THE EUROAVIA MAGAZINE

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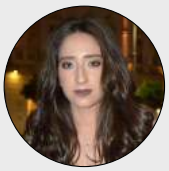

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The EUROAVIA Magazine

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Dear readers,

2019 is not over yet but we can look back at it as a very impressive and successful year, not only for EUROAVIA but for the whole aerospace industry.

This year the whole world has revisited some pivotal moments in the aerospace history and as that happened, there were surely a few events that have made it under the spotlight, stealing the show. On top of that list comes the celebration of fifty years since Apollo 11 landed on the moon and the fiftieth anniversary of Airbus. One represented the dream of centuries coming to realization, while the other gave birth to one of the greatest joint European companies.

However, I feel there are a few other events that might have fallen under the radar, but have, nonetheless, marked significant improvements to air transport. This is about the celebration of fifty years since both Boeing 747 jumbo jet and Concorde had their maiden flights.

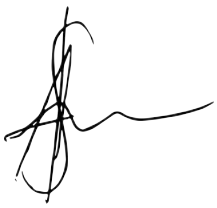
As far as EUROAVIA is concerned, we had one very good reason to turn our attention to past times and that is the **sixtieth anniversary** since the establishment of our dear association. Putting all of these events next to each other leaves no doubt that 2019 was a great year for reflecting on both the past and the future.

Apart from that, EUROAVIA hosted 10 International Events including the Airbus Sloshing Rocket Workshop, another successful edition of the Air Cargo Challenge and the Lustrum. About the latest, you will find more details inside the magazine.

I would like to express my special appreciation to our EUROAVIA members for their contribution and effort to this magazine and for keeping the EUROAVIA spirit alive.

Best regards,

Anca-Maria Stan
Communication Working Group Coordinator



Lustrum Highlights

60 YEARS
LUSTRUM

Sixty years ago, the EUROAVIA founders committed to a bold vision for the community of aerospace students. That moment sparked a movement, which has seen generations of EUROAVIANs connecting together, exchanging experiences and growing to be true professionals in the aerospace sector. Every five years, EUROAVIANs gather to celebrate this moment at an event called Lustrum. This year's event was even more charged with emotion as it took place in Aachen, the place where the first constituent congress of EUROAVIA was held and where the official statues were presented and accepted.
The event has kept its promise to provide a full and memorable experience by immersing each of us in the future of Aerospace. Inspiring speeches, project presentations, panel discussions, a lunchtime exchange, a great variety of networking and last but not least a well-deserved gala dinner have turned the event into a success.

So, here's what happened at Lustrum 2019.

This year's celebration began a day earlier, courtesy to **Grazia Vittadini**. The CTO of Airbus couldn't attend the event itself, but gladly she agreed for a discussion at the Forum M in Aachen. Three prominent topics marked the discussion: cutting down emissions, reaching for autonomy fueled by **artificial intelligence** and the disruptive potential possessed by **quantum technologies**. The conversation was intense and energetic with a big focus on the direction that the industry is heading and substantial clues to prove Airbus' commitment to emerging technologies.

The official celebration kicked-off one day after with the Opening Speech held by AS Aachen which set the tone for the rest of the morning. It was shortly followed by Prof. Ulrich Rüdiger - Rector of RWTH Aachen University and a representative of the City of Aachen with the audience then turning its attention towards EUROAVIA's Past. In this regard, Juan Manuel Lora Alonso-Former IB President of the EUROAVIA International Board and Karsten Kullack - AS Aachen Alumnus contextualized the historical framework in which EUROAVIA was founded and provided background and insightful stories about the activities of AS Aachen during the 1990s.

The first keynote speaker, Juan de Dalmau - President of International Space University launched the discussion on the topic of Multidisciplinary Space Education across the World, presenting the programs available at the institution that he represents and the outstanding success stories of former ISU graduates. The first panel discussion of the day touched upon the topic of *New Space Age in Europe: challenges and outlook*, featuring Juan de Dalmau, Jean-Sebastien Lemay-General Delegate of CVA, Fredrick Bräuer and Jasper Meister-student

Figure 1: Grazia Vittadini, CTO of Airbus. © EUROAVIA Aachen.

Figure 2: Juan De Dalmau, President of the International Space University (ISU). © EUROAVIA Aachen.

at RWTH University of Aachen and member of AS Aachen, that represented the collective voice of students currently studying space-related subjects.
To conclude the morning, EUROAVIA International Board gave an overview on the contemporary activities of EUROAVIA, emphasizing its ambition to represent the interest of thousands of students to the European aerospace sector and its latest achievements, such as securing for the first time in its history the Erasmus+ Grants and updating the corporate identity of the association.

In the afternoon session, Veronica Botti - AS Padua Alumnus spoke about the **activities of EUROAVIA in the late 2000s** and shared her experience as an Engineering Support in the Training and Learning Programme at the European Space Agency's Academy. On behalf of **CVA - The Community of Ariane Cities**, Jean-Sebastien Lemay held a presentation on the topic of Society of Ariane Cities and its activities, focusing on the next-generation launch vehicle, Ariane 6. Besides that, Jean-Sebastien Lemay and Francesco di Lauro - President of EUROAVIA, announced and signed a Memorandum of Understanding, officially marking the collaboration between CVA and EUROAVIA. Subsequently, various interesting topics were tackled by the special guest, Tom Enders-Former CEO of Airbus, who offered his honest input on several matters. Speaking about education, he emphasized that European universities should offer integrated courses that combine both data and machine learning and traditional subjects. Mr Enders also reminded the students in the audience that the industry is changing at an unprecedented pace, going into the details of what he considers the right skills necessary to

Figure 3: Signing of the Memorandum of Understanding between CVA and EUROAVIA. On the left, Jean-Sebastien Lemay, General Delegate of CVA. On the right, Francesco di Lauro, President of EUROAVIA. © EUROAVIA Aachen.

compete in tomorrow's aerospace industry, stating that " Soft skills have become the new hard skills.".

Air Taxi and Urban Mobility was the focus of the second and last panel discussion of the event, stressing the importance of coherent development of both technology and regulations. Moritz Jung represented the young German start-up Lilium, putting into perspective the hurdles of a company that has already iterated a few models for an electric jet-powered craft. Prof. Dieter Moorman represented the academia, Juan Manuel Lora Alonso shared the point of view of students and Tom Enders gave insights into Airbus' efforts to find solutions for future mobility. Lustrum 2019 concluded with a presentation from the main sponsor of the event, CAE Elektronik but not before turning our attention to the future to see what it is in store for EUROAVIA.

by Anca-Maria Stan

Figure 4: Tom Enders, Former CEO of Airbus. © EUROAVIA Aachen.

EUROAVIA newsletter

Introduction to the Newsletter

The EUROAVIA Newsletter is the main mean of briefing about the events and activities that take place in the Local Groups, while also including reports about matters occurring on the International side of EUROAVIA. This year, we updated the structure of the Newsletter, making it more suitable to the kind of information our members tend to engage with. The changes included shorter Newsletters that represent a summary of what has been going on in the association and are easier to read, while also rerouting the Local Groups' reports and news to the website.

In the following pages, you can find a collection of news that has been published during this business year. To start with, you will be reading about a new event, a Drone Workshop, implemented by AS Napoli in their Local Group. Next, you can find a few tweet articles describing the activity of AS Pisa, followed by updates on the beginning of the summer in AS Sevilla.

Newsletter

Local Reports

Napoli - 17 June 2019

Dear EUROAVIAns, this year EUROAVIA Napoli prepared something special for the associates, the first Drone Workshop (DroWo) in the history of EUROAVIA: Game Of Drones.
The adventure started more than one year ago, as the idea was conceived even before the last year's workshop was concluded. But the DroWo's real shape was clear only in October, when three new figures came up to help the Local Board: Luca Miele, Lorenzo Pucci and Andrea Detry from the Mechanical Engineering faculty.
They have been building drones together for many years now. The outcome was a 6-day workshop in a competition format. Twenty-five students divided into five teams and each team could build its own drone using components chosen from a list prepared by the board; every component had his own fictional price depending from its quality. Since every team had a starting budget, overrunning this budget resulted in negative score, while exceeding budget was counted as positive score. All the choices made about the drone design had to be listed in a final report, which was mandatory for each team. Finally, each drone had to be tested and rated by a professional pilot.
Along the year the LB worked hardly on the event, establishing new partnershis, reinforcing the old one and making sponsorship deals with some of the major companies in the drones' world, such as Fat Shark and CL Racing, and gaining the support of worldwide famous brands like Red Bull. Another important deal was closed with the airfield Club Airone, which is equipped for freestyle drone races and was the perfect gust for the competition day. We also wrote a special handbook meant for the event (edited and printed by our sponsor Officina Studenti) and prepared an intensive two-days course about the drone's components, mechanics of flight, physics of beam and so on. For each participant we prepared some unique t-shirts, with five different colours (one for each team: yellow, grey, green, white and orange). Last but not least, there was the option to use a 3D printer to print some components like couplings and plates. The Board even took the responsibility to manage the division of the students into teams; to avoid this, some questions about basic knowledge of physics, electronics and welding were included in the subscription form. After a seemingly endless series of unfortunate events the board finally got everything that was needed to make great the first DroWo signed by EUROAVIA Napoli.
May the 6th, 8 o'clock in the morning: day one. The guys are halfway between the curiosity and thrilling. They silently approach the classroom, where the t-shirts and special badges are waiting for them, together with a package containing two Red Bull cans with different tastes. Some students take place near to their teammates so they can know each other. As the event starts our Secretary Castrese Di Guida and our Executive Member Felicia Della Valle introduce the guys to the rules of the competition. Then it's our President's turn, Gianmarco Valletta: his lesson is just the overture of an 18 lessons course. Luca Miele and Lorenzo Pucci take care of almost every lesson: batteries, flight controller, beams, communication protocols and many other; Andrea Detry too prepared a lesson about 3d printers. But even some Local Board members (Dario de Lorenzo, Raffaele Aucelli, Fulvio Petti and Matteo Mangone) present their own lessons about the issues related with aerospace engineer-

ing: propellers, composite material structures, PID control and drones' mechanics of flight. Swinging between the drones and the coffee breaks the two-day course went by. Wednesday: the sponsors and auction day. In the morning all the participants meet in Aula Bobbio, in piazza Giorgio Ascarelli, where the Gold sponsors (and those who joined the packages over the Gold Sponsorship) are going to present their university. When the presentation is over, Luca Miele and Lorenzo Pucci start their final lesson about BetaFlight, the firmware that must be implemented inside the flight controller's processor to set and to fly the drone. Meanwhile the Local Board is preparing the exposure of the components in the next room; as you already know, participants can choose among different components, with different qualities and features (they are all itemized in a list prepared by Luca and Lorenzo). When they come in after the brief lesson about BetaFlight, they all go inside the other room and start to gaze at the components, designing the perfect drone deep into their minds. As the afternoon goes by each team creates his own little island in which they discuss about the possibilities and the hazards of each choice about their design. Luca and Lorenzo are waiting inside the classroom; each team must commit their design to them to get their approval so they can start to build the drone the day after. The yellow team is the first one to commit their layout and while the Sun goes down the other teams deliver their projects.

