The Quarterly Bulletin of the CEAS

COUNCIL OF EUROPEAN AEROSPACE SOCIETIES

3AF AIAE AIDAA AAAR CzAeS DGLR FTF HAES NVvL PSAA RAeS SVFW TsAGI

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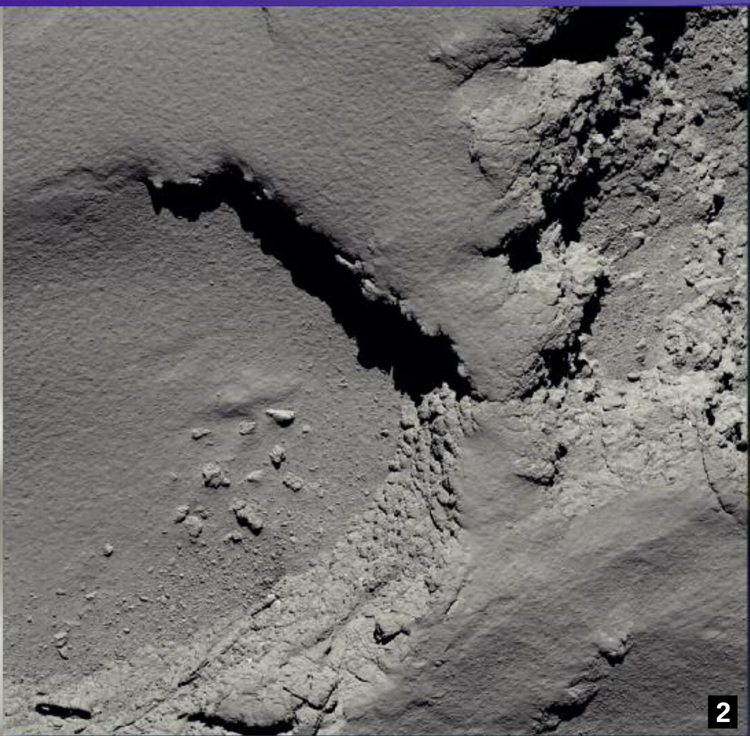
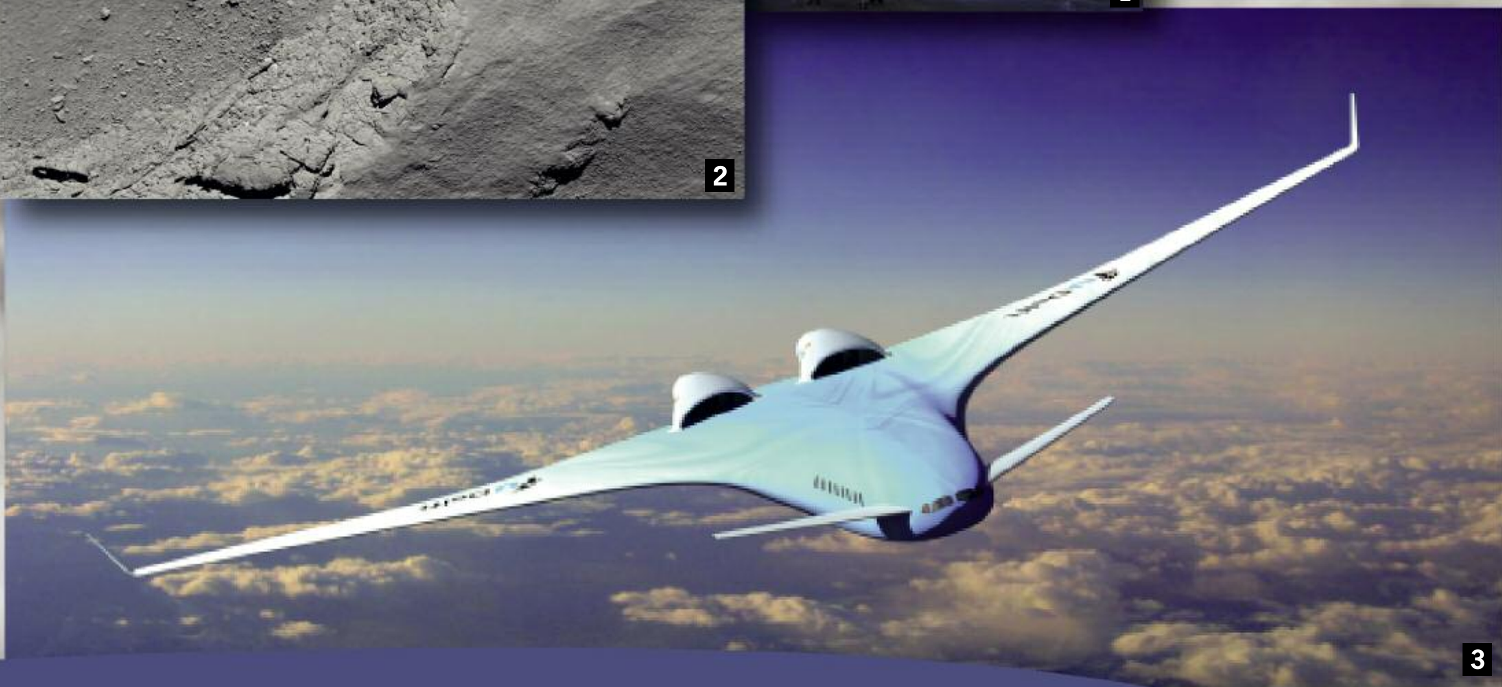
3rd Quarter





- **WILL AIR TRANSPORT BE FULLY AUTOMATED BY 2050?** 1
- **30 SEPTEMBER 2016: ROSETTA ENDS ITS LONG LIFE BESIDE ITS LANDER 'PHILAE' ON THE COMET 67P/CHURYUMOV-GERASIMENKO** 2

"Today we celebrate the success of a game-changing mission, one of that continues ESA's legacy of Firsts on the Comet"

Johann Dietrich Wörner, Director General of ESA

- **TRAINING THE NEXT GENERATION HIGHLY SKILLED FORCE AT DELFT UNIVERSITY OF TECHNOLOGY** 3

WHAT IS THE CEAS ?

The Council of European Aerospace Societies (CEAS) is an International Non-Profit Association, with the aim to develop a framework within which the major Aerospace Societies in Europe can work together.
It presently comprises thirteen Full Member Societies: 3AF (France), AIAE (Spain), AIDAA (Italy), AAAR (Romania), CzAeS (Czech Republic), DGLR (Germany), FTF (Sweden), HAES (Greece), NVvL (Netherlands), PSAA (Poland), RAeS (United Kingdom), SVFW (Switzerland), TsAGI (Russia); and six Corporate Members: ESA, EASA, EUROCONTROL, LAETA, VKI and EUROAVIA..
Following its establishment as a legal entity conferred under Belgium Law, this association began its operations on January 1st, 2007.
Its basic mission is to add value at a European level to the wide range of services provided by the constituent Member Societies, allowing for greater dialogue between the latter and the European institutions, governments, aerospace and defence industries and academia.
The CEAS is governed by a Board of Trustees, with representatives of each of the Member Societies.

