ASCenSIon Innovative Training Network: mid-term overview and lessons learned

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Abstract

The field of access to space is wide and complex, and it involves several disciplines and areas of expertise such as propulsion physics, software development, experimental studies, numerical simulations, thermodynamics, missionisation, etc. A gap in the training of young European researchers at doctoral level has been identified in this field, as no high-level education programme exists with the ability to range across such a large range of research topics. With the aim to fill this gap, 24 European entities from academia, industry and research centers have partnered in the framework of "ASCenSIon", an Innovative Training Network funded by the European Commission within the Horizon 2020 Marie Skłodowska Curie Action. The objective of the project is to contribute to the establishment of a both ecologically and economically sustainable space access for Europe, therefore advancing its State of the Art. This is achieved by training 15 Early Stage Researchers of different background, nationality, gender and age, to become experts in their fields and to have a deep understanding of the access to space domain as a whole. Within ASCenSIon, the Early Stage Researchers, who are enrolled in a PhD programme, acquire both technical and transferable skills thanks to an inclusive and diverse training programme held at local and project level. Unlike more ordinary PhDs, the training offered by ASCenSIon does not only focus on narrow scopes of research fields, one domain (e.g. industry or academia) and one country. It features instead an interdisciplinary, intersectoral and multicultural approach. The offer includes training events in different forms, such as workshops, lectures, experimental weeks and summer schools, which are complemented by the participation in conferences and similar events. Given that the project started in January 2020 and will end in December 2023, this paper provides a midterm overview of the project and the lessons learned so far, with a particular focus on the remote vs in-person training experience forced by the Covid-19 pandemic outbreak.

Keywords

Access to Space, Innovative Training Network, Interdisciplinarity, PhD, Training

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Acronyms/Abbreviations

ESR	*Early Stage Researcher*
GNC	*Guidance, Navigation and Control*
ITN	*Innovative Training Network*
IRP	*Individual Research Project*
RLV	*Reusable Launch Vehicle*
SOTA	*State Of The Art*

1. Introduction

Innovative Training Networks (ITNs) are high-quality, highly-demanding projects funded by the European Commission which aim at raising excellence and structure research and doctoral training in Europe. This is achieved by training a new generation of creative, entrepreneurial and innovative early-stage researchers, able to face current and future challenges and to convert knowledge and ideas into product and services for economic and social benefit [1]. ITNs are expected to have a certain level of impact at researcher, organisation and system level and are characterised by some common aspects, such as: enabling join research training and/or doctoral programmes, enhancing exposure to different participating organisations, addressing both technical and transferable skills, fostering Open Science, increasing the international, interdisciplinary and intersectoral mobility of researchers in Europe [1].

ASCenSIon is an ITN that has received funding from the European Commission within the Horizon 2020's Marie Slodowska-Curie action; it started in January 2020 and ends in December 2023, for a total duration of 48 months. Following ITNs' core objectives, it introduces a research and training programme aimed at developing a generation of researchers who are expected to bring technical, economical and ecological improvements to the State Of The Art (SOTA) of access to space in Europe.

The need for such a training programme at doctoral level becomes evident when analysing in detail the current space market trends: with companies such as SpaceX and Blue Origin leading the change towards Reusable Launch Vehicles (RLVs), the access to space field is clearly undergoing a transformation. In addition, the participation of other ambitious nations like United States, India, New Zealand and China is increasing the pressure and competition on Europe, which risks to fall behind. To keep up with this change, Europe surely needs short-term innovations, but also young professionals able to understand the complexity of field of launcher development as a whole. The changing access to space field raises a series of challenges that the new generation of engineers needs to be able to tackle in its wider context and not only as launch vehicles and operations [2]. With its research and training programme, ASCenSIon addresses exactly this gap, and presents itself as the only doctoral training programme at European level aiming to address the access to space field as a whole.

2. ASCenSIon

ASCenSIon acronym stands for "Advancing Space Access Capabilities - Reusability and Multiple Payload Injection", and it describes the project objective to contribute to the establishment of an economically and ecologically sustainable access to space for Europe. ASCenSIon aims to fulfil it by forming a new generation of researchers with both scientific and soft skills through a dedicated network-wide research and training programme which empowers and prepares them to become leaders in the space transportation sector in Europe. The Early Stage Researchers (ESRs) employed within the project are 15 in total and are enrolled in a PhD programme in different European partners. Within their research they focus on launcher systems that are (partially) reusable and able to inject multiple payloads into multiple orbits. This, while keeping in mind the commercial applications and the needs of the users and the fast-evolving space market. The scope of the project is not to focus on one unique RLV design, but to identify and enhance technologies and solutions which are critical for the space access domain and prove their feasibility.