It's Thursday. The teams are going to build their drones in a special room arranged for the situation, which is inside the main venue of our faculty in Piazza Giorgio Ascarelli. In the morning Lorenzo teaches the guys how to weld, something that is going to be a must during the whole day. The teams start to build their drones, feeling proud of their creations, giving them names and taking care of them like children. Some team even tries the 3D printer: it's something new for the most of them and seeing it in action is a kind of spectacle. On Friday the air is even more tense, the teams have a few hours to complete their drones and the sands of time are running. As the evening approaches some drones are ready and Lorenzo drives the guys in an open garden to test if the drone can fly. By the end of the day every drone is built and ready to fly.
Saturday morning, finally. The teams silently meet at the airfield Airone, everyone is ready to watch their creations fly high above the sky; the fear that something may go wrong is palpable in each of them. The day starts with the guys presenting their work. From the detailed Orange Team report to the funny Yellow Team one the time passes and the test phase approaches. But just before the test starts the Local Board has a special surprise prepared: a tasty cake with the Game of Drones logo on top of it.
The tests done are the following:

- Drone inspection (carried out by Luca and Lorenzo which checked how much the drone build mirrors the team's report)
- Endurance (each drone will fly the same amount of time and the battery charge after the flight is the evaluation parameter)
- Acceleration (to know the right value some sensors are mounted on each drone)
- Stability (this evaluation parameter is going to be assigned by the pilot Emilio)

Another important evaluation parameter was the teamwork, which was assigned by the LB members during the building days.

When the test phase is concluded the Board gets together with Luca, Lorenzo, Andrea and Emilio to choose the winning team. After some tensing moments the winner is decided. The guys surround the takeoff drones' platform on which only the winning drone will fly. The excitement unstoppable grows until the winning team is finally clear: the Green team (Evergreen, as they called themselves) is the team that wins the first Game Of Drones edition! Their little drone "Green Hornet" was the best in all the tests. The Evergreens are: Leonardo Pierro (team leader), Aniello Prisco, Mario Salvatore Puzelli, Oreste Russo and Osvaldo Santillo. Congrats Evergreen: you signed your names in the history of EUROAVIA! After the last drop of sparkling wine has

reached someone's stomach, the participants go to the bus to get back to their home: many fall asleep while others just can't stop talking about the event and the competition. They are all tired but at the same time satisfied because of what they've learned during the "week of the drone".
We would like to thank all the participants and our Professors for helping us during the organization of the event. We also would like to thank our sponsors:

Pisa - 25 December 2018

Conference with TXT e-solutions: Software in Aerospace Industry

The 29th November, our AS, jointly with TXT e-solutions (partner of the Team Vexillum Pisa, participating at Air Cargo Challenge 2019), hosted a conference about software in aerospace industry. TXT e-solutions is an international, specialized provider of engineering software solutions supporting customers in high-tech markets in their core mission-critical and business-critical processes. Dr. Michele Capiluppi , Key Account Manager for the aerospace sector in Italy showed us their high end products used for flight simulators and maintenance crew training. It was mindblowing to see how virtual reality is not just a sci-fi technology, but it is one step away to become the standard for the training of specialized workers, not only in the aerospace field. Also Dr. Francesco M. Cusaro, Head of the HR department, explained to our students which are the key features that an employer expects from his workers. Nothing is more important for us to get as fit as possible to enter successfully in the professional world.

Space Talk with Simona Gallerani

The European Space Talks are an initiative promoted by ESA with the aim of deepening the interest of students and enthusiasts on space and space research. EUROAVIA Pisa took the opportunity and, on November 30th, organized a space talk at the University. The event, which involved many enthusiastic students, has given us the opportunity to retrace the major space missions conducted by ESA and to listen to an interesting presentation by Simona Gallerani, researcher in astronomy and astrophysics at the Scuola Normale Superiore. She talked us about how the man has been gazing upon the space between galaxies and black holes thanks to orbital telescopes.

Visit to VIRGO

On November 10th our members had the opportunity to visit Virgo, the biggest gravitational interferometer in Europe. Ph.D. Valerio Boschi guided us during the visit, starting with an introduction about the dark matter, the origin of gravitational waves and the path that led to their discovery. The Professor has therefore led us to the heart of Virgo, housing a beam-splitter, made of monocrystalline quartz, which divides a laser beam into two equal components, subsequently sent into the two interferometer arms. The visit then continued in one of the two long arms. There, using magnetic fields, they managed to create a pressure even lower than the space void, in order to eliminate every possible source of disturbance for the laser. It was then possible to observe the data collected and the way they process it in real time. It was really exciting, especially because the interferometer was in a period of full activity. It was an interesting experience to discover arguably the main research center on our territory.

Sevilla - 17 June 2019

Dear EUROAVIAns,

With this intense month of June just starting, begins in Sevilla a period of change. The last weeks of this marvelous year in our AS have been marked by the launch and testing of the EUROAVIA Sevilla Rocket Workshop. With the presence of members of the CVA broadcasting staff, we made sure that this activity would reach as many engineering students as possible, while stimulating the younger ones to invest themselves in aerospace studies. The Workshop itself was scheduled as a series of eight classes, two master classes and six workshop-like ones, where the different groups would design and build the rocketry by themselves. This year, and as part of the CVA's plan of activities, we invited several schools to bring their older students as participants of the Workshop, so they can have a first glance of what an engineering project consists on. The 25th of May all teams were convoked to launch all the models. With the help of the altimeters made before by another Workshop in our AS, we got to know how high our rockets had gone.

On other topic, we are happy to announce that EUROAVIA Sevilla has, from the last three weeks, a new Local Board! We all are (the new and the old Board) enthusiastic about the possibilities, opportunities and challenges that next year will suppose. We congratulate our new LB members, and hope to see them around Europe spreading the EUROAVIA Spirit!

Introduction to Interviews

BEING part of the aerospace professional world requires passion and strong dedication. In this section of the Magazine, you will read about the successful careers of Iulian Emil Juhasz, Francesco Palumbo, Federico Di Micco and Professor Aldo Frediani. They were eager to tell us their story and give EUROAVIANs suggestions for their future professional life. Furthermore, this year we wanted to interview also one of our EUROAVIANs: Giulio Autelitano, coordinator of the Company Relations Working Group. He will tell us about his involvement in the association and how this helped him with his future career.

HPS

High Performance Structures
Inovatie si Dezvoltare S.R.L.

Interview to Iulian Emil JUHASZ

ABOUT THE INTERVIEWEE:
Iulian Emil JUHASZ

Iulian Emil Juhasz is currently the Head of Technology Development and Project Management Section at HPS Romania. During his studies, he was very active in the EUROAVIA community, eventually stepping up as an International Board Executive Member in 2008. He agreed to share with us how it is to work at a young company in the space industry and also his experiences in EUROAVIA.

Interview by Emanuel Moraru

What does HPS Romania do?

HPS Romania (High Performance Structures Inovatie si Dezvoltare SRL) is the daughter company of HPS GmbH which is located in Munich, Germany. HPS is a supplier of hardware for the space industry. In Romania, we are developing and manufacturing structural and thermal components for satellites, metallic structures used in the assembly of satellites (i.e. MGSE – Mechanical Ground Support Equipment) and we are also involved in several space antenna development projects having as customers the Romanian Space Agency and the European Space Agency. Up until now we contributed to space missions such as EUMETSAT Polar System –Second Generation (EPS-SG), Sentinel 4, JUICE and BIOMASS, working directly with ESA, ROSA, Airbus DE and Airbus UK. We are currently 15 people covering almost the entire development cycle of a product, from proposal phase to engineering, manufacturing, assembly and integration on customer's site. I say almost the entire cycle as we don't have our own machining capabilities, but we collaborate with very capable suppliers and we coordinate the manufacturing process.

Can you share with us what your work for HPS consists of?

Currently, I am the Technology Development & Project Management Section Head. I am the Project Manager & Technical Officer of several technology development projects that are being implemented at HPS. I am also responsible for the proposals writing and I am involved in pretty much all the technical issues of the company.

What were your first steps into the company? How did you start?

I was actually the third employee of HPS Romania (in 2016) and my first task was to set up the assembly facilities of the company. I had to organize and procure the necessary tools and equipment for the assembly hall and laboratory and to purchase the ISO 8 cleanroom with all its accessories and consumables. I was also in charge of the procurement of parts and services for the first project we contracted.