Its Head Office is located in Belgium:
c/o DLR – Rue du Trône 98 – 1050 Brussels.
www.ceas.org

WHAT DOES CEAS OFFER YOU ?

Knowledge transfer:
- A well-found structure for Technical Committees

High-Level European Conferences:
- Technical pan-European events dealing with specific disciplines and the broader technical aspects
- The CEAS European Air and Space Conferences: every two years, a Technical oriented Conference, and alternating every two years also, a Public Policy & Strategy oriented Conference

Publications:
- Position/Discussion papers on key issues
- CEAS Aeronautical Journal
- CEAS Space Journal
- CEAS Quarterly Bulletin
- **Aerospace Event Calendar – http://www.aerospaceevents.eu**

Relationships at a European Level:
- European Commission
- European Parliament
- ASD (AeroSpace and Defence Industries Association of Europe), EASA (European Aviation Safety Agency), EDA (European Defence Agency), ESA (European Space Agency), EUROCONTROL
- Other European organisations

European Professional Recognition:
- Directory of European Professionals

Honours and Awards:
- Annual CEAS Gold Medal to recognize outstanding achievement
- Medals in technical areas to recognize achievement
- Distinguished Service Award

Young Professional Aerospace Forum

Sponsoring

THE CEAS MANAGEMENT BOARD

It is structured as follows:

- General Functions: President, Director General, Finance, External Relations & Publications, Awards and Membership.
- Two Technical Branches:
  - Aeronautics Branch
  - Space Branch

Each of these two Branches, composed of specialized Technical Committees, is placed under the authority of a dedicated Chairman.

The Officers of the Board in 2015:

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EDITORIAL

INNOVATION IN AEROSPACE

Jean-Pierre Sanfourche
Editor-in-Chief,
CEAS Quarterly Bulletin

Innovation is today the basic key for ensuring the successful future in all areas of industry and in particular in aerospace. How to prepare for innovation in this sector which is simultaneously faced with new market forces and disruptive technologies?

Several market forces are important: development programmes are longer and longer and more and more complex; concerning European defence, budget restrictions oblige to defer acquisitions and sometimes to reduce levels of specifications; contrary to defence sector, airline industry is expected to grow by at least 5% over the next few years while higher efficiency and better environmental performances are endlessly required; operational cost optimisation is more and more imperative; aircraft are generating bigger and bigger volumes of data, therefore demanding 'big data' capabilities; and last but not least, the high percentage of aerospace employee population being or approaching retirement age necessitates to regenerate talent pool.

The digital revolution: constant progresses in digital technologies are going to involve further transformational changes. Aerospace companies have been developing digital capabilities for many years, but the coming disruptive digital technologies are driving decisive changes in the way they will conduct developments and will interact with the world around them.
It has to be noted that while the digital transformation is fast-paced and unpredictable the aerospace sector is characterized by its long development cycles, so using today's technology to plan next generation of aircraft is not an easy task!

Digital computation capacity is pursuing its irresistible climb (410 teraflops (TF) vs 1.7 TF in 2017) and as the need to further improve the accuracy of virtual models rises, there will be a growing demand for High Performance Computing (HPC) power, while automation and artificial intelligence exert a regularly growing influence on industry. Within these new digital environments, flexibility and adaptability will become a key factor of success. Besides with the globalisation of aerospace and extended supply networks, digital security and protection is essential.

Creating favourable conditions for innovation

• ***Education and Training***

Evidently the work starts at aerospace technical universities and higher schools level, where new learning programmes are to be conceived with a view to developing creativity while a stronger and stronger accent is to be put on digital revolution, relationships with research establishments and internationalisation.

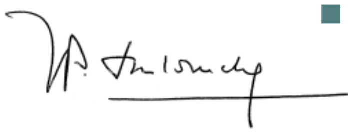
• ***Development of innovative vision in the aerospace landscape***

Industrial companies have to establish solid networks of research facilities, scientists, engineers and relevant partners. **Innovating start-ups** constitute a tremendous layer of disruptive new business ideas: this is the reason why companies are sharply encouraged to set up networks with them. For example Airbus Group has founded a "**nursery**", an internal "**incubator**" which since its creation has enabled the successful founding of a series of spin-off companies and projects to mature and commercialise disruptive capabilities and open new opportunities. And of course, the **IoT** (Internet of Things) will exert a growing impact on the upcoming aerospace future.

• ***Crossing disciplines to boost innovation***

The blurring of boundaries across industries brings new challenges, but also an opportunity to cross disciplines and accelerate innovation.

This summary just provides a general overview of the elements constitutive of the broad and complex innovation subject which will be one of the topics dealt with on the occasion of the CEAS Air & Space Conference 2017. ■



CONTENTS

CEAS PRESIDENT'S MESSAGE

Fred Abbink, CEAS President

A LOADED AGENDA

On 6 September the 36th CEAS Board of Trustees Meeting took place at the Polish Institute of Aviation ILOT in Warsaw. Important points on the agenda were:

- preparation of the CEAS/Aerospace Europe Conference in October 2017 in Bucharest, Romania;
- status of the ECAero 2 project;
- CEAS Corporate Membership;
- Follow-up on relations with the organisations with which CEAS has a Memorandum of Understanding and potential new partnerships;
- CEAS Aeonautical and Space Journals statistics;
- Procedure for the selection of the venue of the next Aerospace Europe / CEAS Air and Space Conference in 2019.

CEAS-Aerospace Europe 2017 Conference in Bucharest

The Romanian CEAS Member Society AAAR is making good progress with the organization of the 2017 CEAS/Aerospace Europe Air and Space Conference. All contacts with the venue are signed, the Programme Committee was formed, the call for abstracts was launched and a special website is on-line now (http://ceas2017.org/).

Corporate Members

A new CEAS Corporate Member is Eurocontrol. This brings the total number of Corporate Members to 6. (ESA, EASA, Eurocontrol, LAETA, VKI and Euroavia). CEAS is actively pursuing to increase the number of European Corporate Members to strengthen its visibility, cooperation and financial solidity.

CEAS Memoranda of Understanding

CEAS currently has Memoranda of Understanding with ICAS, AIAA, AAE, CSA, KSAS, EREA and EASN. CEAS will strengthen the relations with these valued organisations by providing regular information on the status of CEAS, asking them to assist in the CEAS Conferences with participation as members of the Programme Committees and Session Chairpersons, as well as by providing papers for the conferences, CEAS Journals and CEAS Quarterly Bulletins.
Besides CEAS is in contact with the International Forum for Aviation Research IFAR to investigate how to strengthen the relation with partner in the space domain.

CEAS Journals

The CEAS Journals are maturing well since their launch in 2011. The number of peer reviewed articles is steadily increasing and the journals are indexed now in SCOPUS. More than 200 articles have been published in the CEAS Aeronautical Journal and 120 in the CEAS Space Journal. A preliminary Impact Factor is determined by Thomson Reuters for the Aeronautical Journal. Actions have been taken to promote the visibility of the CEAS Journals and to encourage the European (and international) universities and research establishments to make use of the CEAS Journals.

