



THE ROLE OF PEGASUS IN THE EUROPEAN AERONAUTICS AND SPACE UNIVERSITIES EXCHANGE OF STUDENTS AND PROFESSORS

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Abstract

The objective of all universities in the PEGASUS network is to offer highly relevant educational and research programs and thereby attract the best students and scientists. Coordinated developments, exchange of students and staff and innovation are the basis on which these objectives are achieved. The paper shows how PEGASUS is contributing to the increase in the students' mobility among the partner universities, providing a tool to visualize, illustrate and quantify these flows. The tool provides a mapping of agreements and flows, using data based on a questionnaire sent to all PEGASUS partners. The data is available from the courses in years 2012 - 2019 and are prepared for display in the Google Earth application. It is a very flexible tool that allows for multiple searching criteria: per university of origin, per university of destination, per country, per course, etc. Current state of the international exchange is shown emphasizing noticed strengths and weaknesses. Initiatives taken to improve the cooperation weaknesses are discussed and summed up with final conclusions.

Keywords: aerospace education, students' mobility, professors' mobility

1. Introduction

PEGASUS (Partnership of a European Group of Aeronautics and Space Universities) is the partnership of the best European aerospace universities and currently has 28 members in 11 different European countries, representing extraordinarily well the aeronautics and space higher education system in Europe (Figure 1). Today, more than 3000 aerospace engineers graduate at Master level from the member institutions of PEGASUS each year. PEGASUS partners have a reputation for high-quality research and a quality recognition in education and research.

One of the most important tools to improve cooperation in education and research is to extend international students and staff exchange. For achieving the best results, the exchange should be as wide as possible taking into account partners even from beyond the PEGASUS network. Exchange enables to share experience different for every partner, meet cultural differences and improve communication, get to know new approaches for scientific problems solving, combine unique know how of the partners and many more benefits [1], [5].



Figure 1: The PEGASUS Universities network.

The strategic line is, from an internal perspective, to improve the quality of the partners' educational process and curricula to specifically serve the needs of the aerospace industry, which are changing [2], [3], [4]. This means strengthening the cooperation, continuing the harmonization of the different educational programmes and the exchange of students and staff. From an external perspective, PEGASUS works to increase the cooperation between the partners and the industry as well as with national and European research and technology organisations.

Within PEGASUS, the Working Group in Education has been developing different strategies to increase the cooperation and students and staff mobility, adapting always to the changing environment. For instance, for the last months, this Working Group is trying to accommodate the cooperation among partners, like the exchange of students and staff, to a situation of reduced mobility caused by the global sanitary situation, exploring and opening new ways based on distance learning and other blended or hybrid methods.

There is a very intense flow of students among the PEGASUS members, which is facilitated by the mutual recognition among the partners of the quality of their educational programmes.

The tool developed in the framework of this paper shows the success of PEGASUS to promote and facilitate the students' mobility, but also that there is still work to be done to increase the exchange of professors. The Working Group in Education is actively working in this direction, using the opportunities brought by the intensification of the different modalities of distance learning currently

being implemented.

Many members of the PEGASUS network are involved in the EU program “European Universities”. Within this program, universities tend to create seamless, intuitive and natural international exchange processes. Involvement of the PEGASUS members in the project is described and discussed.

2. Future education and science vision

The coming decades the aerospace sector is being confronted with enormous challenges. It is very likely that the amount of air travel will grow significantly. In addition to that aviation will have to play its role in fulfilling the targets set in the 2015 Paris agreement on sustainability. Furthermore, the use of space will increase even further. We will have to invent things at a scale and in a pace that has never before been demonstrated in history. Finally, Europe will have to compete at the highest level. Not only with the traditional aerospace continent of North America but also with other powerful aerospace nations like Brazil and China.

A consequence of these challenges is that there will be a large demand in knowledgeable people. A shortage of well qualified aerospace engineers is already noticeable. Many of them will have to have an engineering background at university level. The engineers to be graduated from the European universities will have to operate in a multinational and multidisciplinary environment. The days that aircraft and spacecraft were designed by aerospace engineers only are over. An aircraft or spacecraft nowadays is a highly integrated object where many (engineering) disciplines have to join forces. This not only means that the future aerospace engineer needs to be knowledgeable in his or her own field of engineering but he or she will also have to be able to work together with experts from other disciplines in a probably international team.

