

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

Jacek Mieloszyk^{1*}, Emmanuel Zenou², Gustavo Alonso³, Franco Bernelli-Zazzera⁴,
Joris Melkert⁵

¹ Warsaw University of Technology, Faculty of Power and Aeronautical Engineering,
Nowowiejska 24, 00-665 Warsaw, Poland

² Université de Toulouse ISAE SUPAERO, Département Ingénierie des Systèmes Complexes,
10, avenue Édouard-Belin, BP 54032 - 31055 Toulouse, France

³ Universidad Politécnica de Madrid, Ingeniero Aeronáutico, Pza. del Cardenal Cisneros, 3, Madrid, Spain

⁴ Politecnico di Milano, Dipartimento di Scienze e Tecnologie Aerospaziali, Via La Masa, 34, 20156,
Milano, Italy

⁵ Delft University of Technology, Faculteit Luchtvaart- en Ruimtevaarttechniek, Kluyverweg 1,
2629 HS Delft, Netherlands

Abstract

The objective of all universities in the Partnership of a European Group of Aeronautics and Space Universities (PEGASUS) network is to offer highly relevant educational and research programmes 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 students' mobility among the partner universities, providing a tool to visualise, 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 offered in the years 2012–2019 and has been 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. The current state of international exchange is shown, emphasising the noticed strengths and weaknesses. Initiatives taken to improve the weaknesses in cooperation are discussed and summed up with final conclusions.

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

Type of the work: review article

1. INTRODUCTION

Partnership of a European Group of Aeronautics and Space Universities (PEGASUS) is the partnership of the best European aerospace universities, and it currently has 28 members in 11 different European countries, representing extraordinarily well the aeronautics and space-related higher education system in Europe (Fig. 1). Currently, more than 3,000 aerospace engineers graduate at the Master's level from the member institutions of PEGASUS each year. PEGASUS partners have a reputation for high-quality research and a high quality in education and research.

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* Corresponding Author: jmieloszyk@meil.pw.edu.pl

One of the most important tools to improve cooperation in education and research is to extend international exchange of students and staff. 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 experiences different for every partner, meet cultural differences and improve communication, get to know new approaches for scientific problem-solving, combine unique know-how of the partners and many more benefits [1, 2].



Figure 1. The PEGASUS Universities network.

PEGASUS, Partnership of a European Group of Aeronautics and Space Universities

The strategic line is, from an internal perspective, to improve the quality of the partners' educational process and curricula to specifically serve the aerospace industry's needs, which are changing [3–5]. This means strengthening the cooperation, continuing the harmonisation of the different educational programmes and exchanging 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 on Education has been developing different strategies to increase the cooperation and mobility of students and staff, adapting always to the changing environment. For instance, over the past few months, this Working Group is trying to accommodate the cooperation among partners, such as 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 in promoting and facilitating students' mobility, but also shows that there is still work to be done to increase the exchange of professors. The Working Group on Education is actively working in this direction, using the opportunities brought in by the intensification of the different modalities of distance learning currently being implemented.

Many members of the PEGASUS network are involved in the European Union (EU) programme 'European Universities'. Within this programme, 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

In the coming decades, the aerospace sector is going to be confronted with enormous challenges. It is very likely that the amount of air travel will grow significantly. In addition, 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 pace that have 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 such as 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 the 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 for which many (engineering) disciplines have to join forces. This means that not only does the future aerospace engineer need 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 about the subject areas on which to focus and where not to focus. Being a member of an international network will make it possible to discuss the options among 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 a highly skilled workforce with a multicultural and multidisciplinary background. Exploiting the strength and diversity of the educational offer of each member of the network, students can benefit from the mobility programmes 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, namely harmonising the fundamental pillars of the aerospace education, on top of which each student can build his or her unique profile and expertise.

3. CURRENT STATUS OF EXCHANGE OF STUDENTS AND STAFF

A questionnaire was sent to all PEGASUS members to collect data about international mobility. The data covered the exchange process in the 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 emphasise connections and their strengths. Separate colours of connecting lines represent the PEGASUS universities. The thickness of the line represents the number of exchanges and so the strength of exchange between universities. The screenshots presented in the paper may appear unclear, but the data exploration is best experienced on the computer screen, with various filter options, possibility to move around the virtual globe and zoom in or out. Fig. 2 shows the control panel on the left with the outlined options.