The approach is highly interdisciplinary and intersectoral, and it relies on the active participation of the entire project consortium. With such an approach, ASCenSIon aims to set the baseline for future collaborations in Europe and bring together professionals who are experts in their fields, underlying the importance for European entities to work together.

2.1. *The Consortium*

ASCenSIon consortium is a synergetic group of 25 European partners, which have been selected based on their expertise and prestige to well cover all the aspects of the access to

space domain and its market, from fundamental research to commercial applications. These entities include universities, small to mid-size enterprises, big companies and governmental research institutes, and they are further divided into: a) beneficiary partners, who are the host institutions of the ESRs, and into b) associated partners, who contribute to the project bringing knowledge and expertise and hosting the ESRs during their research stays (secondments). A full and updated list of the involved partners is available in the ASCenSIon website [3].

The core of the consortium are 15 Early Stage Researchers, who are talented young professionals that have been selected among 276 applicants from all over the world and that are employed within ASCenSIon for a total of 36 months. These 15 PhD students have different genres, backgrounds and nationalities, and have been selected based not only on their technical, but also on their soft skills and motivation to participate in such a highly-demanding project. Last but not least, the consortium also relies on the experience and knowledge of an Advisory Board, constituted by renowned world-wide experts. The Coordinator of ASCenSIon is Technische Universität Dresden (TUD), which is one of the German universities of excellence [4].

2.2. The research programme

ASCenSIon research programme focuses on the main research areas of launch vehicle design: 1) Propulsion technologies and their reusability; 2) Guidance, Navigation and Control (GNC); 3) Aerothermo-dynamics of re-entry and safe disposal. Sustainability is an underpinning factor, and it is considered, for example, in the study of green, environment-friendly propellants or in the safe disposal of space objects, as well as taking into consideration the space situational awareness. The three research areas identified above correspond also to the three technical work packages of the project, and each researcher addresses at least one of them. During the three years of involvement, each of the 15 researchers works on a specific Individual Research Project (IRP) which is highly interconnected with the other IRPs, with a synergetic and interdisciplinary approach. Following the project vision, the IRPs have been shaped to cover all the aspects of the access to space domain.

This synergetic approach exists not only between the PhD students, but also between the partners, and it is well depicted in Figure 1. The idea behind such a synergetic approach is to create a strong network within and outside the project, aimed to last longer after the project end. Within ASCenSIon this is facilitated by the intensive programme of training courses and network wide training events. The full list of the employed ESRs and their IRPs can be found in the paper “Advancing Space Access Capabilities For and By Early Stage Researchers” by Gloder et al. [5], as well as in the project website [3].

2.3. The training programme

Previous analyses of the access to space domain showed that a training programme for young researchers covering the whole field of space transportation, i.e. including fundamental aspects of propulsion physics, system design,