At the same time government budgets for (engineering) education are not growing considerably. This means that the universities have to make hard choices where to focus and where not to focus. Being member of an international network will make it possible to discuss the options amongst each other, make use of each other's successes and failures and exchange staff and students on a large scale.

In this challenging scenario, the network can contribute to the creation of highly skilled workforce with a multi-cultural and multi-disciplinary background. Exploiting the strength and diversity of the educational offer of each member of the network, students can benefit from mobility programs to create their technical and cultural background by mixing a wide variety of contributions. This is made possible because all members of the PEGASUS network have agreed on some fundamental principle, harmonizing the fundamental pillars of the aerospace education on top of which each student can build its unique profile and expertise.

3. Current students and staff exchange status

A questionnaire has been sent to all PEGASUS member to collect data about international mobility. The data covered exchange in years 2012 – 2019. From the data received quantitative as well as qualitative results can be derived. To make data browsing efficient the data was prepared for display in a Google Earth application. The tool is flexible and offers many options of filters to extract interesting parts of data or emphasize connections and their strength. Separate colours of connecting lines represent the PEGASUS universities. The thickness of the line represents number of exchanges, so the strength of exchange between universities.

Results revealed that on average each PEGASUS partner university has exchange agreements with 67% of the other PEGASUS partner universities. The number of students that do the exchange confirm the agreements are effective. On the other hand, the number of staff mobility shows there are few exchanges per year and the situation could be still improved in that field. The PEGASUS workgroup on Education has already picked up this issue. International mobility is not only limited to the PEGASUS universities but includes worldwide partner universities. Taking closer look on the worldwide exchange. Since PEGASUS universities are from Europe the network in here is very dense and strong. This statement refers to the connections among PEGASUS partners as well as worldwide connections with Europe with other partner universities (Figure 2).

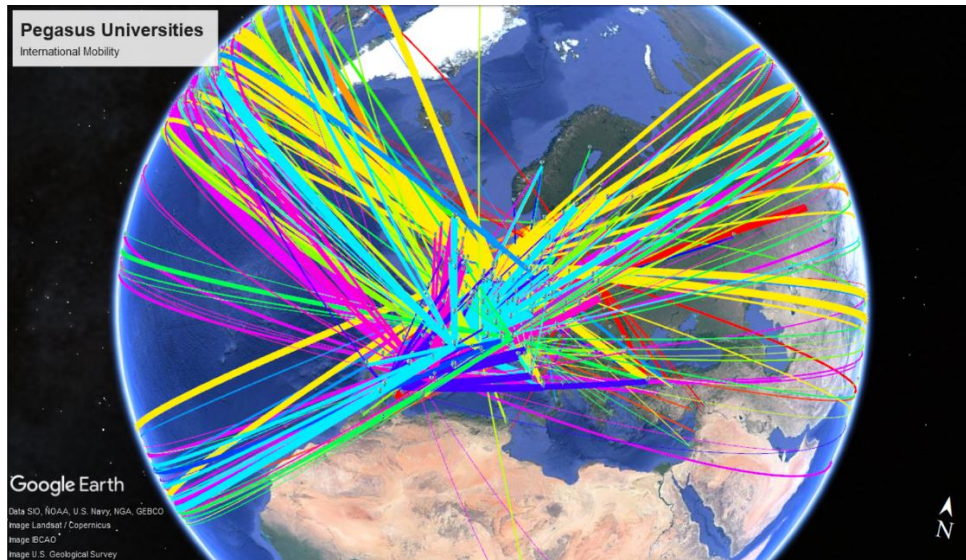


Figure 2: International Exchange of PEGASUS universities in Europe.

Network of exchange connections is also very strong with universities and scientific institutions in North America (Figure 3) and Asia (Figure 4). Bold lines indicate the biggest mobility with particular universities known for aerospace educational and scientific achievements. It is noticeable that exchange between particular partner universities, with long history of fruitful cooperation, is preferred in the exchange of students and staff.

