Research and Innovation Staff Exchange as a Frame for Collaboration of Higher Education with Industry: Lessons Learned from WrightBroS Horizon 2020 EU Project

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The paper focusses on a collaboration between academia and industry. As an *introduction*, we present typical behavior of university researchers, who often define the area of application without consulting it with industrial partners, and we propose different approach which led to the definition of the scope of the WrightBroS project. The project, entitled "Collaborative Factory of the Flight Simulators Branch of RISE" is financed by the European Union in the frame of Horizon 2020 MSCA Research and Innovation Staff Exchange (RISE) programme. The international Consortium composed of Higher education (Silesian University of Technology from Poland) and industrial (LG Nexera from Austria and Virtual Reality Media from Slovakia) sectors, has designed a project as a collaborative platform whose know-how results from knowledge sharing among partners. Then, from the experience gained in the implementation of the WrightBroS and other similar projects, by using *case-study methodology* we demonstrate how representatives of education and industry in the new joint environment supplement each other in common research efforts. We also present methods for knowledge sharing, in particular achieved by intersectoral staff exchanging. Then we present the *results* achieved by collaboration of Higher Education with Industry in the WrightBroS project. Finally, the *discussion* in the context of tackling broader challenges of intersectoral collaboration leads to the conclusions that this kind of environment is very efficient way to overcome typical difficulties in academia and industry dialog, which is so common in the global world.

Keywords: academia and industry collaboration, Horizon 2020 MSCA, research and innovation staff exchange, Horizon Europe MSCA, Augmented Reality (AR), flight simulators

Introduction

In contemporary global world, collaboration between academia and industry is essential for both these sectors: research performed in the former should have a potential for commercialization by the latter. However, despite this fact is widely known, the successful collaboration of higher education with industry is often a challenge. There is certainly a natural temptation to perform research which is useful for deployment in real-world applications, but many examples show that the results of research do not find appropriate ways to be commercialized and deployed. One of the reasons lies in defining applicability goals of a research by the researchers

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only. Typically, they are experts in science and technology but not necessarily, or even rarely, experts in observing market trends. Therefore, instead of trying to define area of application by academic scientists, more productive is to discuss this issue with managers of innovative companies. Their everyday life is focused in recognizing these trends and if the innovative business is successful, it means they do their job well. Such discussions were the basis for defining aims of the WrightBroS project entitled "Collaborative Factory of the Flight Simulators Branch of RISE" and financed by European Union in the frame of Horizon 2020 MSCA Research and Innovation Staff Exchange (RISE) programme. Therefore, at the core of this project is an actual commercial need of the world-class flight simulators manufacturer, Virtual Reality Media company from Trencin, Slovakia. This need has defined the main technological goal: Augmented Reality system supporting training of pilots in flight simulators and allowing for remote servicing and maintenance of the simulator. In order to achieve this goal, the flight simulator should have smart diagnostic features, so the auxiliary goal has been defined as a NewTechnology flight simulator with self-diagnostic modules. Technological and research challenges were identified by the Coordinating Silesian University of Technology from Gliwice, Poland. This bilateral cooperation between Higher Education and Industry was supplemented by LG Nexera, an IT company from Vienna, which added knowledge management concepts whose application makes the results more general and scalable.

Having defined the research and technological goals with strong commercialization potential, the Consortium has designed a project as a collaborative platform, kind of a common factory, whose know-how results from knowledge sharing among academic and industrial partners. This sharing is achieved by intersectoral staff exchanging. Silesian University of Technology researchers and PhD students are seconded to both companies, where, in the industrial environment, they collaborate with staff of their hosts. The EU financial contribution to members of the staff as well as institutions involved in training through research, makes this collaboration possible also from a budgetary perspective. This possibility is continued in Horizon Europe MSCA Staff Exchange programme. From what we have learned as the intersectoral Consortium implementing the collaborative WrightBroS project, we conclude that this kind of environment is a very efficient way to overcome typical difficulties in academia and industry dialog, which is so common in the global world.

More details on aforementioned challenges will be given in the next sections of the paper which is organized as follows: The rest of the paper contains the Literature review and Methodology sections where the model of intersectoral collaboration is presented. Then, Results and Discussion sections precede the Conclusions, Acknowledgements and References which are closing the article.