Tell us a bit more about how it is to work with companies such as Airbus Defence & Space and ESA.

Being a young company, having the opportunity to work with such experienced people and companies is amazing. We have learned a lot in the last 3 years and we are looking forward to learning more and delivering cool products. As the Head of Technology Development, through the position itself, I come in contact with the latest technologies, the latest materials and sometimes it feels almost as travelling to the future. Working side by side with professionals from companies like Airbus or different space agencies offers you the chance to learn from their experience and be a part of some of their most valued projects. I also get to visit some of the most advanced satellite assembly facilities in the world, so I could say that most of the time it is a dream job, especially for a space geek like me.

I know that after university you worked a little bit in the aeronautical field and then you changed to space. What caused the change?

There was quite a bit, about 6 years, that I spent working in the aeronautical field as a stress engineer. I think I always wanted to be part of the space industry. When I say always, I mean since I can remember. I wanted to become a NASA scientist "when I grow up". After university, there were not so many opportunities in the space field in Romania (Romania is an ESA full member only since 2011 and I graduated in 2009). I found space to be more challenging and quite dynamic compared to aeronautics and it also fitted better with my personality as it offered me the chance to have a broader overview on the subjects I was working on, rather than concentrating so much on the details.

What about your activity in EUROAVIA? How did it benefit you to be so involved in EUROAVIA in your student years?

I think that the "EUROAVIA experience", like any experience, can be seen as beneficial from several points of view. I got to know many students that were studying aerospace engineering in universities around Europe. I understood back then that even though we were coming from different backgrounds and cultures, we were not that different after all. We were all experiencing a similar moment in that time of our lives. Being part of EUROAVIA also gave me the chance to experiment on what it meant to be in a leadership position. It was among the first moments in my life where I found out what it meant to be responsible for a decision you were taking, a decision that was affecting other people as well. Of course, the consequences of bad decisions were not the same as in a company, but at that moment, they seemed very important.

This year EUROAVIA turned 60 years old, and we focused on what we can learn from the past so that we can improve the future. How was EUROAVIA organized when you were in the International Board and what was better then, compared to now? Also, what do you consider is better in EUROAVIA now compared to your period in EUROAVIA?

As there are now more than 10 years since I was part of the IB, it is very hard to compare then vs. now, especially that I am not so familiar with what is going on in EUROAVIA right now. I think that now EUROAVIA has more visibility than back then. It might have to do also with social media and communication in general, as nowadays it is a lot easier to reach out

directly to more members than in 2008. The addition of more specialized Working Groups is also a good idea, although it might be harder to manage for the IB. I don't know how the financial situation at the moment is, but during our mandate, we were affected by the financial crisis, as many of the sponsors were cutting on the expenses and this affected our sponsorship contracts. What I see today as an improvement compared to a few years ago is that it seems that now there are more international events being organized by the AS. I think this is very nice and I would encourage the EUROAVIA members to participate in as many events as possible as they are truly unforgettable experiences.

What would you advice the students leading EUROAVIA today?

I would advise them to be careful with what and how much they are planning to do in their mandate. Although one year might seem a lot, it passes faster than you can imagine. The best would be to choose realistic goals and to plan their activities well enough so that they can be achieved.

Last but not least, what is the most important thing in your opinion in order to have a good career as an aerospace engineer?

I don't know if I can say I found the secret behind a good career as an aerospace engineer, but there are some things that are important such as attention to details, willingness to learn constantly and to have an open attitude towards new ideas. It's also important to take responsibility for your actions and to admit when you are wrong.

Interview to Francesco PALUMBO and Federico DI MICCO

ABOUT THE INTERVIEWEES:

Francesco PALUMBO

Federico DI MICCO

Francesco Palumbo and Federico Di Micco are two production technicians in D-Orbit, a Small-Medium Company in the province of Como (Italy). D-Orbit is a service provider for the traditional and new space sectors, with capabilities in satellite manufacturing, launch, deployment, satellite operations, end-of-life strategies and solutions, space propulsion and critical software. At the moment all the efforts of the company are focused on ION, the SmallSat launch and deployment service signed D-Orbit.

Interview by Lisa Ribechini

Hello Francesco and Federico and thanks for your time. I know these are hard days, as you are working on the last phase of ION assembling. So, let's start the interview. Can you explain your studies and your professional careers?

FEDERICO: First of all thanks to you Lisa for this opportunity. I am a graduate high school as perishes of electrotechnics and of automation. During the summer holiday of the last two years, I trained in an electronics company, which confirmed me for six months after graduation. Then, for the following 2 years, I worked for a television studio as cameraman and light technician. When the studio failed, I operated as electrician, but I was bored. In the end, I send my CV to D-Orbit, who was interested in me and I am working here for a year.

FRANCESCO: At the end of my last year of high school, D-Orbit was looking for a technical perishes and so I started to work part-time. When I had gained the title of electric and electrotechnical perishes, I started a trainee of six months and then the company confirmed me. So, I have worked only for D-Orbit in my life. In September I will go in Kourou to implement ION on the launcher. I am very proud of that.

And what exactly do you do in the company?

FEDERICO: In general I take care of the mechanics. In particular, I do the dimensional control of all the incoming components and actuators characterization, I assemble the doors and the tubes of ION.
FRANCESCO: Instead, I take care of the electronic assembly, I do all the electronic tests and the mechanical integrations; then I manage the structural test, for example, pyro shock.

What would you improve in the production phase of a satellite? And which are the aspects that you like?

FEDERICO: I would like some of the components in a single 3D printed component, in accordance with the structural limits. In this way, time and costs of assembling could be reduced.
FRANCESCO: I think that automatization of the production lines is necessary. At the moment, every single step of production is made by one by us, also the electronic processes. For example, It could be useful to have in our Clean Room a Vapour Phase Oven, in order to reduce the production times. Also the test phase on the electronic boards and their integration should be automized.

So, you are suggesting automation to reduce the workload on the production team?

FEDERICO: Not exactly. One day, we will have to produce five of six IONs at the same time and at that moment we will need automation. It is not feasible to rely only on labour, because it requires so much space, men/women and money that it has no sense. Maybe, it is smarter to focus the workforce on other production phases, which mandatorily need humans.

Thanks for your suggestions. But now, let's change the subject. What do you think D-Orbit has in more with respect to other companies?

FEDERICO: People. Humanity. I feel at home when I am here. Even though the number of employees has been increasing in the last year, we are always considered as human and not numbers. Then, I have the possibility to do a fantastic thing every day. I mean, I am working on a satellite. This is incredible for me. I have never dreamed I would work for a space company.
FRANCESCO: In a few months, I can tell that I worked on something that will move around Earth, in the space. We are the only one who does this kind of service. Then there is the aspect that brings me to work on Sunday and 15 hours per day: we are a team. There is not a pyramidal organization between us, each of us has one goal to reach: make ION fly and we will succeed in it.

That's really impressive. And how D-Orbit changed in the last years? I mean, a few months ago, you were half the people you are now.

FEDERICO: Nothing changed, we are always a family, simply bigger than before.
FRANCESCO: When I arrived in D-Orbit four years ago, we were 15 people in total, of which six technicians. Now, we are almost 50. But, nothing changes among us. We are not numbers, as it can happen in big companies, we are friends and colleagues.

How do you imagine the production of a satellite in 50 years?

FEDERICO: In 50 years, I can imagine the production phase more precise, quicker and innovative. The precision tools will be more accurate and less hand-operated. The climatic chambers will be designed in such a way that the thermal cycles will be no longer interrupted. The humans will never be substituted by robots and automatized systems, but their work will be easier than nowadays. I think that this is the only way to produce more devices in parallel and to grow as a company, as professionals and as people.
FRANCESCO: For sure, automation will substitute some phases, but there are some operations which require humans, for example, the integration of a satellite.

Thank you for your time!

UNIVERSITÀ DI PISA

Interview to Aldo FREDIANI

ABOUT THE INTERVIEWEE:
Aldo FREDIANI, Prof.

Aldo Frediani has been a professor of Aeroelasticity and Complement of Aeronautical Structures at the University of Pisa and currently he is the responsible and coordinator of Parsifal Project funded by the European Commission under the "Horizon 2020" Research and Innovation Program.

Interview by Mathilde Zani

Hello Professor Frediani and thank you for this interview. What kind of studies have you done during your career?

I graduated in aeronautical engineering in 1971. After that, I did my military service in Grosseto for a year. In 1985, after some years in the academic world, I won a competition at the University of Rome "La Sapienza" where I taught until 1990. Since that year, I returned to Pisa where I worked for 8 years as rector of construction and, finally, I returned, obviously teaching, to the Aeroelasticity course and Complement of Aeronautical Structures until retirement that I reached in 2017.

Well, did you start working in Pisa?

Yes, I worked in Pisa until 1985 when I moved to Rome for 3-4 years to teach at the School of Aerospace Engineering at la Sapienza. It was a useful experience because I had an experience outside Pisa, in a University that has active international relationships. La Sapienza, despite having many drawbacks compared to the University of Pisa, is less provincial.

Do you think that having international relationships among Universities is important?

Very important, indeed it is perhaps the most important thing because in life we must know how to listen and talk so that we can take advantage of everything that comes from outside. Knowledge is this.

So, do you agree for example, to a thesis abroad or to an experience abroad during university time?

Well, in this case, the matter is different. Going abroad for the thesis has both negative and positive aspects. The thesis aims to train the student as a first goal. In fact, the thesis helps to teach a profession and above all, to insert the young person to his profession in a certain branch that he will cultivate in the future. On the other hand, abroad theses have as the primary purpose of forming the interest of those who assign them. Naturally, this is not always true, you should go abroad and get lucky.

Maybe after the training?

Yes, of course, after the training maybe it is better. Naturally, I say this from my own experience.