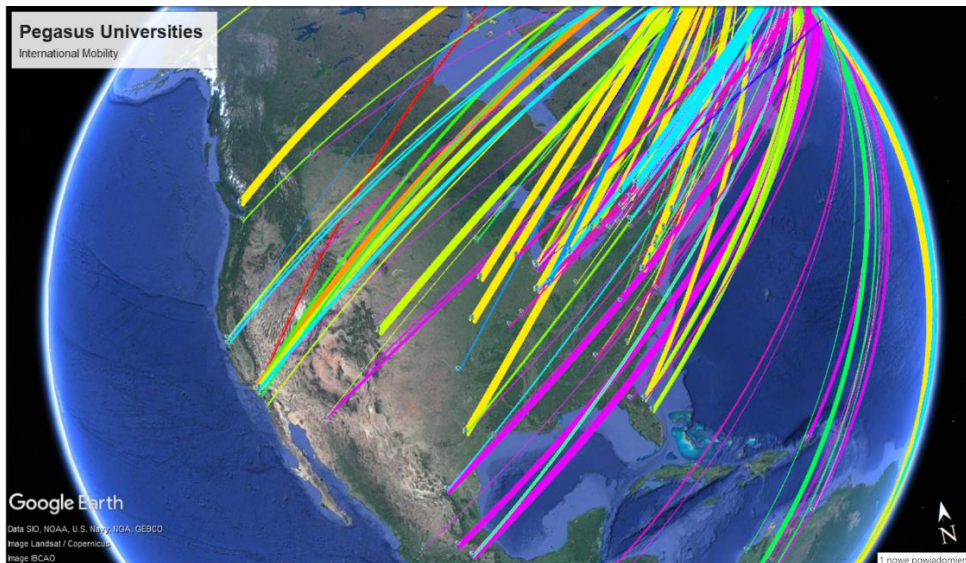


Figure 3: International Exchange of PEGASUS universities in North America.

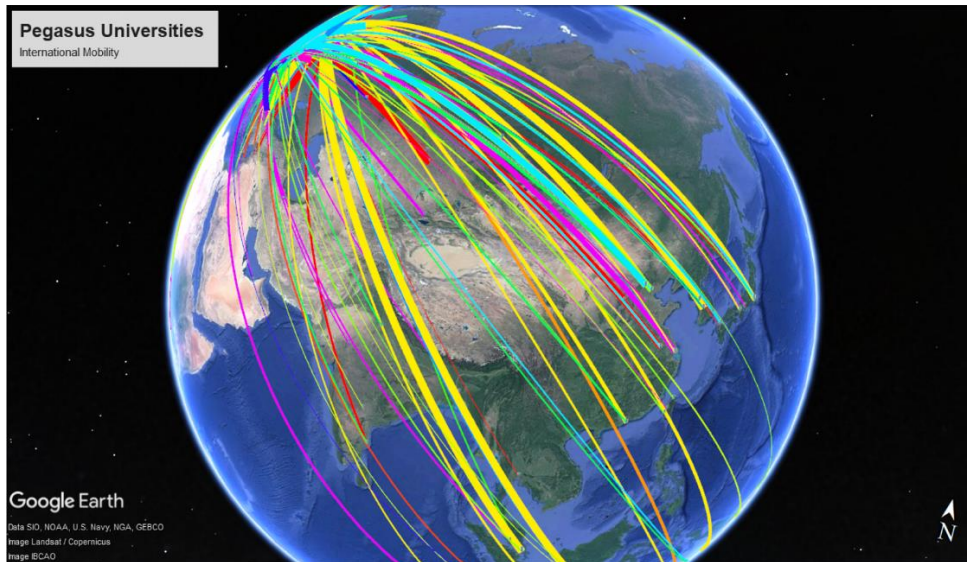


Figure 4: International Exchange of PEGASUS universities in Asia.

There are also strong connections with in particular aerospace institutes in South America (Figure 5) and Australia (Figure 6). Although, there are not as many connections as in Europe, North America, or Asia. Exchange connections with Africa currently are very weak (Figure 7), but it can be a future direction of exchange expansion. Africa is economically emerging and because of the continent's size it will need expansion of efficient air transport.

The data also shows that every year the number of student and staff exchange grows significantly. It is connected with signing new exchange agreements between new partners and seeing international mobility more and more as a natural part of the education process.