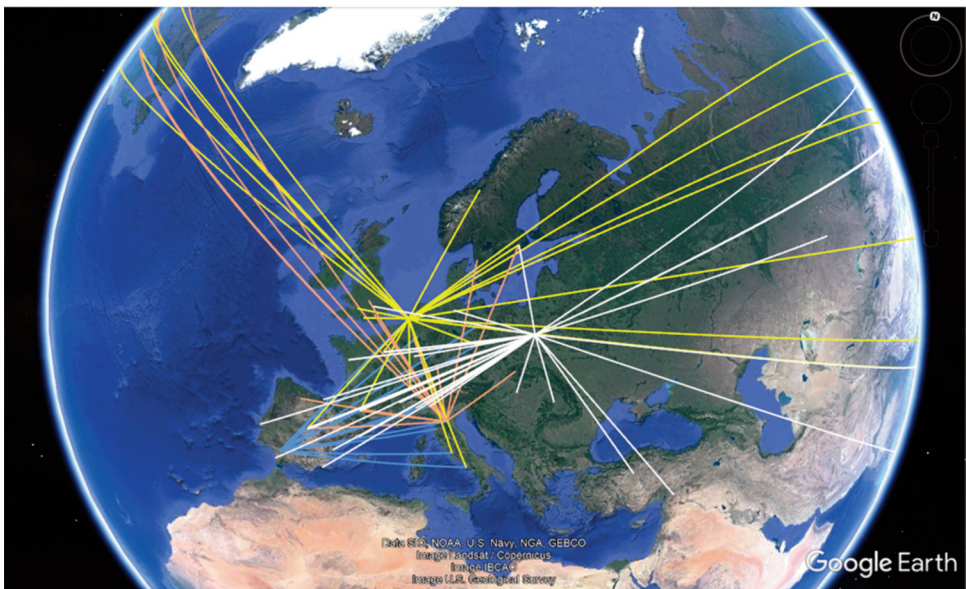


Figure 2. Example of international exchange among PEGASUS universities in Europe.

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 participate in the exchange confirms that the agreements are effective. On the other hand, the staff mobility data shows that there are few exchanges per year and the situation could be still improved in that field. The PEGASUS Working Group on Education has already picked up this issue. International mobility is not only limited to the PEGASUS universities but includes worldwide partner universities. Taking a closer look on the worldwide exchange, we find that since the 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 (Fig. 2).

The network of exchange connections is also very strong with universities and scientific institutions in North America (Fig. 3) and Asia (Fig. 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.

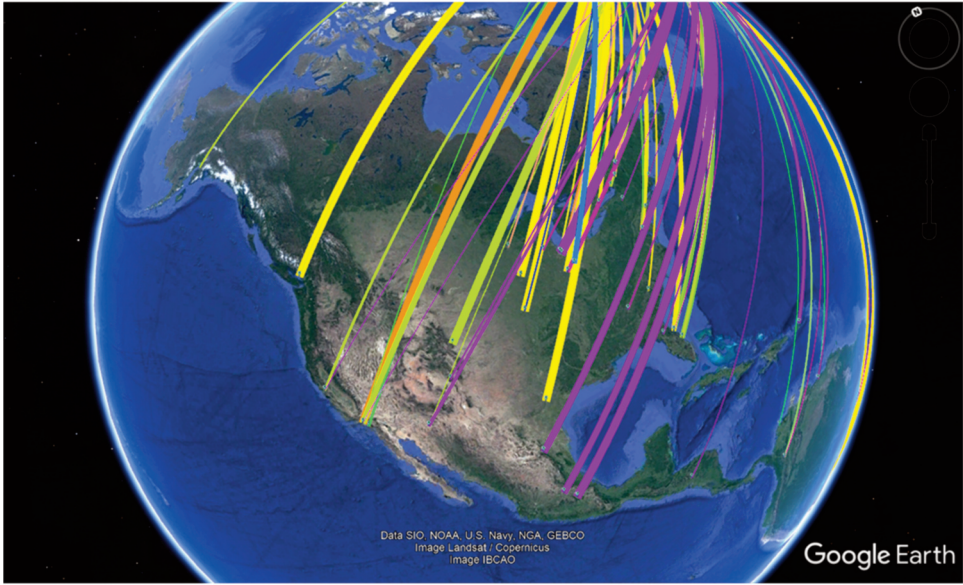


Figure 3. International exchange among PEGASUS universities in North America.