Now I would like to change the subject. Tell me about Parsifal Project. How was this project born? What are the principal goals?

The project originates from afar. In the early 1990s, the dialogue on aeronautics focused on the opportunity to build large machines because those allowed to reduce operating costs per passenger carried. In those years I witnessed this debated in London in the English and American circles from which the A380 was born. The Americans already had the Boeing B747. Then things changed.
At that time, I was already teaching aeroelasticity and it occurred to me to overcome the idea that the airplanes were all made in the same way. From an aerodynamic point of view, wings with negative sweep behave better than wings with a positive sweep but they are unstable. It occurred to me that putting together a positive sweep wing with a negative sweep one, and connecting them to the end, the stability given by the positive sweep could be used to stabilize the negative sweep without losing the advantages given to the aerodynamics. It is a trivial observation, but I was posing the problem of making a biplane with this kind of wings from the aerodynamic point of view. In the end, I found a Prandtl's work of 1924 (NASA published that work in a publication called Tn182 translated from German) in which he proposed the BEST WING SYSTEM, that is a system made from a biplane with wings closed at the tip as a box in frontal view. My problem, then, became how I could apply this concept to transonic airplanes with swept wings.

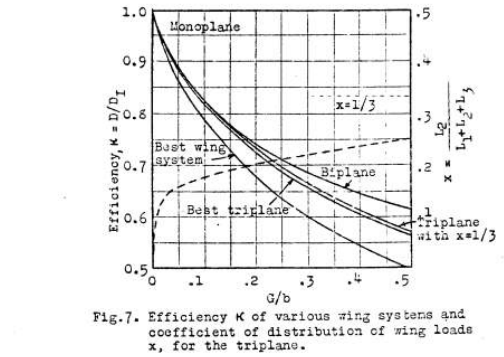


Fig.7. Efficiency K of various wing systems and coefficient of distribution of wing loads x, for the triplane.

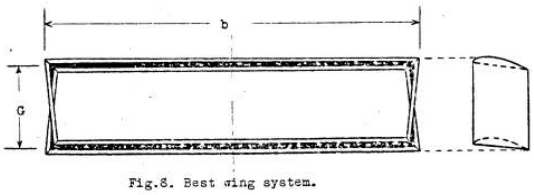


Fig.8. Best wing system.

Figure 1: Best Wing System, Tn182 © NASA.

To solve that problem, I used the theorems of Munk that prove that sweep angle does not modify the results of Prandtl. So, the Best wing system concept could be applied to build a forward-swept wing and a posterior one, merge them at the end and solve, at once, stability and control problems. After that, the last problem that remained to solve was structural: in fact, if I earn from the aerodynamic point of view, I pay in structural terms. This is the typical problem of trade-off: I should analyse all the problems together because an aerodynamic improvement leads to an increase of weight, that will take an increase in the induced drag with a worsening in the aerodynamics. In this aspect, my multidisciplinary formation in the aeronautical construction helped me.
In the year 2000, thanks to a contribution of Italian Ministry, I created a group composed by some Italian Universities among which the University of Rome and the Polytechnique of Turin, to study an aircraft of 250 places and 60 m of wingspan. In 2010, I started the IDINTOS project to realize a seaplane of Prandtl Plane type. With this project, of which we built the prototype and a model for the wind tunnel, we could do at the same time calculations and experiments (experiments in the wind tunnel and in Froude's tank). The correspondence between experiments and CFD was exceptional except for non-linear cases or control's saturation.
From this result, we understood that the idea of a Prandtl Plane was correct, as we measured a maximum efficiency of 18 on a seaplane when this is generally 8. All these years, therefore, took to be aware that we are travelling with our feet on the ground.

Then, was the Parsifal Project born in this concept?

No, Parsifal was born from another concept. I realized that the world had changed and what was interesting for aviation was not the large aircraft, in fact, Airbus has suspended the production of the A380, but above all, the advent of low-cost airlines and, then, the point-to-point. Therefore, as the flights are always full travelling with low-cost airlines, we started to think that the really important application was in this field, with airplanes that work in ICAO airports of type C, in where the aircraft must have a wide of 36 m and a landing gear with a width from 6 to 9 m due to turn around problems.

Why did you think that this would be the right solution?

Because in this field there will be the development of air transport. This fact is confirmed by the fact that both Boeing and Airbus base their production on the single aircraft, that is the family of A320 for Airbus and the family of 737 for Boeing. With Parsifal, we have entered here, in the market with the most difficult competition. From a theoretical point of view, if I calculate the improvement of induced drag of the Prandtl plane configuration, I see that this depends on the dimensionless parameter given by the ratio between the height of the wings and the wingspan.

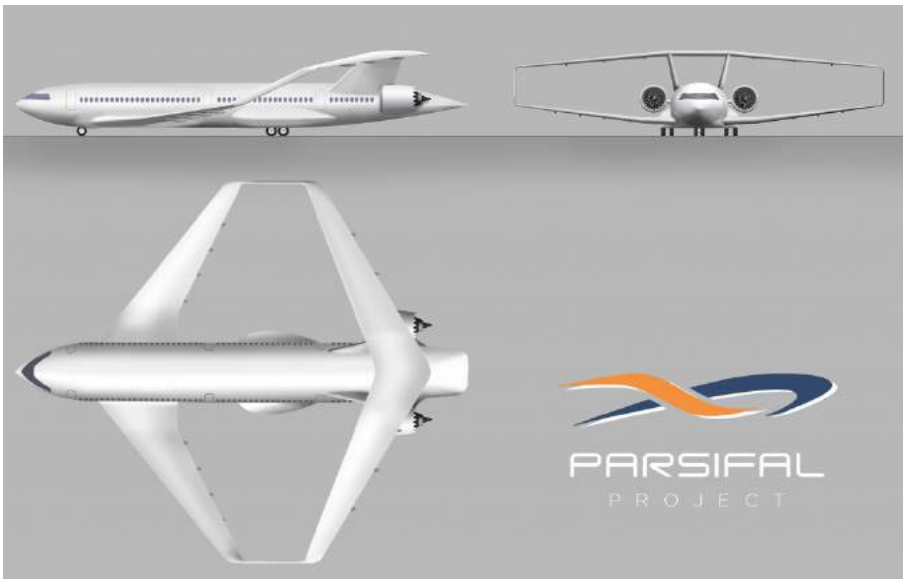


Figure 2: Rendering of the Parsifal Project.

The greater this ratio is, the better would be the gain of drag. Naturally, I speak of induced drag because it is the one that is most available to the engineer and that gives us the quality of the aerodynamic. We have set ourselves the goal of making an airplane which can carry as many passengers as possible so that it has a greater payload than the other aircraft; an aircraft that exploits the possibility of keeping a wingspan of 36 m so that the ratio between the height of the wings and the wingspan becomes favourable. In this way I have also two gains: the first one is that I can increase the load and so I can act on the improvement of drag. The second is that I can operate in airports of type C in where there will be the greatest increase of air transport.

What are the partners of the project?

The Parsifal project is a partnership in which the University of Pisa is the coordinator and I must complete the project as a scientific responsible. Together with the University of Pisa there are: Skybox, that is a spin-off of University of Pisa which needs to preserve all the knowledge acquired, Onera for the aerodynamics, DLR as regards management aspects, ENASAM that is a Toulouse laboratory, the University of Delft and, at last, the University of Madrid for the aeroelasticity part that we are developing.

Do you think that a project of this type, without international interaction, would have been impossible?

Yes, impossible from the practical point of view, but also statutory because there had to be at least 3 European states to accept the project. Obviously working together is fundamental.

Do you think that this idea can renew the world of aviation?

Yes, but not only, even the way of flying. Another key aspect is why we decided to bring more passengers. Nowadays there is a problem: the sky is big, but the airports are not. Most of the airports are in saturation, they operate at their maximum capability, so the planes that take off and land are every few minutes and they are the maximum number bearable by the airports. So, if I want to think about doubling air transport that is expected in the next 20 years, I cannot do it except by building new airports, which is also very complicated because the airport areas are not easy to find, as they would need large airports. Then what we can do is increasing the capacity of the aircraft. In fact, an A320 carries 180 passengers and a B737 approximately the same number, our Prandtl plane, for now, carries 308. The number of passengers would, therefore, increase by at least 50%. Unfortunately, we will not get a big gain in passenger growth if the turn-around time in airports increases by 50%. Then, we must conceive a completely new machine.
The aircraft, in fact, has two corridors with a 2-4-2 configuration so on each corridor there are 2+2 passengers. The number of overhead bins allows you to allocate two hand luggage for each passenger contrary to the current state. The cargo compartment is not divided into two parts, but it is a single compartment with two doors and therefore allows to load and unload at the same time with a capacity much greater than the current one. Moreover, it has the possibility of making a mixed transport. The corridor, at last, is not 50 cm wide but 70 cm and it is made in such way as to allow the passage of one passenger while the other arranges the luggage.
The airplane has three doors: one front, one rear and a central one with independent ladders as the plane is low to the ground. The engines, located on the fuse-

Figure 3: Prandtl plane of the IDINTOS Project. © Marco Ferracci, MBVision.

lage and on the tail, will be of new conception with a larger bypass ratio (12-15). Then, they will give thrust with greater flow rate but with a lower exit speed and therefore less noise. Furthermore, the efficiency will be better with low take-off speed. Lastly, take-off efficiency will be greater also as a result of ground effect that has an enormous impact on anterior wing that is close to the ground. To take advantage of this effect we keep the aircraft very low to the ground by making short, small and side landing gears so that the cargo compartment will not be interrupted.
With all these precautions the flow of passengers during the descent and ascent will be faster. In this way, we think of reducing enormously the turn-around time so that the same pitches will carry 300 drains and loads at the same time. From a general point of view, we approach the problem not only of the airplane, but of air transport in general and for this reason we think that the project can have an important influence in the future air transport.