Literature Review

The first main objective of the Research and Innovation Staff Exchange (RISE) is defined as promoting the international and intersectoral collaboration through research and innovation staff exchanges. The second is sharing of knowledge and ideas from research to market (and vice-versa) for the advancement of science and the development of innovation. The proposed research and innovation activities have the goal to exploit complementary competences of the participants, as well as other synergies between academia and industry. In addition, this kind of project enables networking activities, organisation of workshops and conferences to facilitate sharing of knowledge, new skills acquisition and career development for research and innovation staff members. Following these objectives, the European Commission provides funding for the sending of staff members (called secondments) to participating organisations to achieve two short-term goals of the RISE scheme (H2020 Programme Guide for Applicant, 2018):

1. Staff members perform tasks to achieve the deliverables of the proposed R&I action.
2. Staff members develop new R&I and transferable skills to boost future career opportunities through the RISE action and connected networking activities.

A RISE projects are based on a set of clear R&I objectives and robust project management plan to achieve the goals and maximal impact of the action. The R&I tasks/deliverables are implemented through secondments of staff members with an in-built return mechanism to foster knowledge sharing and long-term collaboration. This scheme has been successfully implemented in many actual RISE projects (Yartys et al., 2021; Boese et al., 2019; Monni, Palumbo, & Tvaronavičienė, 2017). It also has been used in the WrightBroS project, the partial results of which have been given for example by Nurzynska, Skurowski, Pawlyta, and Cyran (2021), Bach, Werner, Mrozik, and Cyran (2021), or Skurowski, Nurzyńska, Pawlyta, and Cyran (2022). This project is coordinated by Silesian University of Technology (SUT) in Gliwice, Poland.

The author of the paper and manager of the WrightBroS project is a director of the Virtual Flight Laboratory (VFL) at SUT which is the professional lab equipped with 15 flight simulators – more on this exceptional lab in Europe can be found in (Zazula, Myszor, Antemijczuk, & Cyran, 2013). Therefore, the capacities offered by academic VFL are used in the project for implementation of the training in flight simulation for industrial partners. Flight simulation uses a technique called flight simulator, to simulate the flight of an airplane and the surroundings in which it flies. In addition, it mimics the model that controls how an aircraft flies and how it responds to flight control applications and its external elements like air density, turbulence, precipitation, wind shear, cloud, etc. In this regard, augmented reality (AR) is a potential technology for developing enhanced interfaces with interactive and wearable visualization systems to apply new techniques for displaying documents as digital data and graphical databases (de Crescenzio et al., 2011).

Interestingly, VFL also participated in some other EU projects (before WrightBroS), such as for example 7FP project EGALITE "Research on EGNOS/ Galileo in Aviation and Terrestrial Multi-sensor Mobility Applications for Emergencies Prevention and Handling". The EGALITE project was designed for intersectorial transfer of knowledge and staff training between large university from Poland, Silesian University of Technology, and two efficient SMEs: Pildo from Barcelona, Spain and LG Nexera from Vienna, Austria. The project's goals were to make research and development activities in the field of multi-sensors mobility applications for emergency prevention and handling using European EGNOS/Galileo global navigation satellite system (GNSS). Through collaborative research programme, the partners aimed at developing prototypes of original and innovative terrestrial and aviation GNSS applications such as integration of ADS-B unit with Emergency Prevention and Handling System (EPHS) (see for example: Baron et al., 2014; Antemijczuk, Sokolowska, & Cyran, 2012).

We also participated in 7FP projects in consortia of more than 10 partners from whole Europe (HEDGE NEXT "Helicopter GNSS Deploy in Europe NEXT", SHERPA "Support on Pre-operational Actions in GNSS).

Methodology

This paper, as a typical case study paper, uses the inductive methodology which is based on inferring the conclusions based on the experience gained in the implementation of this particular project (primarily) and other similar projects. By experience gained we mean in particular understanding how the methods which have applied in implementation of the project and the technological results we obtained, have led to achieve not only the specific goals of the project but also, in a broader sense, how they allow to create the appropriate platform for collaboration between Academia and Industry. We start with presentation of the methods through which this intersectoral collaboration had materialized in our project. Then, in the same section, we will compare it with methods used in other similar projects. The obtained results and conclusions derived from the experience that we (and others) have gained in implementation of RISE type projects, will be presented in subsequent sections.