CEAS at the ILOT Polish-Brazilian Conference

At the day after the CEAS Board of Trustees Meeting, Christophe Hermans and I had been invited to give a CEAS presentation at the 2nd Polish-Brazilian Conference on Science and Technology at the occasion of the 90th anniversary celebration of ILOT. After a warm welcome by Witold Wiśniowski (Director of the Institute of Aviation), Alfredo Leoni (Ambassador of Brazil in Poland) and minister Aleksander Bobko (secretary of State, Ministry of Science and Higher Education), I gave the CEAS in Brief presentation and Christophe Hermans gave a presentation on the German-Dutch Windtunnels DNW and some exemplary DNW projects.

CEAS at the 30th ICAS Congress

From 25 – 30 September, the 30th ICAS Congress was held in Daejon, South Korea. It is very good to note that the CEAS Member Societies submitted over 40% of the overall almost 500 presented papers. Furthermore members of the CEAS Societies participated actively in the ICAS Executive Committee, the ICAS Programme Committee, as Session Chairpersons and by providing keynote lectures: an excellent example of the CEAS participation in ICAS.

CEAS at the AAAF Greener Aviation Conference

From 11-13 October the CEAS French Member Society 3AF is organising the Greener Aviation Conference in Brussels. CEAS presents itself on this conference and is providing support to the programme committee

CEAS at the 6th EASN International Conference

From 18-21 October, EASN our new partner will organize the 6th EASN International Conference on Innovation in European Aeronautics Research in Porto, Portugal, with support of CEAS.

CEAS Awards

On 28 November 2016 the CEAS Board of Trustees will meet in London. In the evening the CEAS Gold Award will be presented to Gordon McConnell and the CEAS Distinguished Service Award to Constantinos Stavrinidis

Aerospace Europe 2017 Conference

(6th CEAS Air & Space Conference)

Organized by AAAR - The Aeronautics and Astronautics Association of Romania on behalf of CEAS
PARLIAMENT of ROMANIA, 16th-20th October 2017
with the contribution of EUCASS, ECCOMAS, EUROMECH, EUROTURBO, ERFCOTAC, ACARE, EREA, EDA, EASA, EUROCONTROL, EASN

The Aerospace Europe CEAS 2017 Conference brings together academic, research, industry and operator representatives for a fruitful date exchange of the latest ideas and developments in European aeronautics and aerospace.

The Council of European Aerospace societies CEAS comprises the European national aerospace societies, and one Russian research institute involved in every aspect of aeronautics and space, including academia, research, industry, operators and MRO organizations. The aim for the Aerospace Europe 2017 Conference is to create a unique opportunity for knowledge dissemination in aeronautics where east meets west.

The conference is supported by the EU E-Caero2 project and its partner societies EUCASS, ECCOMAS, EUROMECH, EUROTURBO and ERFCOTAC, that will organize special sessions in their field of expertise. Aerospace Europe will furthermore offer the 2 major EU Joint Technology Initiatives CleanSky and SESAR project partners a platform for sharing their research and development results. Academic research and its application potential will be presented in dedicated sessions under responsibility by EASN.

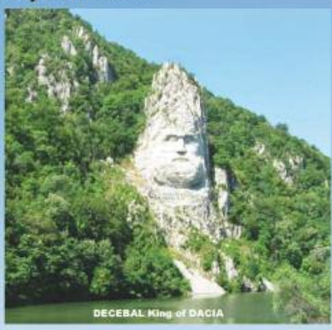
The Aerospace Europe Program Committee, with major support of all member societies, local organizers, EREA, EDA, EASA, EUROCONTROL and EASN will safeguard the scientific and technical quality of papers to be presented by reviewing applications.

For all those involved in the aeronautical or space fields, we therefore wish to invite you to be our guests at the conference.

The principal channels for the publication of selected high quality papers are the two journals reviewed according to Springer's procedures: CEAS Aeronautical Journal and CEAS Space Journal. Selected conference papers will be published in the CEAS Journals as well as in The Aeronautical Journal of The Royal Aeronautical Society.

First Call for Papers has been published and it includes all the details of the conference on the web site: **www.ceas2017.org**

Aerospace Europe Advisory Committee



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AIAA ANNOUNCES THE 2ND DEMAND FOR UNMANNED SYMPOSIUM

Thomas Irvine, AIAA Managing Director for Content Development (tomi@aiaa.org)

Unmanned aerial systems (UAS), or drones, have caught the attention and stoked the imaginations of both the aviation world and of the public. Fortunately for our industry, most of that attention has been favorable. And the possible future uses of drones are limited only by our imaginations. In the United States, an impressive 500,000 hobbyists registered their drones within eight months of the Federal Aviation Administration creating a drone registration system. To put that in perspective, we only have 320,000 registered manned aircraft in the U.S. And it has been over 100 years since the Wright Brothers invented the piloted aircraft. With the size of the worldwide UAS commercial market projected to be greater than $2B and over $10B for commercial and defense combined by 2022, the limiter on a future of ubiquitous UAS operations may be technologies that allow for ever increasing autonomy of operation. Regulation and societal acceptance are also likely to be two other factors that affect how quickly regular drone operations become routine in both rural and urban areas all around the globe.

To help the aeronautics research and development community address the technology development and maturation that will be necessary if we are to realize the full potential of unmanned systems, the American Institute of Aeronautics and Astronautics (AIAA) held the inaugural Demand for Unmanned UAS Symposium in June 2016 in Washington, DC. The focus of Demand for Unmanned is on the research and development in areas such as autonomous vehicles and operations, robotics, and machine intelligence. We had 275 enthusiastic participants at this first symposium.

If a practitioner in this field of unmanned systems research and development so desired, he or she could attend any numerous unmanned systems conferences, meetings, and symposiums. Some emphasize technology, some emerging regulations, and some are more focused on industry trade shows. At AIAA, we believe we have created a distinguishing event in an unfilled niche area. Our Demand for Unmanned event addresses the need of the R&D community to meet, present research results to peers, and network and discuss challenges in both vehicle and traffic management automation technologies.

We are currently making plans the 2nd Demand for Unmanned Symposium, to be held in in conjunction with the AIAA Aviation and Aeronautics Forum and Exposition in Denver, Colorado, 5-9 June 2017. The Demand for Unmanned Symposium brings together stakeholders from academia, government, and industry to identify research challenges that will lead to operational opportunities for the UAS community. We see UAS as an aviation-related catalyst for autonomy, robotics, and machine intelligence. These systems are already changing the nature of civil and military aviation, and they will do even more so as they become increasingly autonomous. Following up on the successful inaugural 2016 Demand for Unmanned Symposium, our 2017 Symposium will include plenary talks from the industry's thought leaders, a technical program, and UAS-related social activities.