When will the production of the aircraft start?

What will happen of the production, it will start after the ending of the project. If everything goes right and the interest for the project grows, which means that we are good at convincing that this is an idea that could change the world of air transportation and the global economy, so in reasonable time the production can begin because it is only the idea to change, not the parts of the aircraft. However, it is uncertain. What we are sure is that we must always keep our feet on the ground and think of a rigorously scientific approach of what we do.

What were the most difficult situations to overcome during the development of the project?

The most difficult was to adequately involve all the partners with the same speed with which we operate here between Skybox and the University of Pisa, so that they use the same kind of approach and enthusiasm in dedication the right resources to do what they have promised. We make a web call every 15 days, and every 6 months we have meetings in the various locations. We also have an economic and scientific administration that helps to bring together the speeds of all partners and coordinates them to work as a team, which is the most complicated thing to do.

Ok, the last question: What will be the next step for the project?

It is the closure of the project with a ceremony both for the European community and for young people to make them understand the wealth that can derive from this opportunity. Moreover, I would like to build a flying scale model that will need to solve problems and uncertainties of flight mechanics and flight stability. In addition, the model will help us understand how to make fuel transfers efficient during the flight to improve the efficiency of the plane.

Thank you for this interview, Professor Frediani!

Thank you too, for so little.

Photo credits: NASA

Interview to Giulio AUTELITANO

ABOUT THE INTERVIEWEE:
Giulio AUTELITANO

Giulio Autelitano is currently the Coordinator of the Company Relations Working Group in EUROAVIA and he agreed to chat about his studies, his personal achievements such as securing an internship at NASA's Jet Propulsion Laboratory and his thoughts towards EUROAVIA.

Interview by Alejandra Gonzalez Valido

For those who don't know you, can you tell us who Giulio Autelitano is?

I am currently studying the Aerospace Master in Pisa. I define myself as an absolute EUROAVIA believer because I really share its mission and the European feeling. When I got to know EUROAVIA, I found there an opportunity to strengthen relationships between European citizens and share different cultures. Since I was very young I was linked to different cultures because I lived 6 years abroad: 3 in Oviedo, Spain; and other three in Paris, which allowed me to learn both Spanish and French.
I am a curious person, always ready to embrace all the feelings that life could offer. I was as well movie director, which gave me creative skills and taught me how to manage a team. Competing fencing since I was young allowed me to learn how to cope with anxiety. It was very mentally demanding, and thanks to that I developed the necessary skills to be structured as well.

When did your passion for Aeronautics and Space begin?

When I was very young: with 6 years I used to travel a lot to Spain and France. Flying seemed to me something magical, and I wanted to maintain that magic in my studies, so I decided to join aeronautics.

Can you tell us a little about your academic and professional background?

I did the scientific high school, moved then to the aerospace bachelor and right now, as I've said, I'm doing the master in aeronautics. During my second year of the bachelor's degree, I participated in an exchange programme in Illinois. I spent there two months, time in which I did two exams: the English Proficiency, and the other one of Nuclear and Radiological engineering. I've been as well the aerospace students' representative since 2015 until 2018. I wanted to take responsibilities and to make an impact on my course by helping my colleagues with their problems. I had a good experience holding this position. In 2016 I participated in a Business game. There were two days in which selected students tried to solve real problems which are proposed by the companies that participate. Companies evaluate the work of the teams, and the best ones earn some points. I got the third place. It was very demanding, a real working experience. We had to deliver creative solutions to the problems, to

think out of the box. I really recommend it to everyone, you meet a lot of ambitious and skill-talented people.
I did an internship at the JPL in Pasadena, Los Angeles, for 5 months (September 2018 – February 2019). I sent an email with my CV to a professor of the MIT because I wanted to spend a period in the laboratory, but he resent it to the JPL. They called him back with an interview offer, and he resent that to me. It was very emotionally and intense when I saw the NASA logo on the email and I realised I had the opportunity to have an interview with the JPL. After three weeks, I received an email which said that I was accepted for the internship. It was one of the most powerful emotions of my life, I cried a lot once I read it. I stopped my studies here, spent five months there and returned to them once I came back.

Can you explain to us how is to work at the JPL? What did you feel when you receive the news that you were moving to California?

The first day you arrive and see the NASA logo is a big emotion, you never expect to be there, is very emotional. Then I met the supervisor and found a very good atmosphere to work. The building is inside nature, you can even see deers there, is a green environment. The people there are very kind, which creates a friendly environment that improves productivity. Is not something stressful and your creativity is valued. You're not afraid to propose crazy ideas or to speak. I didn't meet only colleagues, but friends.
They encouraged me to get out of the box. The field I was on wasn't the one I was studying: I'm on aeronautics and I worked on robotics. You have to give the robot the perception of the surrounding environment, it has to understand exactly the position and orientation and then act autonomously. My robot implemented algorithms that could use this perception so that the robot moved in autonomy. The experience was great and the place where you are, allows you to propose your idea, work on it and put it in practice. You go to work with a smile on the face because you're doing something that you love. Working with a smile is the best thing.
On the social part, Los Angeles has a lot of attraction and opportunities. I found a lot of friends with whom I had a good time there. One of the greatest parts of the experience was the fact that my group of friends, which was exclusively from work, came from the 5 different continents, from all over the world; so I interacted with different cultures.

What is your current occupation, and which are your perspectives for the future?

Right now, I'm finishing my master's degree in Pisa. This fall I want to do a scholarship of excellence with the Italian Space Agency. There I will decide if I continue studying starting a PhD or I start working.

Based on your life experience, do you recommend a student to enrich its knowledge in specific topics or to enlarge the culture in many fields in order to get its first job?

I've never had a job, but I want to try to shape a T skills profile. That means to go deep in one topic (vertical part) and develop all the skills complementary to the studies (horizontal part) and more demanding ones so you don't miss things. My topic is about fluid dynamics because my master is focused on that, but I want to learn about other studies fields.

In your opinion, how do companies and universities evaluate extracurricular activities, like EUROAVIA, in comparison to the academic path in a job interview?

For the moment, I don't have any doubt: people who are engaged in extracurricular activities show that they have interests and that they are ambitious. They try to prove themselves and give a contribution, deliver something. Doing anything else apart from studying requires a lot of effort and exposes a huge learning desire. From an external view, you demonstrate that you want to do things, more that you are supposed to do, going out of your comfort zone improving and challenging yourself; that you don't relax on the standard part. As a personal advice, we don't have to be afraid of receiving a no. Don't stop yourself because of that, the no is always a possibility and that scares us, but if we don't try, we will never receive something. Fight for a yes and try, it's better to lose than never try. And don't put yourself a limit, surpass it.

How was your first approach to EUROAVIA? What did you feel in your first International Event?

I started as a local member in Pisa and later collaborated organizing the Space-Up event held by AS Pisa in 2018. EUROAVIA helps you to deliver more than what the university provides you, and in all the activities that it organizes you get to know a lot of new people, which makes you a better person by confronting different opinions and different cultures. My first International Event was the EMEAC in Istanbul in 2017. There, I understood how big and well-structured was EUROAVIA, and how important were its actions. I felt part of a great project with a great mission and had a lot of satisfaction for completing those demanding days of event where we worked a lot, with the important feeling of giving my contribution to EUROAVIA.

Have you been in any working group before CR WG? What you stand out from your time there?

No, just in the CR, which I joined on September 2017. Being the coordinator can give you a great chance to see your limits because you take on yourself all the responsibility of the results. You get a deep understanding of how a team works, and it's satisfying to see that your organisation does real effects on the teamwork. I

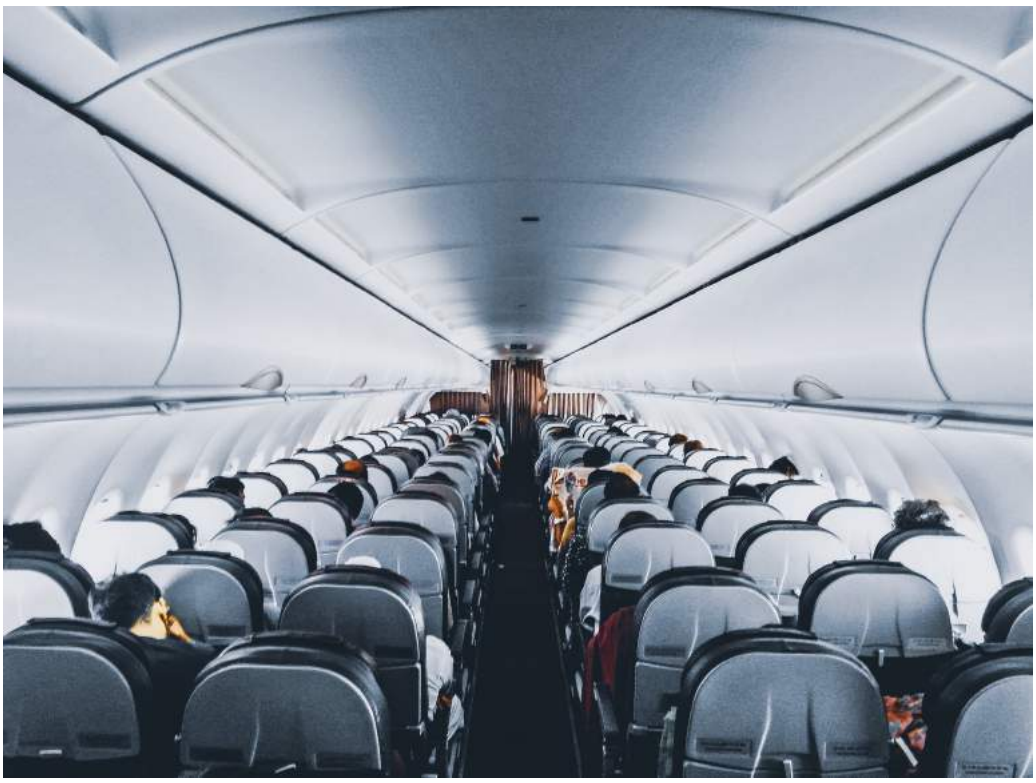
had the pleasure of working with people from different countries and run projects of different things. Being the responsible of a WG where people deliver their complete effort, gives you the sensation that you can not disappoint your colleagues. You have to take care of being efficient on Skype because is straight more difficult than in person; keep the engagement level high, develop the ideas that members can propose and keep the projects going. During my period inside the WG, I had the privilege of getting in contact with companies like Lilium and talking with international officers on behalf of EUROAVIA. Connecting with great companies like that one can really benefit EUROAVIA in the future because it shapes the direction in which the association should go.