One new initiative proposed within the PEGASUS network is the creation of thematic working groups. These should be composed of scholars working and teaching in the same disciplines, creating a higher awareness of the possible cooperation in the specific sectors. The first of these thematic groups is in the area of astrodynamics and has already started working on proposing a European PhD-level course on advanced astrodynamics tools and techniques. The same group has already provided dedicated online seminars for the PhD School at the University of Seville, as initial activity.

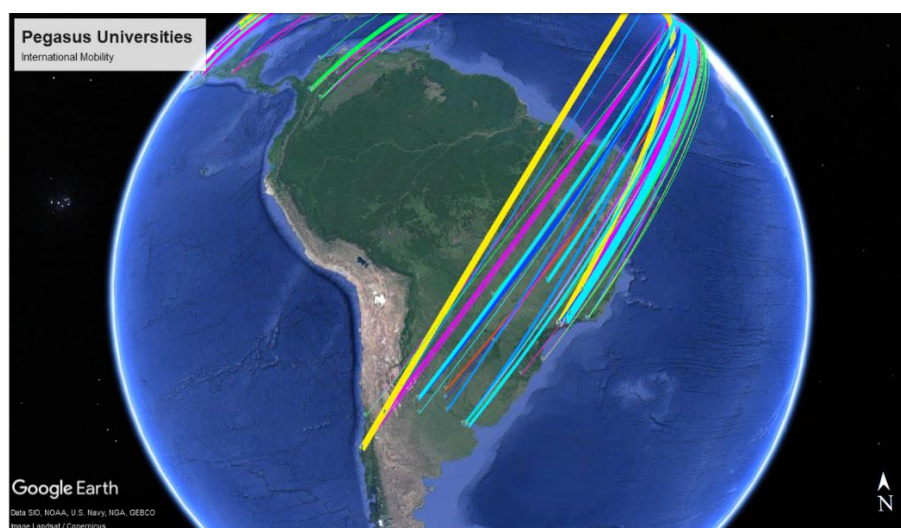


Figure 5: International Exchange of PEGASUS universities in South America.

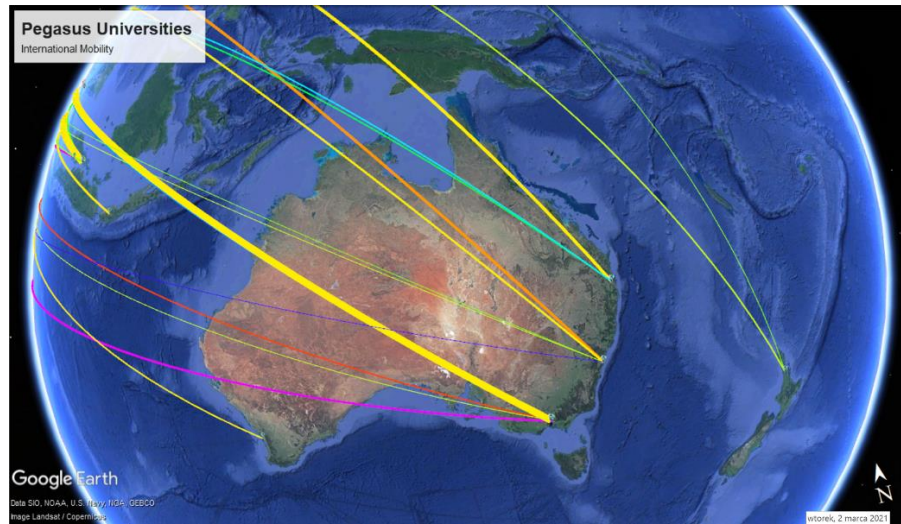


Figure 6: International Exchange of PEGASUS universities in Australia.