In addition to the R&D community, our target audience includes UAS manufacturers, operators and end-users with applications in such areas as agriculture, surveillance, law enforcement, border patrol, aerial cinematography, delivery of products, goods and services, universities/academicians working in UAS area, government organizations with a stake in UAS such as the FAA, NASA, and the Department of Defense, venture capitalists, the international community, the media, and the public. We welcome the participation of our European colleagues and collaborators in this 2nd Demand for Unmanned Symposium.

More information can be found at: https://www.aiaa-aviation.org/DEMANDforUNMANNED/

In addition to our own Demand for Unmanned Symposium, AIAA is actively partnering in two other UAS-related events in which there might be interest from our colleagues in Europe. We are excited to be partnering with Drone World Expo. Drone World Expo (DWE) is the defining event for the commercial applications of UAS technology. Thought leaders, industry experts and end-users gather at DWE in the heart of Silicon Valley of California to present real-world solutions to business and environmental challenges. Attendees have the opportunity to learn about commercial strategies, platforms and payloads, data collection, safety, security, privacy, the current regulatory environment, international lessons learned, and the impact drones are having on Geographic Information Systems, Big Data and the Internet of Things. More information is available at: http://www.droneworldexpo.com. This year's Drone World Expo will be held 15-16 November 2016 in San Jose, California.

AIAA is the organizer of the Innovative Drone Exploration and Application (IDEA) Competition at DWE. IDEA is a competition with the objective of a providing a platform for sharing ideas and research related to the design, utilization, and applications of autonomous aerial systems and to foster interaction between the R&D and the end-user communities by highlighting funded research in autonomous aerial vehicles that will affect end-user operations and applications in the future. The winners of this year's competition have been selected and will be presenting their work in an AIAA-sponsored technical track session during DWE 2016.

AIAA has also partnered again with the Association for Unmanned Vehicle Systems International (AUVSI) to hold the 3rd AIAA Workshop on Civilian Applications of Unmanned Aircraft Systems to be held in Dallas, Texas in 8-11 May 2017. This workshop will be held in conjunction with AUVSI's XPONENTIAL 2017. The workshop's objectives are to assist the civil and public UAS community in creating a vision of UAS applications in the national airspace in the next decade. And to transition from the "civil decade" (2005-2015) to the public decade (2015-2025) by identifying technologies that will provide the push for UAS applications and acceptance and by providing assistance to the Federal Aviation Administration in the safe integration for the UAS in the national airspace. Previous workshops have attracted as many as 750 participants, making this workshop an essential event for all members of the UAS community.

More information on XPONENTIAL can be found at http://xponential.org/xponential2017.

WILL AIR TRANSPORT BE FULLY AUTOMATED BY 2050?

Jean-Pierre Sanfourche

DURING A CONFERENCE WHICH TOOK PLACE IN TOULOUSE ON 1 AND 2 JUNE 2016, THE AIR AND SPACE ACADEMY PROPOSED A REVIEW OF THE MORE AUTOMATION ROLE TOWARDS THE NEEDED ACTIONS NECESSARY TO CIVIL AVIATION SAFETY IMPROVEMENT DUE THE FORECAST INCREASE OF AVIATION TRAFFIC AT 2050 TIME HORIZON. EXPERTS ASSERTED THAT THIS OBJECTIVE WILL BE REACHED THROUGH MORE AUTOMATION ON BOARD. BUT EVEN IF CONSIDERABLE INCREASE IN AUTOMATION IS EXPECTED IN THE COMING YEARS, THE FULLY AUTOMATED PASSENGER TRANSPORT AIRCRAFT CANNOT BE ENVISAGED FOR 2050: HUMAN PRESENCE ON BOARD WILL REMAIN INDISPENSABLE UNTIL AT LEAST THIS DATE.

HOWEVER, A LIKELY HAPPENING FOR 2050 COULD BE ONE PILOT ONLY ON BOARD (PB) WHATEVER THE FLIGHT DURATION IS, BEING ASSISTED, WHEN NECESSARY, BY A PILOT ON GROUND (PG). SO A NEW ROLE – GROUND-BASED PILOT, COULD, CONSISTENTLY APPEAR IN AVIATION OVER WITHIN TWO OR THREE DECADES.

THIS PAPER PROVIDES A SUMMARY OF THE MAIN STATEMENTS AND FINDINGS OF THE CONFERENCE.

NEEDS AND MOTIVATIONS

According to **Xavier Champion**, former Chief Engineer at Airbus, with air traffic expected to multiply by a factor of more than 3 by 2050, the imperative necessity to maintain – and if possible reduce – the current accident rate worldwide requires from all parts concerned very important efforts, more particularly in the most accident-prone regions. In fact a global accident rate of 0.16 per million flights (result achieved today in the US and in Europe) should be targeted against the global current 0.64 rate, i.e. a global worldwide reduction by a factor 4.

Thanks to the considerable progresses in science and technology, the machine is safer and safer, so that in today's accidents, human factors are clearly preponderant: as a matter of fact the human factor accounts for 50% of primary causes identified and 66% of principal causes.

Aviation accidents can be classified into categories, of which the main ones are: (i) loss of control in flight; (ii) controlled flight into terrain; (iii) runway excursion and (iv) non-explained accidents.

Obviously important efforts must be dedicated to technological assistance to the pilots, particularly by means of more and more performing automated systems, being quite clear that more automation on board translates into better safety. **Alain Garcia**, former Airbus Engineering Executive Vice-President said: "*A decisive stage was passed in the 1970s and 1980s when greater automation was made possible by the electronic revolution from analogical to digital. Thanks to automated systems, crew tasks have been* *simplified, which has reduced the number of crewmembers and has led to a significant drop in the accident rate.[...] An extension of automation, aimed at countering persistent failures such as loss of control in flight, collision with mountains, or runway excursions, will improve flight safety.*"

In addition to assistance with automated systems it will of course be mandatory to permanently improve the direct pilot-related subjects: selection, education, permanent training (with simulator and in-flight), and medical and psychological permanent surveillance.

INTRODUCTORY CONSIDERATIONS

Pierre Calvet, former principal lecturer at SUPAERO School, recalled the history of assistance to the pilot with automated systems and communications *(Illustrations 1 to 5)*. The first automated aids-servomechanisms, radio direction finder, the first automatic pilots and VHF verbal communication appeared in the 1930s. Post WW2 aircraft had hyperbolic positioning and inertial measurement units. Transistorised electronics and analogical computers resulted in new equipment; VOR-DME, ILS, on-board radars, transponders and effective liaisons with a developing ground infrastructure. Avionics were developed from within an innovative framework of international regulations and procedures. The sixties were marked by the first automated landings (Caravelle) when the following decade saw the development of Concorde, the first aircraft equipped with fly-by-wire controls and the first digital computer. Then by around 1980 flight mechanics equations were generally integrated into aircraft landing system (A320), enabling automatic protection of the flight envelope. Presently a broad set of data provided by many primary sensors and propulsion control systems is available in a central computer. Other computers (FMS – Flight Management System) deal with pre-recorded navigation settings and programme the Automatic Pilot (AP) for all flight phases after take-off. The rationalisation of glass cockpits together with many interconnected automated circuits gradually made it possible to reduce crew to 2 pilots.