WrightBroS as a H2020 RISE project is coordinated by Silesian University of Technology, Gliwice, Poland, who collaborates with two industrial partners: LG Nexera, Vienna, Austria, and Virtual Reality Media, Trencin, Slovakia, using a budget of around 1mln EUR. The methods which are used in the WrightBroS project to obtain its specific goals include:

- Intersectoral secondments of the staff.
- Training of the seconded staff.
- Research and Development activities.
- Networking and culture sharing.

How each of these methods was implemented by actual activities is described in what follows.

Communication in the project started by creating the project's website available under address http://wrightbros.lgnexera.at. This is a living platform intended to grow together with accumulation of interesting facts occurring during project's execution. Currently, after the first reporting period, WrightBros webpage contains information about the main goals of the project, the Consortium responsible for its implementation, as well as notes about main events which have been organized thus far. In the second reporting period it is planned to act also as the dissemination tool by supplementing its content with a brief description of the results achieved and a list of published papers.

The home page of the WrightBroS website is given in Figure 1.

Figure 1. WrightBroS Webpage

Having the acronym which commemorates the Wright Brothers, our project, in addition to achieving all scientific and technological objectives, has been focused on broadening among its participants the knowledge about pioneering aviation works of Wilbur and Orville. Therefore, on 24th of July 2019, the SUT staff seconded to NXR visited the Museum of Technology in Vienna, where artifacts relevant for the history of aviation (and thus for the project), such as the original airplane engine built by Wright Brothers, could be seen.

The 1st Thematic School on Knowledge Management Systems was the next event organized. It took place from 26th to 27th of September 2019 at the LG Nexera company's headquarters in Vienna.

We also organized communication events for public at large. In the first reporting period they were organized in Virtual Flight Laboratory (VFL) at SUT (see Figure 2).

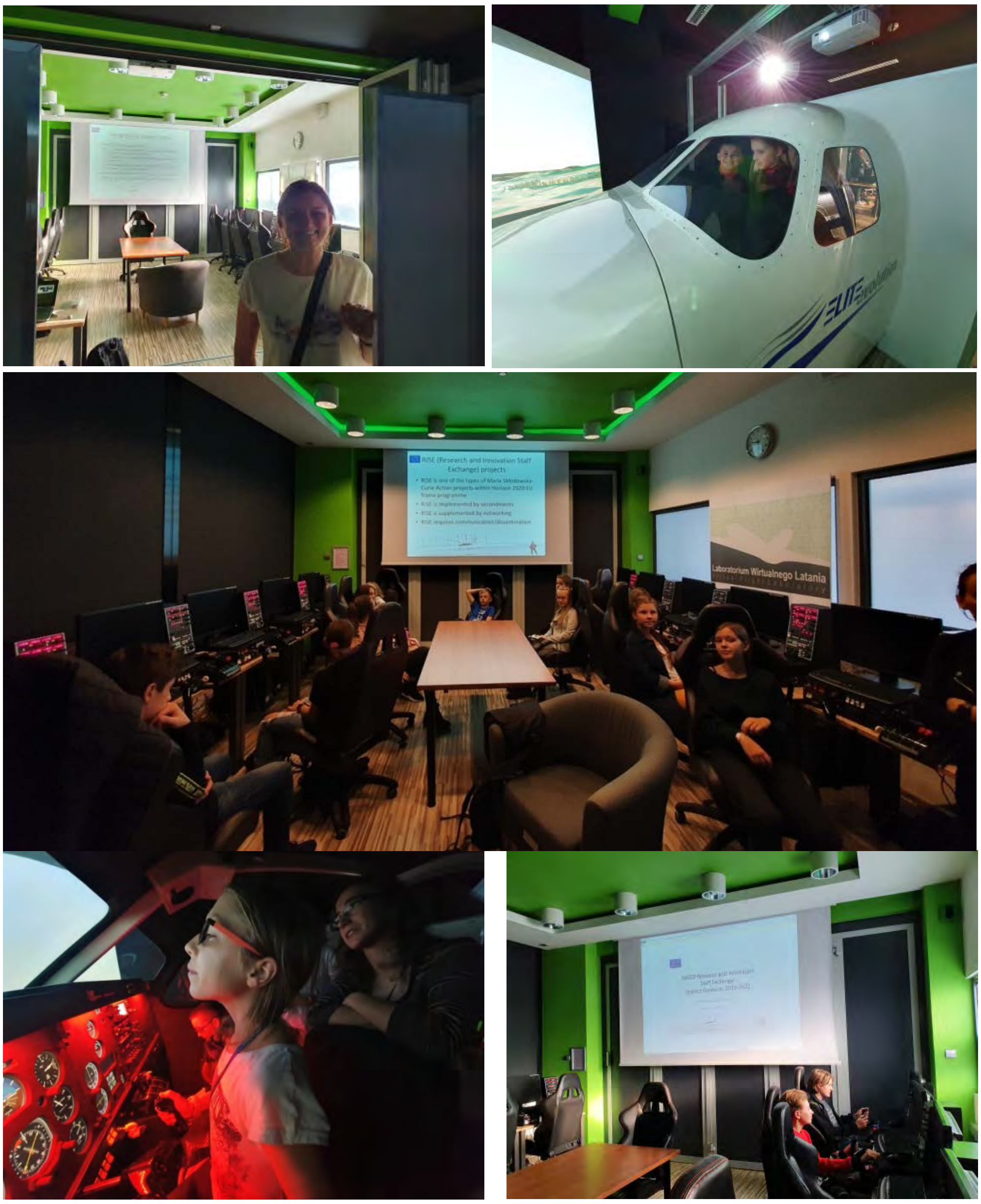
Figure 2. Virtual Flight Laboratory at SUT