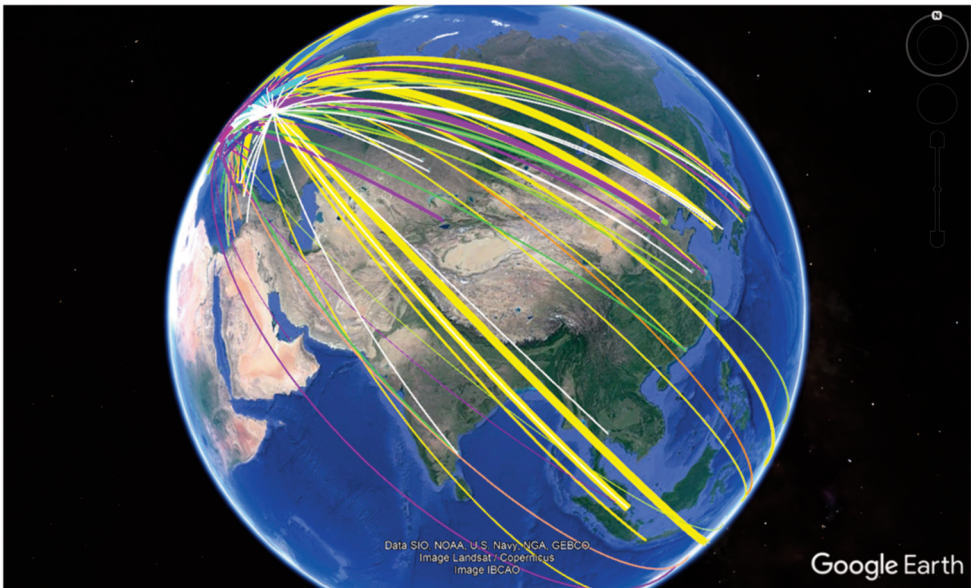


Figure 4. International exchange among PEGASUS universities in Asia.

There are also strong connections within particular aerospace institutes in South America (Fig. 5) and Australia (Fig. 6). However, there are not as many connections as in Europe, North America or Asia. Exchange connections with Africa currently are very weak (Fig. 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.

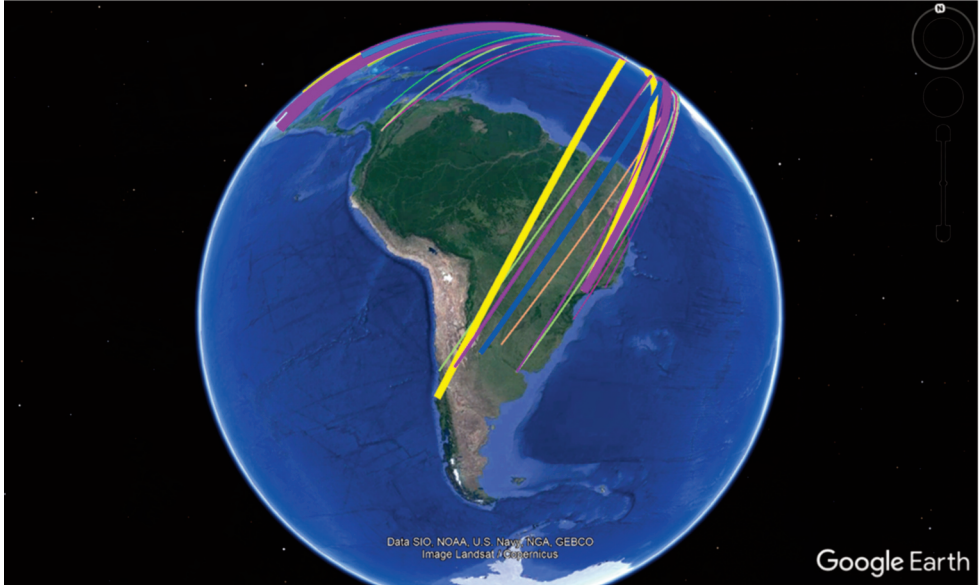


Figure 5. International exchange among PEGASUS universities in South America.