What do you think is the key to success for EUROVIA and for EUROAVIAns?

EUROAVIA is really developing a European community. We should feel privileged because we are taking part in this European network, responsible for putting people from different countries and cultures in contact. We should put equal effort on social events, for the connection and development of this European feeling. Also, companies should see EUROAVIA as a place to select talents. We are developing skills where European companies can choose. From the Company Relations WG, we are working to obtain digital competences so that we deliver the image of EUROAVIA being an association where the greatest talents are. I would like the name of EUROAVIA to be a talent enhancer, a great opportunity of recruitment for the European companies. Because in EUROAVIA, those branches, the talented and social that promotes the European feeling, are together.

Thank you, Giulio.

Articles from EUROAVIANs



In this section, you will read two articles written by EUROAVIANs for EUROAVIANs. The first one deals with the hybrid propellant rocket project of EUROAVIA LPU, the first local chapter of the association in India. The second one, written by Andrei Mihai Bota, concerns the feasibility of the forward swept wing technology and the interesting story behind it.

EUROAVIA LPU starts India's first student hybrid rocket project

EUROAVIA LPU is a recently founded member of EUROAVIA in Lovely Professional University, India. In their monstrous campus larger than 600 acres, they have been working hard to involve more and more students of which a major portion are Aerospace Engineering students in their activities. They started with a simple workshop on reciprocating engines and a guest lecture. To boost up the involvement of their members in real applications of concepts, the senior members Suraj Patil, Rajat Kulkarni, Shubham Padekar and Adharsh Unni have introduced a goal of building a Hybrid Propellant Rocket with propulsive landing capabilities. This ambitious project is running in parallel with several events being held by the organization in their campus.

The main attraction of the hybrid propellant rocket is going to be its Para-Peroxide Engine, the design being led by Rajat Kulkarni and Adharsh Unni An engine powered by paraffin wax and hydrogen peroxide. The selection of the fuel can be traced to the properties of paraffin wax. It liquefies before vaporizing and combusting. This leads to a higher regression rate of the fuel which further leads to more acceptable oxidizer to fuel ratios. Oxidizer to fuel ratios are a major issue in development of hybrid propellant rockets. Low regression rates cause very high oxidizer content in the exhaust which leads to nozzle erosion and unstable combustion. Another interesting feature of this engine shall be the ignition system. In concept, they have planned to ignite the engine from the decomposition of hydrogen peroxide. A pre-combustion chamber that houses a catalyst bed to cause the decomposition releasing a huge amount of heat resulting in a temperature in excess of 800K which is well beyond the ignition temperature of the fuel. This ignition system also allows them to start and stop the engine simply by controlling the oxidizer flow. The first iteration of the engine is being designed to develop a thrust of 1.5kN with a specific impulse close to 220 seconds.

The Aerodynamics and Structures team is led by Suraj Patil and Shubham, Suraj has been part of a team that participated and won the STEM Award at NASA Human Exploration Rover Challenge (NHERC) and during design of the rover. He has patent on his name. He shares the Patent with the Mentor of the team and with Lovely Professional University. In addition to this, Suraj has participated in and won several Awards at competitions all over the country involving Aeromodelling and Aerostructures. Shubham has been part of a nanosatellite project as a member of the Thermal Control System team during which he has gained a considerable amount of experience in the field of Finite Element Analysis and Computational Fluid Dynamics both of which are essential to any project in the Aerospace domain. The Nose Cone shall effectively have the Von- Karman Ogive Nose Cone Design, which mostly used in the rockets and missile. The Recovery mechanism shall be implemented by the application of the parachute. The Nose cone design shall provide a low Drag coefficient value.

The rocket is being designed to reach a target altitude of five thousand feet. Though not a very high target, actual flight path prediction and control is not going to be an easy task. Because they aim to recover the rocket using a propulsive landing system, it is essential for them to have a robust and precise Attitude Control System or ACS to maintain a vertical orientation during descent. The current ACS they have conceptualized has an integrated GPS, Gyro and Accelerometer that can measure the acceleration and rotational rates with a stunning speed and accuracy. Aerodynamic control surfaces and attitude control thrusters are to maintain the attitude of the vehicle These devices coupled with a strong flight computer might make this team the first to actually land their rocket like massive space companies in the launch industry are doing. This concept of the ACS comes from the experience of Propulsion Lead Rajat Kulkarni in a different project involving working with an Attitude Control System.

Before performing a static fire test of the engine, the propulsion team is planning to perform a Propellant Test to measure the burn rate of the propellant before moving ahead with the combustion chamber design. The design of the Test rig is underway and they are to move ahead with the fabrication once the test rig is approved by their guide. Once the data is collected, they aim to move ahead with the fabrication and static test of the engine to test for reignition, restart capability and for thrust measurement. Because the facility for static fire test is not available at their institution, the team is approaching the Indian Institute of Technology to allow for the test to performed at their facility.
The team currently has support from SpaceCAD in the form of an in-kind sponsorship as the company gave licenses to the team for their software that allows to predict a flight path of model rockets. They are grateful to SpaceCAD for this support.
Since the current team has somewhat less of an experience in the field of electronics, they are planning to recruit a number of technically sound students from the field to help with further development of the vehicle. Additionally, a certain number of students from Mathematics are to be recruited to help develop the attitude control algorithm who are to work with the electronics team to write the algorithm in a code for the flight computer to understand.
The team are calling their rocket Peregrine. It is named after the fastest living creature on the planet, the Peregrine falcon. They have selected a deadline of one year for the first launch and landing of the rocket which puts the first attempt around spring of 2020.

About the Author:
EUROAVIA LPU

EUROAVIA LPU is the first local group of EUROAVIA in India. The local group joined the association as a Prospective Adjoint Member in October 2018 during the AMEAC Bremen. EUROAVIA LPU is based at the Lovely Professional University in Jalandhar, India.

The forgotten Forward Swept Wing technology

Introduction

After the successful flight of the Wright brothers in 1903, the field of aeronautics experienced "a marvellous technological boom". Therefore, nowadays state of the art technologies(you might think that some of them are some Bollywood Designs) available to design aircraft that meet our requirements. On the other hand, technological developments are continuously researched to overcome the aeronautical challenges, such as reducing drag and increasing lift, improving range and reducing fuel consumption. One from these technologies is the case of forward swept wings (FSW), some of the advantages of the aircraft incorporating this technology are high manoeuvrability and controllability, significant drag reduction for the transonic speed range and enhanced aerodynamics.

Figure 1: Illustration of Junkers Ju287 [10]

The benefits of FSWs have long been understood. As the Germans built in 1943 the first experimental aircraft featuring forward swept wings being capable to exceed Mach 0.8. Since the phase of the design concept, the Junkers team understood from the available information on wing sweep the Ju 287 would gain convenient low-speed characteristics. The wind tunnel results performed by the Germans proved the theorised characteristics of the aircraft. However, the results unveiled a stumbling block; that is, "the wing structure was prone to potentially disastrous twisting loads lifting the leading edge of the tips at higher speeds"[1]. Shortly before the end of the war, the aircraft completed 17 flights and validated the slow-speed benefits of the wing plan-form and the nature of flow separation at high angles of attack (leaving the outer panels with attached airflow after the inboard airflow was degraded"[1]. The structural and control impediments would remain for the immediate post-war era to be solved.

Besides, the FSW had also a bright side but perhaps the most successful incarnation was the German HFB 320 Hansa jet transport (see Figure 4)). The moderately FSW planform of the Hansa business jet reflected the structural constraints of incorporating an FSW planform constructed of the conventional metal structure. Even so, the aircraft was intended to have low drag, speed and a range of 800 km/h, and 2,600 km. Additionally, it enabled an unobstructed cabin, an important consideration for passenger comfort. Traditional straight or rear swept wing design would have either necessitated wing spar location in the cabin area to the detriment of passenger accommodations or, possibly, a larger diameter fuselage, which would add to drag and weight. The Hansa's forward swept wing placed the wing-fuselage juncture aft of the main passenger cabin, allowing smaller dimensions that yielded better performance the use of a smaller horizontal tail than a traditional plan view would call for, and this further reduced drag. Teardrop wingtip tanks projecting well ahead of the wing on the Hansa helped tame wing twisting and bending [2].

A novel solution

Meanwhile, the Americans researched FSW technology on their own. Several experiments were per-

formed on gliders and later the famed P-51 Mustang fighter design. In the immediate post-war era, this technology was implemented on high-speed research aircraft, such as the illustrious Bell XS-1 (first aircraft to break the sound barrier). The results obtained by the Americans matched with the ones obtained by the Germans. Afterwards, the Soviets and the Americans worked out the hurdles of the puzzling FSW technology.