Jean-Claude Ripoll, former head of SUPAERO, presented an elementary and philosophical theory of automation of flight's conduct. He insisted in particular on the following

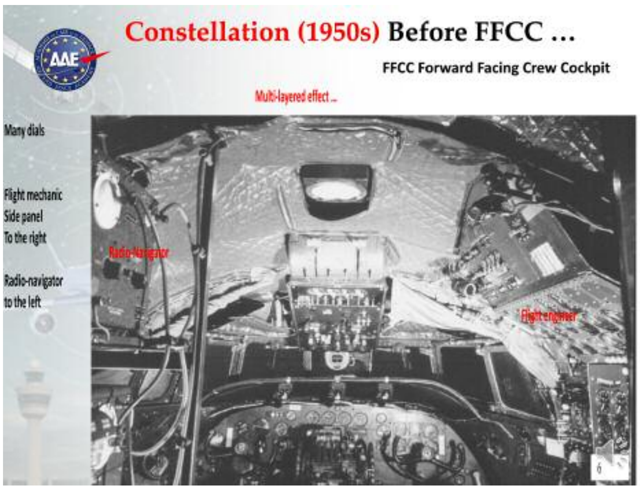

Illustration 1 : cockpit of Constellation

Illustration 2: cockpit of Caravelle

Illustration 3: cockpit of Concorde

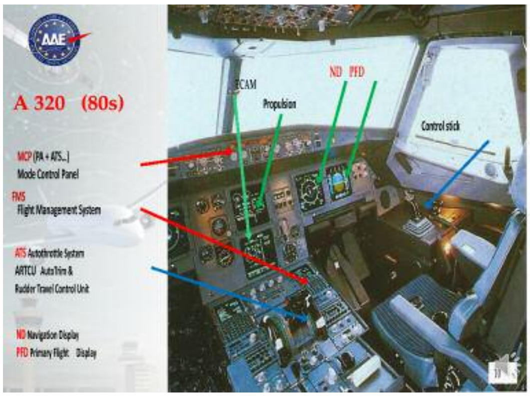

Illustration 4: Cockpit of A320

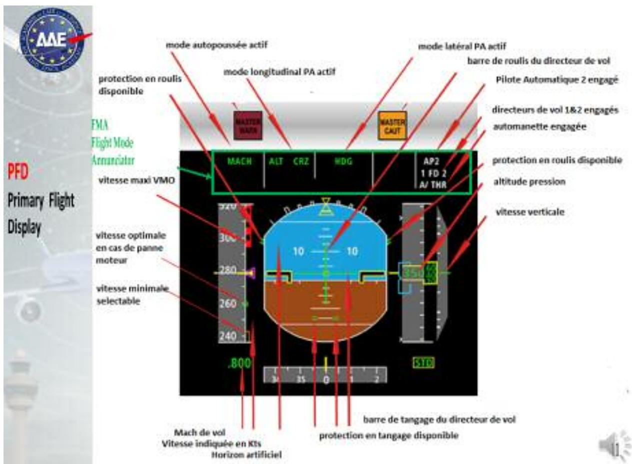

Illustration 5: Cockpit of A350 XWB

Illustration 6: Toulouse-based researchers are monitoring a pilot(s brain activity in flight, equipping his head for functional near infrared spectroscopy.

aspect: automated systems must be designed and introduced in such a way as to reduce possible dysfunctions in all stages of the conduct of flight, by humans or machines. ►

How many pilots on board in the future? 2, 1 or 0? The irresistible evolution in technology has given rise to the idea that it will be soon or late possible to do without an on board pilot on commercial passenger aircraft, but the way is still very long before the realisation of this dream is achievable!

A FIRST STEP: TO CONTINUE IMPROVING THE 2-MEMBER CREW SETUP

• MODERN AUTOMATED SYSTEMS

The "4th Generation" of airliners integrates highly reliable automated systems, including envelope protection and advanced flight controls.

• TO DEVELOP CREW'S ABILITY TO DEAL WITH UNEXPECTED SITUATIONS IN MODERN AIRLINERS. HUMAN LIMITS IN THE FACE OF AUTOMATION

Pilots and automated systems – which can be compared to "prosthesis" – are agents and cooperate with each other. According to **Jean Pinet**, former flight test pilot of Concorde, (and doctor in psychology and ergonomy), "*In their operational tasks, humans are equivalent to intelligent high-level automation, using defined – but not deterministic – algorithms, unlike the deterministic algorithms of automation-prostheses. The human flaws observed are for the most part due to well-known mental limitations that are insufficiently taken into account (cockpit interfaces, procedures, etc.).* ***Indeed considerable progress can be made in the 2-member crew setup, sometimes overturning current standards.***"

Frédéric Deshais, expert in "Neuroergonomics for flight safety", commenting pilots' behaviour in unforeseen and dangerous situations – neglect critical information (e.g. auditory alarms), persist in irrational decision-making, etc. – proposed an innovative way to address these challenging safety issues: to merge knowledge, and methods from cognitive psychology, system engineering and neurosciences. It is necessary to adapt the flight desk to the way the human brain works best, taking advantage of the most recent developments in neurosciences: in the future, safer cockpits should help the pilot in case some situation degrades his or her performance.

Safety specialists believe that aviation must retain a high level of human presence arguing that the brain has long proved itself to be effective as master of the cockpit *(illustration 6)*.

A special focus has been alarm deafness: for most human beings, sense of sight is dominant; a simultaneous stimulus coming from eye can outweigh – in 100 milliseconds – a simultaneous stimulus coming from the ear. This happens before the person is even conscious of the stimuli, which takes 300 milliseconds. Before the brain knows what is happening, it can shut down its own aural channel.

Mind wandering is another important issue: the delayed response to an unexpected urgent situation.

The issue of monitoring was also discussed. Humans are not so good at monitoring. For instance the human brain is poor at detecting even a gross visual change if it occurs in an object that is not the focus of attention.

Jean Broquet, former Director of Technology Strategy at Astrium, presented an analysis of possible improvements (automation/human).Based on a preliminary estimate of "positive pilot interventions", aims at quantifying the possible evolution in the accident rate within a 2050 timeframe for crews of 2 on board pilots, taking into account measurable improvements in pilot's action performance for all flights and thus enabling preventive actions to be taken.

Guy Boy, Florida Institute of Technology, presented the HCD (Human-Centred Design), a new tool is leading to tangible interactive systems enabling to take into account human factors from the beginning of design (putting software first and hardware after).

THE CONTRIBUTION OF RESEARCH

Michael Feary, research scientist in the Human-Systems Integration division at NASA Ames Research Center, focused on the development of tools to support design and analysis of Human-Automation interaction in complex safety critical systems. He described big data as an "associative intelligence", while the human brain's skills are more precisely "generative intelligence". He stated that "Humans are particularly good at adaptive problem-solving and discovery, areas where there has been little machine intelligence progress".