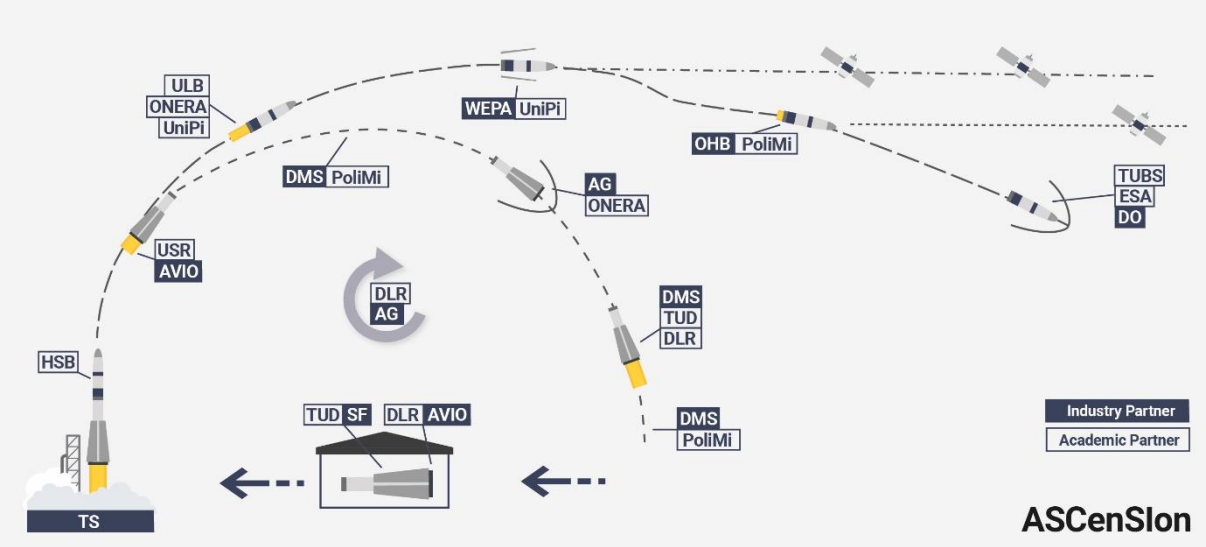

Figure 1: Synergies of the ASCenSIon consortium.

GNC, sustainability and reusability, is currently missing in Europe. Three other research training programmes for launcher systems have been identified in three countries addressed by ASCenSIon: the master in Space Transportation Systems (STS) at Sapienza University of Rome in Italy, the French "Project etudiant de recherché spatiale Européen universitaire et scientifique (PERSEUS), and the German programme "Studentische Experimental-Raketen" (STERN). Despite this, these three programmes address students at bachelor and master level, leaving ASCenSIon as the only doctoral programme in Europe that focuses and advances the field of space transportation.

The training of ASCenSIon goes beyond the more traditional PhD programmes that normally focus on one discipline, one domain and one country. It develops on two levels: a local programme, carried on by the institutions that host the PhD students and include the usual offers, and a network-wide training programme which aims at expanding the training of the ESRs with a structured, multicultural and multisectoral approach and introduces them to the whole launcher development field. These network-wide trainings are offered quarterly in the form of experimentation weeks, summer schools, workshops and conferences.

Moreover, the young researchers are expected to gain not only technical, but also transferable skills (for example on scientific communication and entrepreneurship). To complement the training, they experience at least two periods of secondments during their employment, one at an academic and one at an industrial partner. They are trained by experts from industry and academia and gain not only theorical, but also practical knowledge. A structured approach is maintained to ensure that all the ESRs get equal benefits during their training, as well as multi-partner supervision and access to unique research environments.

3. Mid-term overview on the training programme

Despite the structured approach of the training programme, the original plan for ASCenSIon had to be re-discussed and partially changed due to the outbreak of the worldwide Covid-19 pandemic. The real training programme of ASCenSIon started in January 2021 after the selection and employment of all the ESRs, so still in the middle of the crisis. Being ASCenSIon highly reliant on the mobility of both its researchers and supervisors within Europe, as all other ITNs, it was almost impossible to organise in-person events for the majority of 2021, due to the different safety and travel rules in place in the different countries and institutions involved. Consequently, the proposed network-wide events had to be switched online, and this required a quite different approach in terms of organisation, commitment and offer with respect to what was initially foreseen. Of course this partially affected the content and quality of the training and, in particular, some of the hands-on experiences had to be cancelled, as well as visits to partner institutions. Being highly reliant on the synergies between the involved people, starting such a complex and dynamic project without meeting in person indeed represented an additional challenge.

The main training events organised within ASCenSIon from its beginning until the date of delivery of this paper are: a kick-off event (January 2021), during which the ESRs and supervisors met each other virtually for the first time, were introduced to the project and received lectures on both technical and entrepreneurial aspects; a technical conference (June 2021), during which the main technical aspects of the research were discussed and presented to both associated partners and external experts; a training week (November 2021), which was the first in-person event of the project and took place in Politecnico di Milano (Italy), during which the ESRs experienced partner and lab visits, received lectures on both technical and soft skills, had the chance to directly interact with the project partners and work package leaders and receive feedbacks and suggestions on their research, and, last but not least, had the chance to gather together and get to know each other better. These major network-wide events were also integrated with other opportunities, such as the attendance of the lectures of the Master in Space Transportation Systems organised by Sapienza University, a dedicated special session at the AIDAA XXVI International Congress, the attendance of the DLR Summer School on space propulsion, as well as the participation in other conferences and events, such as the International Astronautical Congress (IAC) in Dubai in October 2021, or the dedicated workshop on Human Spaceflight Mission with astronaut Gerhard Thiele.