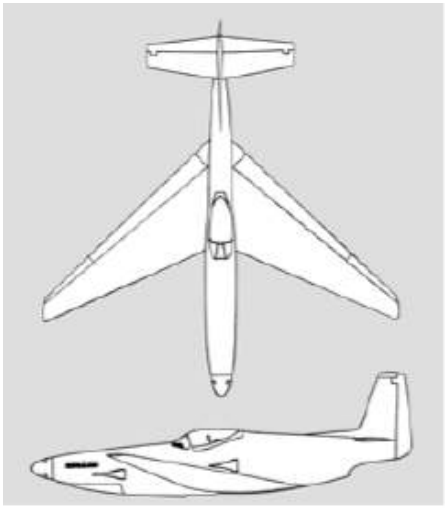


Figure 2: FSW derivative of the P-51 Mustang [1].

More specifically, the Americans developed the X-29 (see Figure 3) an experimental lightweight aeroplane. The X-29 used several components from other aircraft such as the fuselage from the Northrop F-5A, the main undercarriage and other equipment from the F-16, and the engine from the F/A-18. Its wings were made of composite materials and it was equipped with canards [4]. "The X-29's FSWs were mounted well back on the fuselage, while its canards were in front of the wings instead of on the tail. The complex geometries of the wings and canards combined to provide exceptional manoeuvrability, supersonic performance and a light structure" [5]. However, during the late '80s the Soviets developed a similar aircraft the SU-47 illustrated in Figure 3). Unfortunately, the aeroplane's documentation is briefly presented in the available literature.

"Air moving over the forward-swept wings tended to flow inward toward the root of the wing instead of outward toward the wing tip as occurs on an aft-swept wing. This reverse airflow kept the wing tips and their ailerons from stalling at high angles of attack" [5]. "At high speed, the air passing over conventional aft-swept wings tends to flow out to the wingtips, a phenomenon called spanwise flow. The air piles up near the wingtips and makes the ailerons ineffective, so designers install wing fences and use several tricks to block this flow. Sweep the wings forward and the air flows in toward the fuselage". [6] Problem solved.

Why composite wings?

Firstly, "FSWs also allows the spar box, to which the wings are anchored in the fuselage, to be located farther aft, where it's out of the way of the cabin or a pressure bulkhead; that's good. But few aeroplanes have been built with a forward sweep. This is because forward sweep also has a disadvantage" [6].
Secondly, it is well known that the lift force acting on a wing will tend to bend it upwards. What is less well-known is that this lift force can also cause the wing to twist, which is quite bad. "This is because the centre of pressure is not necessarily coincident with the shear centre, the point through which a bending load needs to be applied to get pure bending without any twisting" [7].
"The Grumman X-29 is an excellent example for the early mentioned problem. Rather than adding more material to the wing to make it stiffer (but also heavier) an alternative solution is to use the bend-twist coupling capability of composite laminates. This capability is an example of elastic tailoring and remains one of the most under-exploited advantages of composite materials" [7]. "The layers of composite fibres were tailored so that as the tips bent upward, the wing's leading edge twisted down, countering the nasty tendency of the wing to diverge and fail" [6].
The wings used 752 crisscrossed composite tapes building up to a maximum thickness of 156 layers to create the top and bottom surfaces of the wing's torsion box. The lightweight strength of these composites enabled a practical timing of the divergence problem that thwarted earlier notions of high-speed FSW designs. The X-29's designers were emboldened by the inherent strength of the aeroelastically tailored wing construction to employ a thin supercritical wing airfoil. The supercritical wing was one of several aerodynamic breakthroughs fostered by NASA's prolific Richard T. Whitcomb. The supercritical airfoil shape delays the onset of transonic shock waves on the upper surface of a wing. Since these shock waves increase drag and decrease lift, their minimization with a supercritical wing increases the efficiencies of that wing in the transonic speed range [1].

Figure 4: HFB 320 Hansa jet transport [9].

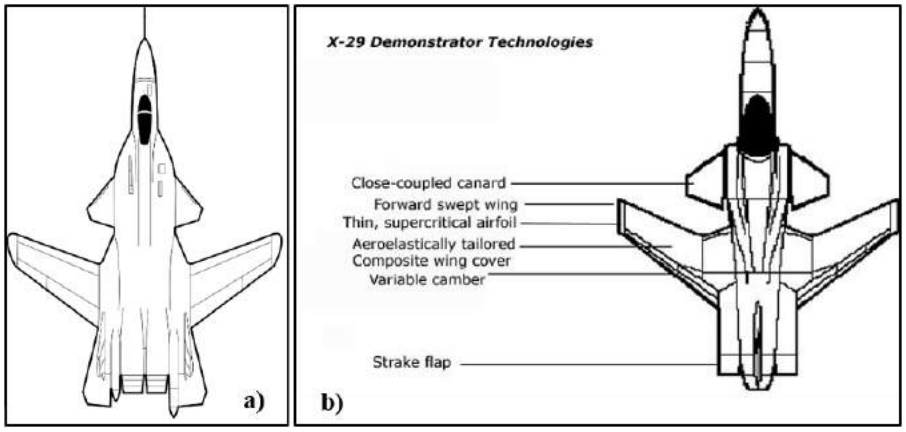
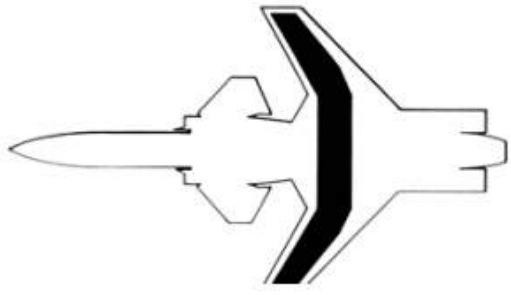


Figure 3: Illustration of: a) SU-47(Russia); b) X-29 (USA) aircraft [3].

Taming the beast

According to the statements made by NASA's project pilots, "the X-29 aircraft had excellent control response to 45 degrees angle of attack and still had limited controllability at 67 degrees angle of attack. This controllability at high angles of attack can be attributed to the aircraft's unique forward-swept wing and canard design. The NASA/Air Force-designed high-gain flight control laws also contributed to good flying qualities" [5]. "The X-29 also had a forward control surface, a canard, which rendered the aeroplane completely unstable. No human pilot could manage it without help, which came in the form of three computers that constantly adjusted the control surfaces" [6]. It happened so fast (about 25 ms) that the aeroplane appeared to have a bad case of coffee nerves, but it felt stable. Why three computers? If one malfunctioned, it was outvoted by the other two.

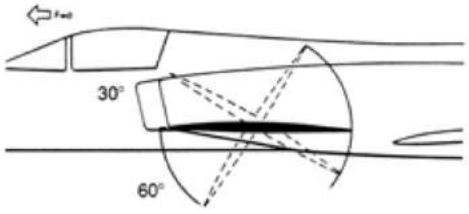


The X-29 Wing Torsion Box; robust composite construction ensured it had sufficient rigidity to withstand aeroelastic divergence. (NASA)

Figure 5: X-29's Wing Torsion Box.

Aerodynamics at its finest

Simply put, wing sweep delays the formation of shock waves over the wings; that is, it reduces the associated rise in aerodynamic drag. The major cause of the increased aerodynamic drag is due to the flow separation close to the wing surface. Staying in the same context, FSW compels the air to flow inwards towards the fuselage. Therefore, wingtip vortexes and the accompanying drag are reduced. In Figure 7 is illustrated how these vortexes are developed; thus, they form when the higher-pressure air underneath the wing is sucked up onto the lower pressure top surface of the wing, thereby reducing the effective lift-generating surface of the wing. Consequently, this phenomenon is stopped from occurring, due to the winglets and sharklets fitted on nowadays aircraft. Similarly, FSWs are reducing this effect by re-routing some of the air flow towards the wing root; hence, a smaller wing can be used and keeping an identical lift performance. The second advantage of FSWs is that the risk of tip stall is reduced; thus, the shockwaves are disposed to develop first at the wing's root, rather than towards the tips. In general, ailerons are located near the tips of the wings, because of the further outboard, the greater their effect on controlling the rolling action of the plane. Tip stall essentially makes these ailerons obsolete and therefore jeopardises the control of the pilot over the aircraft.



Range of motion of the X-29's canard control surfaces, from +30 degrees leading edge up to –60 degrees leading edge down. (NASA)

Figure 6: Depiction of the X-29's canard [1].

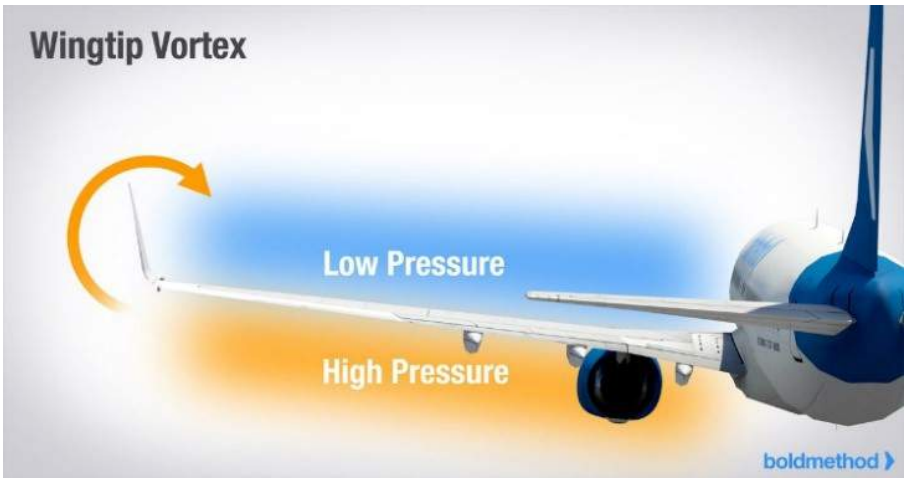


Figure 7: How wing tip vortexes are formed [12].