Stéphane Chatty, ENAC School, proposed four categories of R&D orientations: (i) identification of new interaction media; (ii) determination of concrete requirements given in a project (participatory design: reactions of users give insight on the actual requirements); (iii) devising software and systems architecture to support continuous evolution during the project; (iv) continuation of efforts to modem human behaviour.

Jean-Charles Fabre, LAAS-CNRS, gave an overview of the methodology, the development of adaptive fault tolerance mechanisms and the evaluation of the approach in term of performance and agility.

Arjan Lemmers, Netherland Aerospace Centre – NLR -, presented 'Man4G'. Despite the very significant benefits of automation systems, it is observed that when faced with unexpected and critical situations, pilots sometimes labour under difficulties to quickly react to situations which necessitate a rapid transition in their flight management from monitors of reliable systems, to active manual control of the aircraft. In fact how to deal with unexpected situations in highly automated cockpits? This problem is being investigated within the framework of the European Research Project "Manual Operations of 4th Generation Airliners – Man4Gen". The crew's actions and behaviour were investigated using Cognitive Systems Engineering (CSE) methods in particular to understand the 'sense making' processes which take place after an unexpected event. Improvements are needed in procedures, training and technology after the experiments conducted revealed several flaws in existing operations. A structured strategy is necessary when the crew is faced with an unexpected situation in flight.

Jean-Louis Brenguier, Météo-France R&D programme, explained the solution consisting in data processing on the ground to detect the possible occurrence of weather hazards along the 4D trajectory, raise awareness on board and uplink a subset of filtered data along the flight corridor. Alain Joselzon, former national expert in the EU Commission and former chairman of the International Environmental Committee of Aerospace Industries (ICCAIA) evoked the different ways in which civilian RPAS (Remotely Piloted Aircraft Systems) experience could contribute to preparing for future air transport.

Bruno Nouzille, Technical VP Avionics, Thales Group, presented studies of future achievements on the flight management. He introduced the subject saying that greater automation in current systems has improved safety and has also led to a sharp increase in the complexity of avionics systems, the crew's role shifting from flying the aircraft in the traditional sense to a more supervisory role of managing, programming and monitoring complex systems. With the automation increases to come, the pilot(s) will probably be less involved in decision-making except in case of complex degraded situations, consequently possibly in a position of weakness at critical moments. So, it is imperatively necessary to drastically improve the human-machine relationship.

SECOND STEP: PILOTS ON BOARD, PILOTS ON GROUND

According to **Alain Garcia**, the extreme conceivable scenario for 2050 could be to have **one pilot on board (PB)**, whatever the flight duration is, with, in case of necessity, **one additional pilot on ground (PG)**. Reasoning on the basis of logical and human possibilities, several certifiable scenarios are conceivable, each with operational consequences: 6 scenarios were examined going from scenario 1 'as today' to scenario 6 'no pilot on board, pilot on ground all flight (see pages 12 and 13), all ensuring full human control, as necessary. Important considerations were highlighted, centred on: the mandatory high quality of preparation of future crews, the automated systems necessary to carry out potentially hazardous situations, the necessity to check the availability of the pilot on board, the need for high performance communication for ground monitoring and assistance, cyber-crime protection, clear definition of task/responsibility distribution between the main players of the system pilots on board and on ground, aircraft operators/airlines, air navigation services, weather services).

Two other aspects were also touched on: the contribution of U(C)AV technologies, the tangibility concept for a new human-centred approach.

Greater automation, moving towards full autonomy requires considering a larger and larger number of situations and particularly their combinations thus increasing complexity and necessitating new approaches. Simulation in all its forms will be sued more and more.

Final remarks were made on the changing legal framework and the natural human resistance to change, issues which will need to be resolved.

Scenarios / Functions	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5	Scenario 5bis
Nb of Pilots : PB ---------- PG	**As today** ---------- PG not necessary	**PB-1 LR** (2PB in TO, App/lg; SPO in cruise) ---------- PG monitor In cruise (reaction time =10mn)	As for S2+SPO **for M/SR** with diversion airport at less than Xmn ---------- PG monitor during all flight for M/SR (reaction time 10mn)	**SPO for all Ranges** **(in cruise for LR while PB at rest PG in A/C control)** ---------- PG all flight (reaction time ~10mn but 2mn while PB at rest)	**SPO for all Ranges** (PB at rest in cruise for LR) ---------- **No PG**	**No PB** (Captain role tbd) ---------- **PG all flight** (rest by 2[nd] PG alternate on ground
Automatisms functioning ---------- Reliability	**Auto. during all flight** **Gate to gate** ---------- **Keep control for failures $p \geq 10^{-5}$ /fhr** (AMC to JAR1309 -minor effect)	As S1 +Keep control for **unexpected event of $p \geq 10^{-3}$/fhr in cruise for 10mn** (prevent catastrophic condition until PG takes over)	As S2 + Keep control for **unexpected** event of $p \geq 10^{-3}$/fhr **in all flight phases for 10mn for M/SR**	**As S3 but for all ranges**	As S3 +Keep control for **unexpected event of $p \geq 10^{-6}$/fhr in all flight phases** (equals, about, 2[nd] PB or PG availability)	As S5
ATM function Strategic separation Tactical separation Sequencing Authorisations/Instructions	As today with **voice** comm. **completed with digital** comm.	As today **+ATC send instruction to Pilot in function. If necessary in case of disabled Pilot in function ATC commands the AC during 10mn cruise before PG recovery***. **Includes detection means of pilot disabled giving warning.* *ATC is informed of the Pilot in function status (PF, PG, disabled).* *The assumption is that the ATC can command directly the trajectory of the A/C in place of the PG.* *The alternative is to give instruction to the other A/C for collision prevention as today in case of loss of communication with basic A/C*	As S2+ **covers all phases of flight for M/SR** (and not only cruise)	As S3 **+for all ranges**	As S4	As S4

Scenarios / Functions	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5	Scenario 5bis
Meteo function	Update permanently weather prediction to ATM and Pilots **Advise for A/C Change of trajectory**	**As S1 plus permanent improvements**	As S1 plus permanent improvements	As S1 plus permanent improvements	As S1 plus permanent improvements	As S1 plus permanent improvements
Communication function	As to day	Give PG main A/C flying parameters. Permanently in cruise + **Detailed ones within 1mn in cruise** **(distance!)**	As S2+ **covers all phases of flight for M/SR and not only cruise . Detailed within 1mn**	As S3 **for all ranges** + **For LR detailed A/C flying conditions continuously while PB at rest** (distance!)	**Permanent exchange with A/C-PB & ATM** **(distance!)**	**Give PG** **Detailed A/C flying cond. Permanently** **(distance!)**
ACAS	ACAS as today	Control directly A/C avoidance trajectory during all flight – except if the Pilot in function denies.	As S2	As S2	As S2	As S2
Cockpit design principles	As to day + Simplified infos in rapidly evolving situation. **Piloting more by functions than parameters**	As S1	**Can initiate new cockpit paradigm with less controls and more comm. means vs internal and external world + /emergency PB**	As S3	As S3	**Dramatic changes to cockpit controls and displays**
Remarks		**Shared responsibilities to be well defined**	Airline pilots training based on simulation means (fix and moving ones). **+as Flying Pilot with checker on actual A/C**	Pilot role more as an observer!	***Very difficult to achieve in 2050***	***Pilot training ? Unlikely to be feasible in 2050 ?***