In the fall of 2019, the communication to a wide public has been performed during the Scientists' Night of the Silesian University of Technology 2019. In Virtual Flight Laboratory, the comprehensive information about the WrightBroS project has been given to over 40 participants at the age of 6 to 70 years, who learned learned to pilot flight simulators (see Figure 3).

After February 2020, due to outbreak of the coronavirus pandemic, we were not able to implement planned for year 2020 communication activities. Therefore, a number of dissemination/communication/networking activities planned for 2020, such as Competition for European students, 1st Biannual Workshop planned to be organized by VRM, and 2nd Thematic School planned to be organized by SUT by Month 22 has been postponed until next reporting period and have been organized when coronavirus situation allowed for efficient implementation.

A qualitative brief comparison of our experience in implementation of WrightBroS with three other similar projects we start with the project FIRST "virtual Factories: Interoperation suppoRting buSiness innovation". This is European H2020 project, founded by the RESEARCH AND INNOVATION STAFF EXCHANGE (RISE) Work Programme as part of the Marie Skłodowska-Curie actions. The project consortium includes five university partners and two industrial partners from Europe and China. As Boese et al. (2019) write, the RISE scheme used in the FIRST project, promotes international and cross-sector collaboration through exchanging research and innovation staff, and sharing knowledge and ideas from research to market (and vice-versa).

Figure 3. VFL during Scientists' Night of the Silesian University of Technology 2019



The next project we consider here is HYDRIDE4MOBILTY which is a joint effort of consortium uniting academic teams and industrial partners from two EU and associated countries Member States (Norway, Germany, Croatia), and two partner countries (South Africa and Indonesia). As given by Yartis e t al. (2021), the work within the project is focused on the validation of various efficient and cost-competitive solutions including advanced MH materials for hydrogen storage and compression, advanced MH containers characterized by improved charge-discharge dynamic performance and ability to be mass produced, integrated hydrogen storage and compression/refueling systems which are developed and tested together with PEM fuel cells during the collaborative efforts of the consortium. Finally, let us consider the project ADDOPTML "ADDitively Manufactured OPTimized Structures by means of Machine Learning" also belonging to the Marie Skłodowska-Curie Actions (MSCA) Research and Innovation Staff Exchange (RISE) H2020-MSCA-RISE-2020. Kallioras, Nordas, and Lagaros (2021) describe the deep learning based topology optimization developed in the project coordinated by Greek ETHNICON METSOVION POLYTECHNION and implemented in the consortium of as many as 12 other beneficiaries (6 from Academia, 6 from Industry) and a partner organization, a university from Jordan.

All three mentioned projects contain significantly more partners in their consortia than we have in the WrightBroS project. Despite this difference, in all them the composition of the consortium includes both academic and industrial partners collaborating on a common research topic through the exchange of the staff of participating organizations. Also, their methods to achieve technological goals, include activities focused on training of the seconded staff, networking and culture sharing which supplement (like in WrightBroS) research and development activities.

