace business; this is the case for University "Carlo Cattaneo - LIUC" ("Helicopter and Airplane" Master) and SIOI ("Master In Istituzioni e Politiche Spaziali" Master in Space institutions and Policies) The University of Rome La Sapienza offers a Master on "Satelliti e piattaforme orbitanti" (satellites and orbiting platforms). Designed for recent engineering graduates, it provides a competence evenly split between management and technical knowledge in the branch of space missions for data acquisition. Currently, the last choice is offered by Polytechnic of Turin, with its Master "Navigation and related applications". It gives students the opportunity to study in detail the navigation and localization systems and their main applications.

4. CONCLUSIONS

As a conclusion from our preliminary review of aerospace educational offer in Italian universities, it seems reasonable to reach a conclusion that different aspects of aerospace science are well covered in Italy at the MSc level, with approaches that are different according to the size of the considered University. On the other hand, the offer of post-graduate 2^{nd} level Master courses seems to be still limited and not capable of fully exploiting the excellent skills found in this Country in the Aerospace and Remote Sensing sector. This is probably also due to financial reasons, which may be addressed by stronger links with industry interested to hire the newly graduated, and by encouraging initiatives in the framework of e.g. "Knowledge Alliances" [6] of Erasmus+. An extended version of this work is in progress at the European level, with the long-term goal of understanding how the process of internationalization of aerospace industry can be supported on the educational side. A review of the educational activities can be found in [3], and the work is extending to understanding the links with the employment opportunities. After this partial, still pretty wide, review of the educational initiatives in the aerospace and remote sensing, the initiative we took in Pavia to start a "Space Communication and Sensing" track seems to be sensible in that it proposes to address a field next to the classical, main declination of aerospace without needlessly overlapping with it; and in fact the preliminary response from the "education market" appears encouraging so far.

Neither this paper nor [3] claim any sort of completeness nor final conclusion on a very complex and multi-faceted issue; the purpose of publishing these papers is to trigger the debate on how education in aerospace and remote sensing currently is meant and how it could possibly evolve. Feedback from the interested readers is encouraged at the author's e-mail address fabio.dellacqua@unipv.it.

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