Hypothesis: given automatism reliability order of magnitude based on pilot deficiency probability of 10^{-6}/Fh

Glossary:
PB= pilot on board
PG= pilot on ground (of same qualification as the PB)
M/SR= Medium/Short Range operation
LR= Long Range operation
Si= Scenario i
P≥ probability more or equals to
SPO= Single Pilot Operation
Xmn= duration (in minutes) based on agreed reliability of automatism with authorities
TO=Take Off
APP/lg= Approach/Landing
AMC to JAR 1309: Acceptable means of compliance to JAR 25 § 1309
ATM: Air Traffic Management
ATC: Air traffic Controller

Colour code

increasing severity/difficulty

SOME COMMENTS

•The pilot on ground (PG) would need to be able to react within 10 minutes. This calculated time assumes that the PG will have to analyse the situation before acting. On a long-haul flight, the PG would be in control while the PB is in a rest period. In that situation, the PG would have to react in 2 minutes in case of a problem.

• The PG should contact the PB regularly in order to ensure the latter is physically able to conduct the flight. Contact should be continuous during take-off, initial climb, final approach and landing. In cruise, a frequency of one contact every 30 minutes would seem adequate.

• PGs should be qualified as pilots. Each would hold a type rating. Airlines might manage PGs and PBs together in human resources.

• One PG could take care of 5 flights as an average in short-to medium-haul operations when for long-haul operations, two PGs would be able to deal with 6 to 8 flights. For PB-PG cooperation, communications will play an essential role, implying more demands on coverage and bandwith. Real-time video could be a key solution. The spectrum required is a critical issue. The Ka band is a potential additional spectrum for PB-PG communication needs.

• There will be the need for two independent radio-links to ensure redundancy.

• **TOWARDS SPO**. According to **Jean Pinet**, "*Progress towards SPO (Single Pilot Operation) will be made step by step, starting from simple, easily controllable case – short flights and/or long cruising stages) and adopting the principle of leaving to each agent, pilot or prosthesis, what it can do best. Risk management is essential and will require experiments, measurements, and quantified estimates, combined and validated according to situations and configurations. The enlightened arbitration of the certification authorities is of primary importance.*

To achieve autonomy, an estimation will need to be made of the possible breakdowns and risks of the many, complex combinations of systems and situations, probably by means of new paradigms.

Studies into SPO in the USA and in Europe are currently approximate and should really benefit from a global, systemic approach encompassing all the technical, financial, environmental and human risks involved. A full analysis should compare SPO with the 2-member crew configuration after introduction of known, listed improvements."

It must be very clear the SPO goal will be reached through a rigorous step-by-step "incremental" approach.

AND ZERO PILOT ON BOARD?

Jean Pinet said: "*Making flights without a human pilot on board would be a serious mistake. Like automation, the human brain combines the skills for calculating derivatives (trends) and integrals (short-term memory) thanks to his perception of the present time.*"

ABOUT MILITARY AIRCRAFT EXPERIENCE

French Air Force and Dassault Aviation have accumulated a considerable amount of expertise and experience with automation on combat aircraft and autonomous aircraft with the unmanned combat demonstrator nEUROn. It is obvious that the new high-level technologies acquired constitute quite an important source of fundamental knowledge for progressing towards more automated commercial air transport.

OTHER CONSIDERATIONS

• ETHICAL QUESTIONS were evoked by **Catherine Tessier**, senior researcher at ONERA: the division of authority between robot and human, the adaptive autonomy, the modelling of human-machine conflicts and ethical questions related to the use of robots. She emphasized the need for transparency: we must ensure that an automated system will not make a decision unbeknown to the pilot.

• **Philippe Brecassa**, ENAC School, talked about TRAINING, insisting in particular on the fact that it is still too much oriented towards using the system rather than understanding it: as a matter of fact, critical situations dwindle but grow in complexity.

• Regarding the LEGAL POINT OF VIEW, **Sophie Moysan**, Chief Claim & Legal Officer at La Réunion Aérienne et La Réunion Spatiale, endorsed the view that with the development of automation, it will become more difficult to establish responsibility for the accidents in a context of multiple, complex, inter-connected, shared technical responsibilities. It is probable that the legal framework governing responsibilities in the area of air transport will have to be modified to take account of the technology developments.

IN SUMMARY

• By 2050 we can expect more and more highly automated passenger air transport, using ultra-connected aircraft with a single pilot on board charged with supervising the machine and intervening in the event of any unforeseen problem, supported by a pilot controller based in an operation centre on the ground, connected to the machine and the pilot on board by reliable, secure communication links.

• This goal "PB/PG" will be attained step by step, continuing first developing automates systems to assist better and better the present 2-member crew.

• The fully automated passenger air transport is not envisioned even at 2050 time horizon.

• Increasing automation of air transport will indeed have the effect of pursuing the accident rate reduction since today human factors are still significant contributors to accidents.

• The roadmap proposed by the Air and Space Academy should strongly encourage the aeronautical industry to without delay actively prepare itself in view of this. In that respect closer relationship between research establishments and industry should be ensured on research subjects for priorities setting.

The Air and Space Academy is preparing a dossier on "AVIATION IN 2050: GREATER AUTOMATION AND INTERCONNECTIVITY" which will appear in early 2017.

European MALE RPAS - Medium Altitude Long Endurance Remotely Piloted Aircraft System - Programme takes off

September 28th 2016 - Manching, Germany. Since beginning of September the development of a common European drone has entered a new phase. The contract for the Definition Study of the European MALE RPAS (Medium Altitude Long Endurance Remotely Piloted Aircraft System) Programme, assigned to Airbus, Dassault Aviation and Leonardo-Finmeccanica has been launched by a kick-off meeting chaired by the Organisation for Joint Armament Cooperation (OCCAR) with the attendance of the programme participating States France, Germany, Italy and Spain.

MALE RPAS will be a new generation remotely piloted air system for armed Intelligence, Surveillance, Target Acquisition and Reconnaissance (ISTAR) missions. Air traffic integration and certification for European densely populated environment are part of the key distinctive objectives of the programme.

The two-year definition study starts from September 2016. It will be jointly executed by Airbus Defence and Space, Dassault Aviation and Leonardo-Finmeccanica Aircraft Division with an equal work allocation. The three companies are co-contractors to perform the definition study.

Following the study, the start of the development phase is planned for 2018, with a prototype first flight in early 2023 and a first delivery of the system in the 2025 timeframe.