Results

In this section we present the results achieved by collaboration of Higher Education with Industry in the WrightBroS project. It started in the premises of the industrial partner VRM with the Kick-off Meeting (Figure 4).

Figure 4. Kick-off Meting in the Premises of VRM, Trencin, Slovakia

Regarding the training of the staff during secondmetns to SUT, the capacities offered by VFL were used in the project for implementation of the training of the staff from industrial project partners. The training took place on 24.11.2020 in Virtual Flight Laboratory at Faculty of Automatic Control, Electronics and Computer Science of the Silesian University of Technology, Gliwce, Poland. The secondee from VRM to SUT was trained by SUT employee engaged in WrightBroS project who is experienced user of flight simulators. At one point of his career he was responsible for maintenance and service of such devices; he also finished postgraduate studies in the field of information systems in civil aviation. The trainer explained to the trainee a configuration of the simulator ELITE Evolution S812 installed at VFL. The trainee studied maintenance and service documentation (Figure 5).

Figure 5. Studying Maintenance and Service Documentation in VFL by VRM Secondee

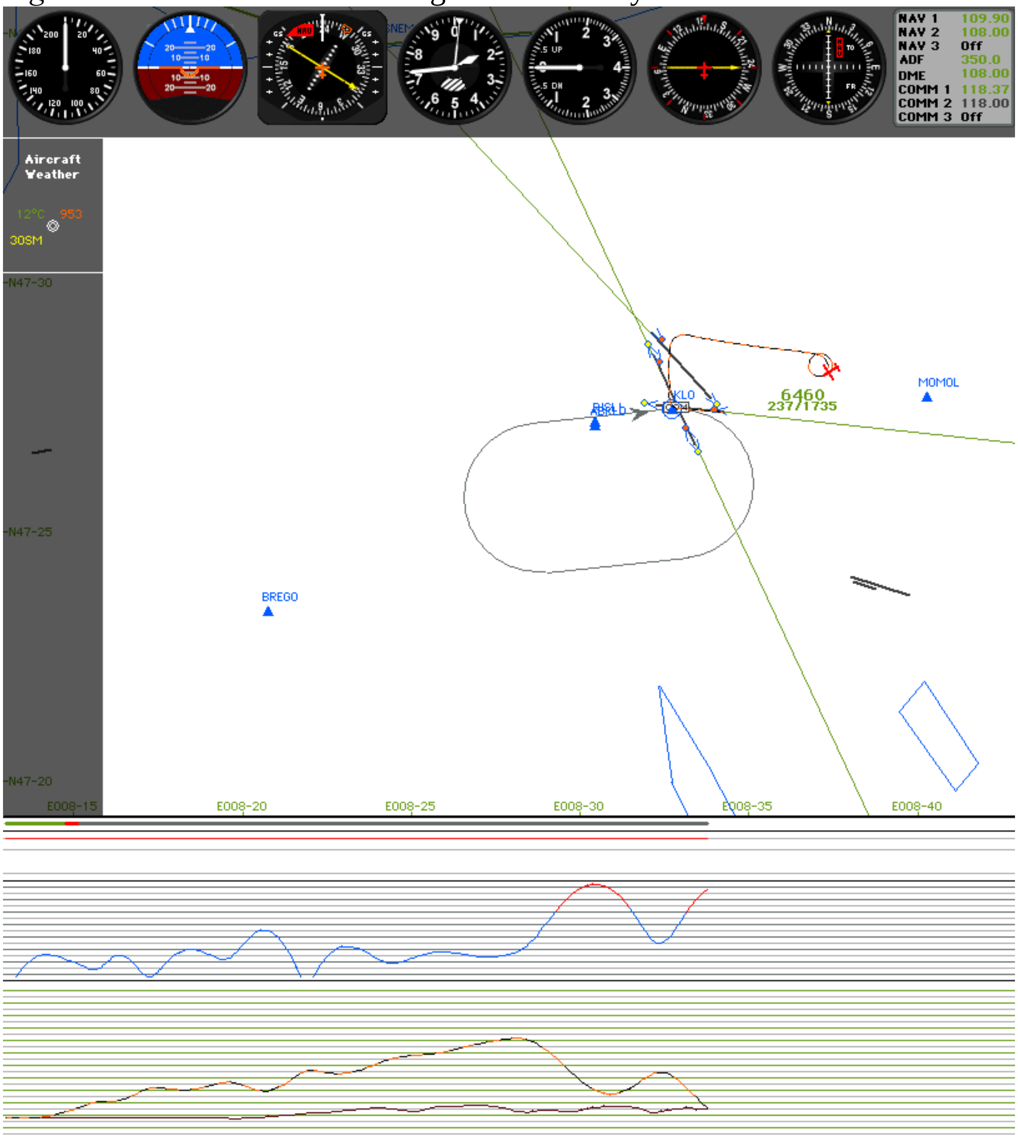
After documentation analysis, the secondee was acquainted with the hardware (instructions on how the hardware is built, the configuration of the hardware layer of the simulator) as well as the software. Finally, he was seated in the simulator for the training in the following activities:

- Pre-flight check.
- Turn on of the plane systems/equipment.
- Take off.
- Manoeuvre of circles over the airport.
- Landing.

Figure 6. Secondee from VRM in Elite FNPT II Flight Simulator at SUT VFL

There were also trials of execution of above mentioned activities in bad weather conditions (weather and clouds). During these activities the simulator was configured as cockpit of Cessna 172 RG. Therefore, the corresponding settings were selected for simulation software. SWISSRV environment was selected which by default indicated to the area around Zurich Airport in Switzerland.

Figure 7. Results of the Virtual Flight Performed by the Trainee



Regarding the research and development collaboration it is important to focus on AR in flight simulators environment where AR glasses can be used. Therefore, two main approaches to the AR based on AR glasses were considered for the WrightBroS project. The first approach uses smart glasses, the second holographic goggles. Holographic goggles are intended for more immersive display, encompassing the whole three dimensional scene and enabling interaction with the scene contents – for example, it is possible to add new objects to the scene, or to occlude real existing objects, to enclose objects with emphasizing virtual wrappings and to annotate them. All this requires such abilities as head tracking for localization and mapping of the environment – this task is jointly named SLAM (simultaneous localization and mapping) and requires depth mapping and is computationally intensive, therefore Micosoft built-up own compressors for deep learning tasks in HoloLens 2 goggles, whereas Magic Leap One employs NVidia GPU for the same purposes. On the other hand, smart glasses augments the reality close to the edge of the display presenting typically peripheral view of the scene. In this approach, abilities for interaction with the scene are quite limited. Typically these include position or head position tracking (IMU, GPS) and computer vision methods (such as QR codes detection). Taking in mind the capabilities, product availability, support from the vendor and the main development environments (such as UNITY or Unreal) the Microsoft HoloLens 2 goggles have been selected as the most appropriate device for the WrightBroS project (Figure 8).

Figure 8. Certified EASA Pilot (VRM Staff) Wearing HoloLens 2 in the Simulator Cockpit

Regarding the ethics, the fundamental principles of research integrity and the good research practices, have been addressed as described below.

The first fundamental principle (reliability in ensuring the quality of research, reflected in the design, the methodology, the analysis and the use of resources) has been addressed in the WrightBroS project by following the research work (including design, methodology, and use of resources) as it was described in Annex I of Grant Agreement (Description of Work).

The second fundamental principle (honesty in developing, undertaking, reviewing, reporting and communicating research in a transparent, fair, full and unbiased way) has been addressed in the WrightBroS project by honest and unbiased reporting of the results achieved during research works in internal reports, scientific deliverables and in papers submitted for independent review to a scientific journal.

The third fundamental principle (respect for colleagues, research, participants, society, ecosystems, cultural heritage and the environment) has been addressed in the WrightBroS project by promoting and achieving friendly atmosphere between secondees and staff of hosting institutions (in particular during networking events such as visit in Museum of Technology in Vienna or during the 1st Thematic School, but also during regular research duties). This friendly atmosphere positively influenced the effectiveness of the research and promoted in practical terms the rule of respect for colleagues coming from different research cultures (academic and industrial) and respect for cultural heritage (especially by mentioned above visit in the museum).

The last fundamental principle (accountability for the research from idea to publication, for its management and organization, for training, supervision and mentoring, and for its wider impacts) has been addressed in the WrightBroS project by following the envisaged organization of the project and by using its management structure composed of Scientific Committee. The management events have been organized as quarterly meetings of Scientific Committee. These meetings have assured effective supervision of the progress in research and constant open discussion on achieving its significant impacts.