"The forward swept wing allows these fighters to have higher manoeuvrability with a smaller stall speed, provides spin proof characteristics and reduced drag at transonic speeds. As the majority of the dog fights occur at subsonic speeds, the FSW characteristics make a nearly perfect dogfighter. Given the current operational tempo, a modern air superiority fighter should be capable of destroying an enemy opponent without having to engage in a dog fight as well as destroy multiple ground targets" [8].

Conclusion

Finally, the FSWs paraded to be a novel solution for aircraft design. These aircraft did not demonstrate the overall reduction in aerodynamic drag that earlier studies had suggested. Instead, the programs of these aircraft exhibited numerous new technologies, as well as new uses of proven technologies including aeroelastic tailoring to control structural divergence and use of a relatively large, close-coupled canard for longitudinal control. Also, the program validated control of an aircraft with extreme instability while still providing good handling qualities; use of three-surface longitudinal control; use of a double-hinged trailing-edge flaperon at supersonic speeds; control effectiveness at high angles of attack; vortex control; and military utility of the overall design. It is clear that aircraft incorporating forward swept wing technology were lightweight speedsters geared for the test environment, not operational military service [5].

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Andrei Mihai Bota is an aerodynamics enthusiast. Aircraft always sparked his curiosity in finding answers to questions such "why" and "how". The first step in finding answers to his questions was to enrol into AS Cluj-Napoca where he met other aviation enthusiasts who represented for him a second home and a family.

Space Tech Expo Europe

SPACE TECH EXPO
EUROPE

Space Tech Expo Europe lands in Bremen, Germany on 19-21 November with a jam-packed exhibition programme and carefully curated conference agenda tailored to inform, inspire and champion invaluable professional engagement. Free-to-attend, Space Tech Expo Europe showcases the latest space tech solutions and offers expert insights from technical designers, sub-system suppliers, component manufacturers and systems integrators for civil, military and commercial space.

400+ exhibitors include:
ArianeGroup, Airbus, Skyrora, Mynaric, Element,
PLD Space, SLR, Exolaunch, ISIS - Innovative Solutions In Space

Across three days, more than 400 specialist suppliers will present their innovations to more than 4,500 attendees – including industry leaders, decision makers and buyers. Discover game-changing 3D-printing technology from Additive Space, learn about the European Space Agency's latest activities, and find out how SkyLabs is developing miniaturised onboard data-handling solutions, all featured among hundreds of other exhibitors on the show floor.

The largest event of its kind for the space supply chain, Space Tech Expo Europe is a chance to engage face-to-face with current and prospective customers, as well as potential partners. It also marks a unique opportunity to stay ahead of the curve by optimising your products with cutting-edge testing solutions, as this year, testing is in the spotlight.

The focus comes as the space tech industry continues to grow exponentially – the global launch services market is set to hit $27.18 billion by 2025, while smallsats are forecast to reach $22 billion. Combined, rapid space technology expansion is creating huge demand for testing solutions.
The event has an expanded format for 2019. An additional exhibition hall is dedicated to smallsats, while the free-to-attend conference programme now features three separate conferences. The Industry Conference explores industry coaction, how to improve inter-satellite communications and deep-dives into everything from LEO commercialisation to human settlement in space. The Technology Conference includes spotlight sessions on startups and workshops on the launch vehicles of the future and next-generation satellites. The Smallsats Conference covers forecasts, challenges and opportunities in the smallsats market, considering how to break through the bottleneck barrier and highlighting future requirements from end-user verticals. Experts from ESA, EXOLAUNCH, Rocket Lab, ThrustMe and Earth-I are among the conference speakers.

Conference

Space Tech Conference Europe offers a comprehensive agenda across three tracks – the Industry Conference, Technology Conference and Smallsats Conference – all designed to inform and inspire, with a host of trailblazers and thought-leaders billed to take the stage. The free-to-attend conferences bring together professionals in the space industry working in Europe and beyond to discuss current trends, developments and challenges in the market, as well as groundbreaking technologies and testing solutions.

The conferences are tailored for engineers, manufacturers and decision-makers at commercial, (aero)space and defence organisations, start-ups and Europe's space agencies, as well as industry professionals from similar companies and organisations based around the world – making it a great opportunity to network with international peers. Featured speakers across all three conferences include: Jan Woerner – Director-General at ESA; Agnieszka Lukaszczyk – Senior Director of European Affairs at Planet; Dr. Sandy Tirtey – Launch Director at Rocket Lab; Ane Aanesland – CEO at ThrustMe; Pascale Ehrenfreund – Chair of the Executive Board, DLR; and Jean-Yves Le Gall, President at CNES and Chair of the ESA Council, among many others. Together, this line-up of industry trailblazers promises exciting, educational discussion and debate – essential content for those looking to push ahead in these fast-growing space segments.

New for 2019: Smallsats

Each year, Space Tech Expo Europe evolves and grows with new elements built around industry developments, attendee feedback and innovations in space technologies. This year is no different: the all-new Smallsats at Space Tech Expo Europe is a dedicated exhibition and conference programme specially designed for those working on Smallsats applications. Discover Smallsats solutions from suppliers including ISIS, PLD Space, Skyrora, Hyperion Technologies and Open Cosmos. At the conference, get the latest on growth and opportunity areas, technology developments, downstream end-user requirements and the state of the small launch-vehicle market as experts from Airbus Defence and Space, Vector Launch and ICEYE take the stage.

Space Tech Expo Europe (19 – 21 November 2019, Bremen, Germany) is free to attend. Find out more and register for your free pass with the following QR code.

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Abbreviations

AS	Affiliated Society
WG	Working Group
FoWo	Formation Workshop
AMEAC	Annual Meeting of the EUROAVIA Congress
EMEAC	Electoral Meeting of the EUROAVIA Congress
IB	International Board
PAS	Prospective Affiliated Society
RoWo	Rocket Workshop

AS Aachen
AS Ankara
AS Athens
PAS Beograd
AS Berlin
PAS Bordeaux
AS Braunschweig
AS Bremen
AS Bucureşti
AS Cádiz
AS Carlow
AS Cluj-Napoca
AS Covilhã
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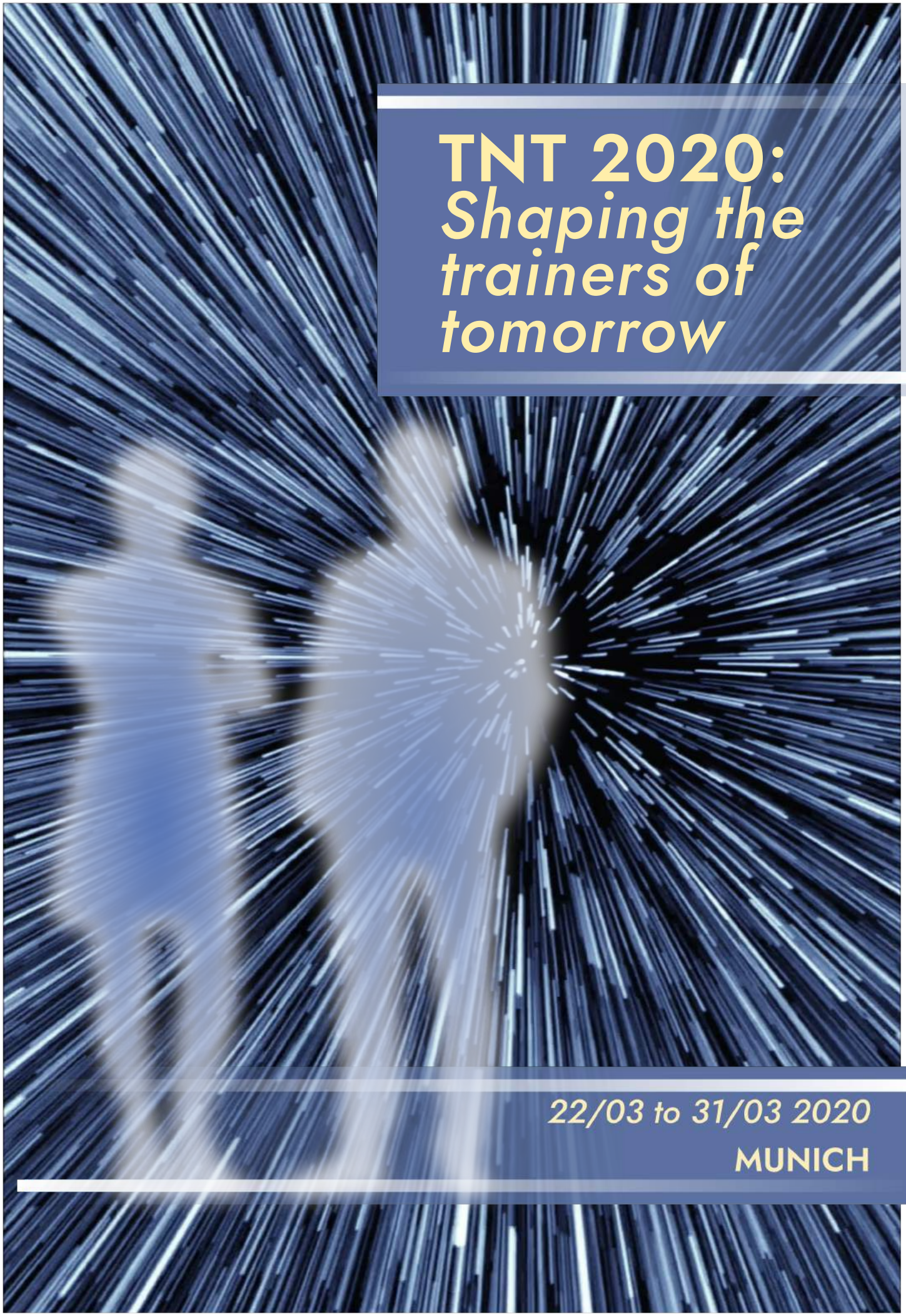
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