As a mid-term consideration, the authors of this paper, who are the Coordinator of the consortium, can say that overall it was possible to maintain quite satisfactory standards for the training, including a varied offer in terms of partner and expert participation, content, and format. Thanks to the softening of the safety rules in place during 2021, secondments could be organised almost in the initially foreseen

times, and only a few suffered delays, without having major impacts on the overall research programme. Despite this the authors are convinced that, for such a training programme, online events are a good alternative, but they certainly cannot fully substitute in-person events. Meeting in person is fundamental to keep up the quality of the proposed training, the motivation of the participants, their involvement and a fluent and efficient communication among the participants, which are all fundamental aspects for the well-being of a project and its synergy.

4. Lessons learned

Given that the project started in January 2020, this paper is written approximately in the middle of the project length, therefore allowing already the sharing of some lessons learned and some considerations.

First of all, while on one side a rigorous approach is needed for the fulfilment of the requested deliverables and tasks in such a large project with so many partners, it is important that all the involved people maintain an understanding and flexible attitude. This is fundamental to avoid discontent, the arising of misunderstandings and for the people to be able to work in a productive and stimulating environment. This does not apply only to interpersonal relationships, but also with respect to the planning and management of the project itself. The training offered by ASCenSIon is highly demanding for both the people who organise it and receive it, as it adds to all the tasks that the researchers carry on locally, and the matching of the two does not happen easily. The participation in conferences and events, the planned secondments and the availability of the involved partners also contribute to the need for a flexible approach with respect to the initial technical and training schedule, which therefore needs constant revision and adaptation. Overall, ASCenSIon requests quite an effort from all the involved people that needs to be taken into careful consideration.

A fundamental lesson learned by the authors is that a good planning of the risks and mitigation strategies can save a lot of problems in case one (or more) of these risks materializes; to the list of potential risks also high-impact, low-probability events such as worldwide pandemics, wars, etc should be included since the beginning, especially if a project lasts some years. A paper previously published by the authors [5] addressed for example the impact of the Covid-19 pandemic on the project, which in the case of ASCenSIon happened right at the beginning. Being the pandemic an unforeseen risk, its impact on the project was quite high, even though the implementation of timely mitigation strategies allowed to greatly reduce the collateral damages. Such an apparently afar risk, as well as others (e.g. a war), should therefore not be underestimated. A part from this, other foreseen risks materialized during the period of interested addressed by this paper (January 2020 – March 2022), such as the unexpected loss of key expertise/staff (due to the withdrawal of a beneficiary partner, for reasons not linked to the project), the withdrawal of an ESR (again, for external reasons), technical problems to achieve the research objectives, and delays in the recruitment of the ESRs (due to the outbreak of the pandemic). In these cases, proper mitigation strategies and timely interventions were fundamental to avoid the rise of bigger problems and allowed to tackle the issues before they escalated.

Another aspect of outmost importance is the careful selection of the partners and of motivated ESRs. For the project to achieve its final objectives, especially in the case of a synergetic project such as ASCenSIon, not only their prestige and good curricula are essential, but also their involvement, proactiveness and motivation for the entire duration of the project, as well as an open and efficient communication at all levels. The training programme relies in fact on the availability of the project partners to host and organise the events, while the research programme relies on the sharing of information, knowledge and best practises, as well as on the production of high-quality work and supervision. Unmotivated, unavailable and uncommunicative persons highly affect the whole structure of the project, and put at risk the achievement of its goal.

Conclusions

ASCenSIon is the only doctoral training programme in Europe that addresses the access to space field as a whole, setting a new standard. It addresses the field of space transportation with an interdisciplinary, multicultural and intersectoral approach, which highly relies on the synergy of the whole consortium.

It is a highly demanding project, in which factors such as risk mitigation strategies, partners' collaboration and involvement, timely communication and proactivity are essential for the project development and tracking, as well as for ensuring visibility and delivery of reports, deliverables and milestones.

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