Good research practices enumerated in European Code of Conduct for Research Integrity have been addressed among others by:

- regarding research environment: transparent practices in selection of researchers for secondments based on requirement of acceptance of the candidates by Scientific Committee using competence criterion,
- regarding training, supervision and mentoring: senior researchers and research leaders, in particular the Chair of the Scientific Committee, mentored team members, offered specific guidance and training to properly develop, design and structure their research activity
- regarding research procedures: taking into account the state-of-the-art in developing research ideas which have been explored in the WirghtBroS project,
- regarding data practices and management: ensuring that access to data is as open as possible (by giving an open access to WrightBroS data on the webpage and as closed as necessary (for planned patent application),
- regarding collaborative working: taking by all beneficiaries responsibilities for the integrity of the research, as well as informing and consulting all beneficiaries about submissions for publication of the research results,
- regarding publication and dissemination: full responsibility of all authors for the content of a paper submitted for publication.

Regarding gender issues, the proportion of women and men among secondees achieved level of 40% for women and 60% for men. In the field of engineering, where a background strong disproportion towards women underrepresentation is observed, such levels indicate success of the project in fostering equality of chances for both sexes.

Fostering respect for heritage of technical culture was achieved by organizing a visit in Museum of Technology in Vienna for SUT secondees in NXR (on 24th of July 2019). SUT staff seconded to NXR visited the Museum of Technology in Vienna, where such relevant for the history of aviation (and thus for the project) artefacts as the original airplane engine built by Wright Brothers could be seen (Figure 9a).

This museum was opened in 1918 and it aims to communicate technical principles to wide public. Its collection follows a "learning by doing" approach, and additionally historical exhibits, many of them unique, are showcased in their cultural context. Knowledge is transferred in an accessible, and sometimes even funny way, that makes it possible in an easy way to better understand principles standing behind many technologies. In the museum, SUT secondees had the chance to see not only the engine of the Wright Brothers, but also the Lilienthal's original storm wing model (see Figure 9b), which is one of five Lilienthal's gliders still in existence worldwide, and the only one of its kind. The other Lilienthal's gliders are to be found in London, Moscow, Washington, and Munich. During the trip, team of the project could discover, experience and reflect on history of the Wright flyer but also on different fields of technology and its history as well as to train new skills by performing many interesting experiments and by participating in interactive presentations. Additionally, it was a great opportunity to social integration and to know each other better.

Figure 9. Visit in Museum of Technology in Vienna

a 

b 

Conclusions

In the paper the collaboration between Higher Education and Industry was illustrated by lessons learned in Horizon 2020 Research and Innovation Staff Exchange WrightBroS project. In the course of the project we identified many Industry and Academia collaboration challenges such as:

- Different research cultures.
- Different time-scales for achieving results.

- Mobility problems in COVID-19 era.
- Availability of staff ready to be seconded.
- Intellectual Property Rights of particular organizations in a common Consortium.

The paper presented how we dealt with them in order to maximize impact of Industry and Academia collaboration opportunities. These measures include:

- Transfer of theoretical knowledge from university to industrial environment.
- Training of university staff in practical skills on secondments.
- Return mechanism which assures usage of new skills in home organizations.
- Gaining added value of collaborative efforts.

Transfer of theoretical knowledge from university to academic partners we consider as essential factor which allows for common research work. Typically, industrial partners possess excellent skills regarding the domain they operate in, however in order to produce innovative products and market breakthroughs, often a broader theoretical knowledge from university is required. By RISE type project such knowledge is naturally transferred together with seconded from universities staff.

On the contrary, university staff is typically oriented on writing scientific papers but not on practical applications of the results of their research. Therefore, a contact with industrial environment given by RISE projects is an essential step towards learning academic staff the practical skills required for commercialization of their research results.

RISE projects assume also that the knowledge of practical skills gained by university staff is transferred to university other staff and incorporated in university procedures. This is done by the return mechanism and guaranteed by the legal rules included in the RISE program assuring that the home organization assimilates the seconded staff after the end of the project.

All these measures allowed us to gain added value of collaborative efforts. To achieve success we profiled our project by observing synergy in collaboration of Wilbur and Orville – the two brothers who, by a common passion, have changed the world. Academia and Industry by working in our project side by side in a common “Factory”, tries to commemorate the collaborative success of the Wright Brothers.

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