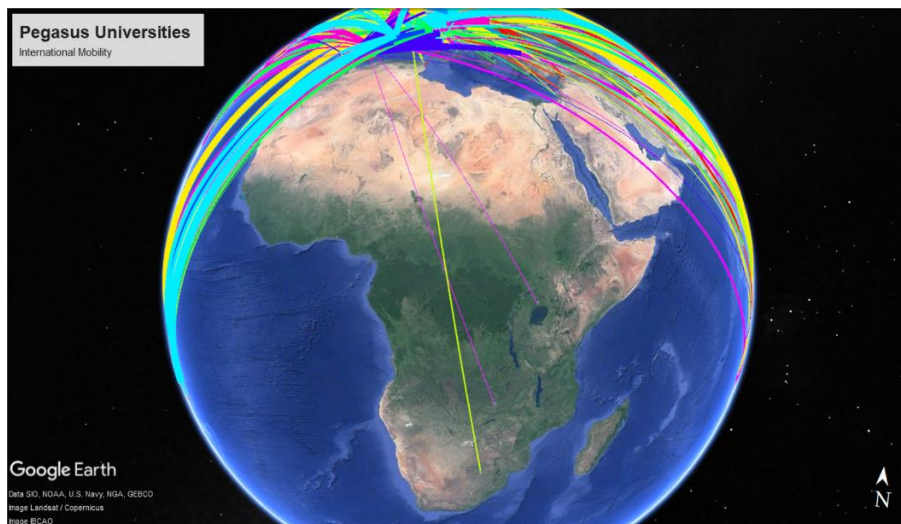


Figure 7: International Exchange of PEGASUS universities in Africa.

4. European Universities initiative

As already stated, student, administrative and academic staff exchanges are becoming natural part of the education process, and many new activities have to be developed to increase this mobility.

One of the European Commission's prestigious current projects is the "European University Initiative" (EUI), which aims to "strengthen strategic partnerships between EU higher education institutions and encourage the emergence, by 2024, of some 20 'European Universities', consisting of bottom-up networks of universities across the EU, which will enable students to obtain a degree by combining studies in more than one EU country and contribute to the international competitiveness of European universities".

Two experimental calls have been launched in 2019 and 2020. 6 PEGASUS members are involved in 4 (out of 17) selected projects of the first call (Table 1) and 10 PEGASUS members are involved in 5 (out of 24) selected projects of the second call (Table 2).

EUI Project name	Acronym	PEGASUS partner(s)
Aurora Alliance project	Aurora Alliance	Universita di Napoli
European Civic University Alliance	CIVIS	Universita di Roma 1 – La Sapienza
University Network for Innovation, Technology and Engineering	Unite!	Politecnico di Torino Kungliga Tekniska Högskolan (KTH) Universidade de Lisboa / IST
UNA Europa	UNA Europa	Universita di Bologna

Table 1: PEGASUS Universities involved in the first call selected projects (2019)

EUI Project name	Acronym	PEGASUS partner(s)
European Universities of Technology Alliance	ENHANCE	Politecnico di Milano Universidad Politécnica de Valencia Rheinisch-Westfälische Technische Hochschule Aachen (RWTH) Technische Universität Berlin Warsaw University of Technology
European Engineering Learning Innovation and Science Alliance	EELISA	Universidad Politécnica de Madrid
European Engineering Education of the Future	EuroTech	České Vysoké Učení Technické v Praze (ČVUT)
European University for the citizens of the Future	Ulysseus	Universidad de Sevilla Technical university of Košice (TUKE)
European Space University of Earth and Humanity	UNIVERSEH	ISAE-SUPAERO / Université de Toulouse

Table 2: PEGASUS Universities involved in the second call selected projects (2020)

16 universities are involved in total, out of the 27 partners of the PEGASUS network (incl. UK partners), thus 59%, from Italy (5), Spain (3), and Germany (2).

All these networks strongly aim to develop student mobility in their respective EUI. However, the direct impact of EUI on mobilities among PEGASUS partners is not obvious. The PEGASUS network is an Aerospace Engineering network, whereas EUI have a much broader perimeter, sometimes outside Aerospace Engineering. Additionally, one specific EUI called UNIVERSEH is space-centered, but beyond Engineering, including space medicine, art & cultural studies, etc.

5. Conclusions

The paper shows that the future aerospace engineers will have to operate in a multinational and multidisciplinary environment. The process is already running and cannot be stopped.

Exchange opportunity during studies enables to share experience, meet cultural differences and improve communication. Current students and staff mobility status was analysed and conclusions drawn, showing that there is a very intense flow of students' mobility among the PEGASUS members, which is facilitated by the mutual recognition among the partners of the quality of their educational programmes.

Although, mobility is becoming natural part of education, there is still much to do to achieve the best possible results. PEGASUS has played a fundamental role in this process, and will continue to do so.

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