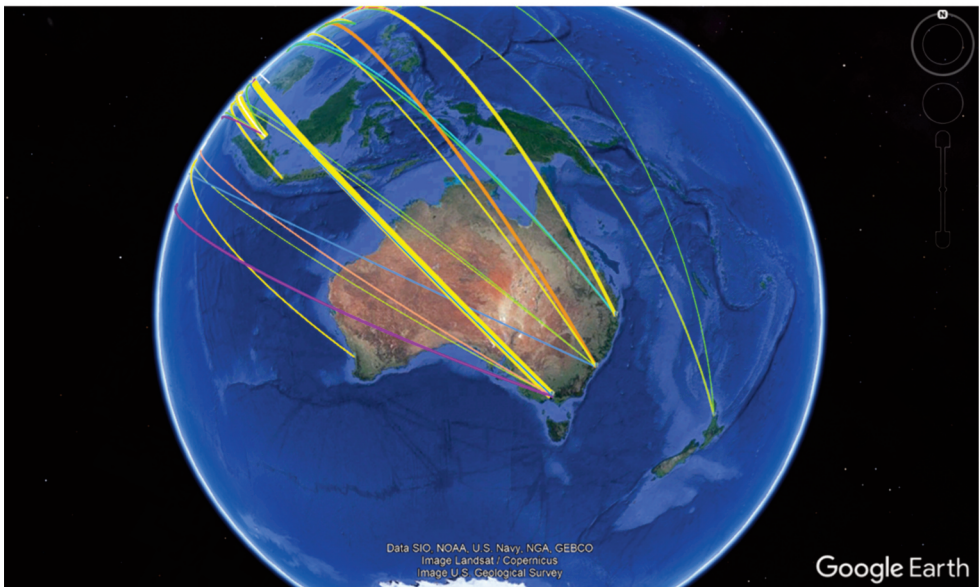


Figure 6. International exchange among PEGASUS universities in Australia.

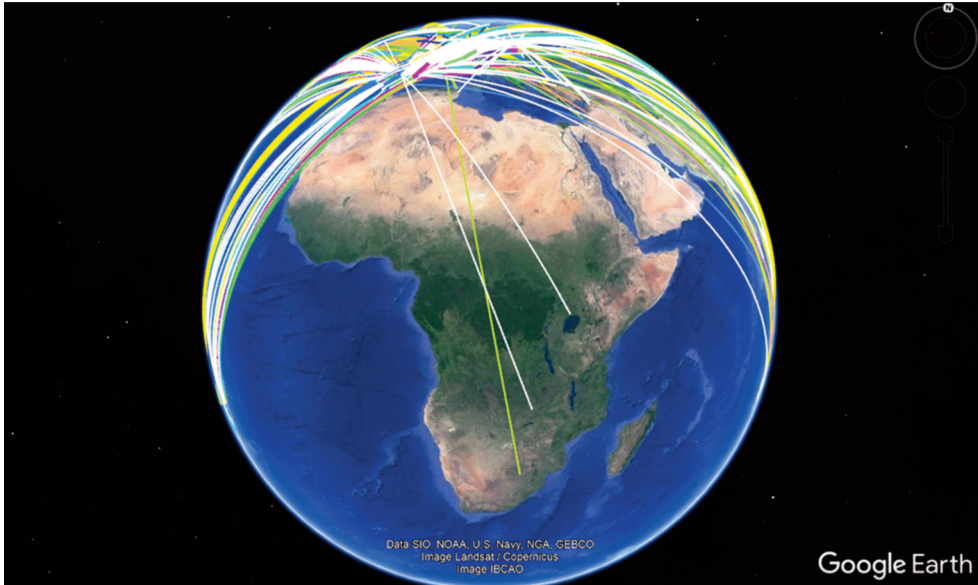


Figure 7: International exchange among PEGASUS universities in Africa.

The data also shows that every year, the number of students and staff exchanged grows significantly. It is connected with the signing of new exchange agreements between new partners and the seeing of international mobility increasingly 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 it 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.

4. EUROPEAN UNIVERSITIES INITIATIVE

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

One of the prestigious current projects of the European Commission is the ‘European Universities 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. Six PEGASUS members are involved in four (out of 17) selected projects of the first call (Table 1), and 10 PEGASUS members are involved in five (out of 24) selected projects of the second call (Table 2).

Table 1. PEGASUS universities involved in the first call selected projects (2019).

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

CIVIS, European Civic University Alliance; EUI, European Universities Initiative; PEGASUS, Partnership of a European Group of Aeronautics and Space Universities; UNA, European University Alliance.

Table 2. PEGASUS universities involved in the second call selected projects (2020).

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

EUI, European Universities Initiative; PEGASUS, Partnership of a European Group of Aeronautics and Space Universities; EELISA, European Engineering, Learning & Innovation; UNIVERSEH, Science Alliance European Space University for Earth and Humanity.

Sixteen universities are involved in total, out of the 27 partners of the PEGASUS network (including UK partners), thus making up 59%; there are five universities from Italy, three from Spain and two from Germany.

All these networks strongly aim to develop student mobility in their respective EUIs. However, the direct impact of EUI on the mobilities among PEGASUS partners is not obvious. The PEGASUS network is an Aerospace Engineering network, whereas EUIs have a much broader boundary, sometimes outside Aerospace Engineering. Additionally, one specific EUI called UNIVERSEH is space-centred, but beyond Engineering, and it includes space medicine, art and 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 experiences, face cultural differences and improve communication. The current mobility status of students and staff was analysed and conclusions were 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 a 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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