Operational requirements of the nations will be defined in close cooperation with the Armed Forces.

"Successfully teaming European nations, industries and defense ministries to improve sovereignty and independence is an outstanding mission, and today marks a new milestone in this innovative partnership" said Dirk Hoke, Chief Executive Officer of Airbus Defence and Space.

"This cooperative programme will contribute to European Industry leadership and autonomy in the strategic field of surveillance drones and will provide Armed Forces with high performance and sovereign operational systems" emphasized Eric Trappier, Dassault Aviation Chairman and Chief Executive Officer.

"The European Male RPAS programme is a unique opportunity to promote the development of high technologies expertise, capabilities and jobs, of fundamental importance within Europe. Technological and operational sovereignty will be delivered to Nations, relying on the experience of decades of European cooperation in military programmes," said Mr. Filippo Bagnato, Leonardo-Finmeccanica Aircraft Division Managing Director.

About European MALE RPAS - Previously known as MALE 2020 Project, the European MALE RPAS Project foresees the development of an European Unmanned Aerial System for long-range missions at medium flight altitudes (MALE). Besides being an answer to the European armed forces' requirements, it will take into account the need to optimize budgetary resources through pooling of research and development funding. With a European development, critical requirements around the certification of drones and sovereignty of operations by Armed Forces are inherently built into the programme from the onset. The European MALE RPAS is orientated to foster the development of high technologies and will contribute to sustaining key competencies and jobs within Europe.

Airbus Defence and Space, a division of Airbus Group, is Europe's number one defence and space enterprise and the second largest space business worldwide. Its activities include space, military aircraft and related systems and services. It employs more than 38,000 people and in 2015 generated revenues of over 13 billion Euros.

About Dassault Aviation: With more than 8,000 military and civil aircraft delivered to more than 90 countries over the past 60 years, and having logged nearly 28 million flight hours to date, Dassault Aviation can offer recognized know-how and experience in the design, development, sale and support of all types of aircraft, from the Rafale fighter to the Falcon range of high-end business jets, as well as military unmanned air systems. In 2015, Dassault Aviation reported revenues of €4.20 billion. The company has almost 12,000 employees. In 2016, Dassault Aviation is celebrating the first centennial of its history, which started in 1916 with Marcel Dassault and the Éclair propeller.

Leonardo-Finmeccanica Aircraft Division in one of the Leonardo-Finmeccanica's business divisions. Leonardo-Finmeccanica is among the top ten global players in Aerospace, Defence and Security and Italy's main industrial company. As a single entity from January 2016, organised into business divisions (Helicopters; Aircraft; Aerostructures; Airborne & Space Systems; Land & Naval Defence Electronics; Defence Systems; Security & Information Systems), Leonardo-Finmeccanica operates in the most competitive international markets by leveraging its areas of technology and product leadership. Listed on the Milan Stock Exchange (LDO), at 31 December 2015 Finmeccanica recorded consolidated revenues of 13 billion Euros and has a significant industrial presence in Italy, the UK and the U.S.

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VEGA RELEASES FIVE SATELLITES IN COMPLEXE MISSION

16 September 2016

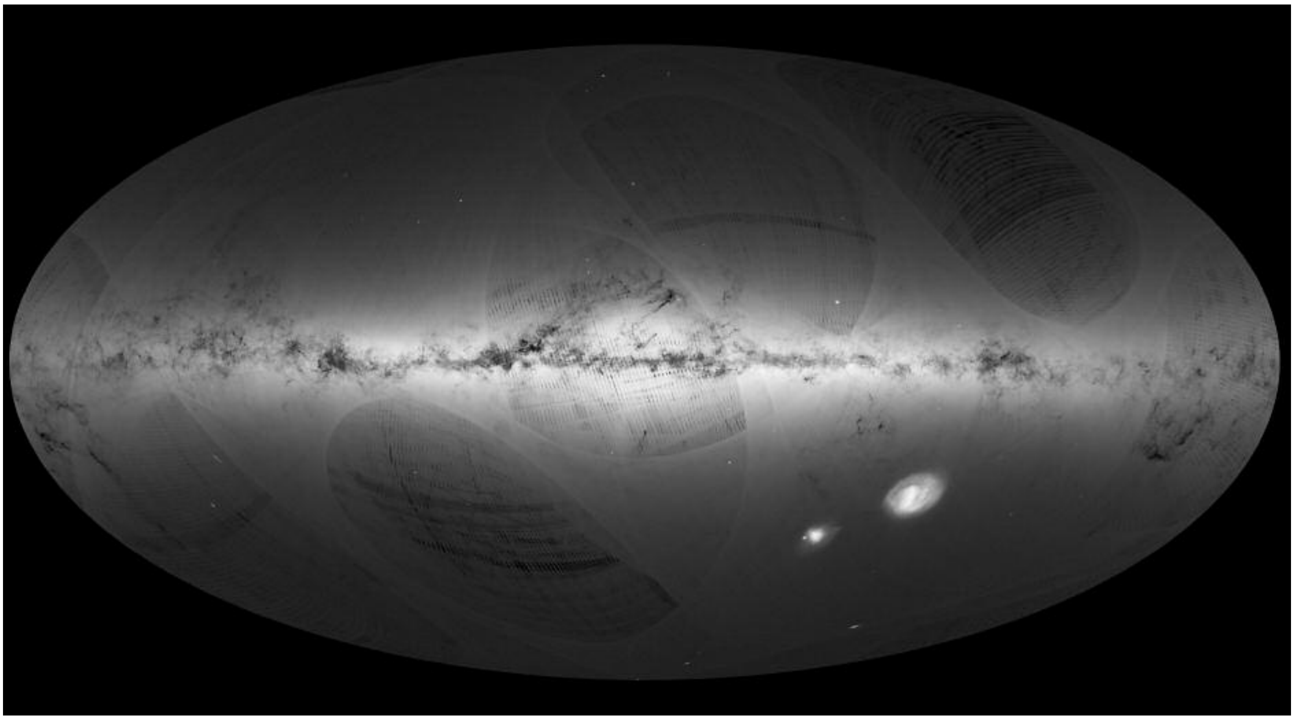
Arianespace launched a Vega rocket on a complex mission on 16 september in the early morning that demonstrated the flexibility of its upper stage and multisatellite carrier.
In its first six flights, Vega delivered a wide range of satellites into very different orbits, demonstrating its flexibility.
Liftoff of the seventh mission from Europe's Spaceport in Kourou, French Guiana came at 01:43 GMT on 16 September.
Four SkySat microsatellites for Terra Bella, with a total mass at liftoff of 440 kg, were released into their target orbit about 40 minutes into the mission.
This was followed about 62 minutes later by the release of the 430 kg PeruSAT-1, Peru's first Earth observation satellite.
Vega is a 30 m-high, four-stage vehicle designed to accommodate small scientific and Earth observation payloads of 300–2500 kg depending on the orbit and altitude.

Vega lifts off

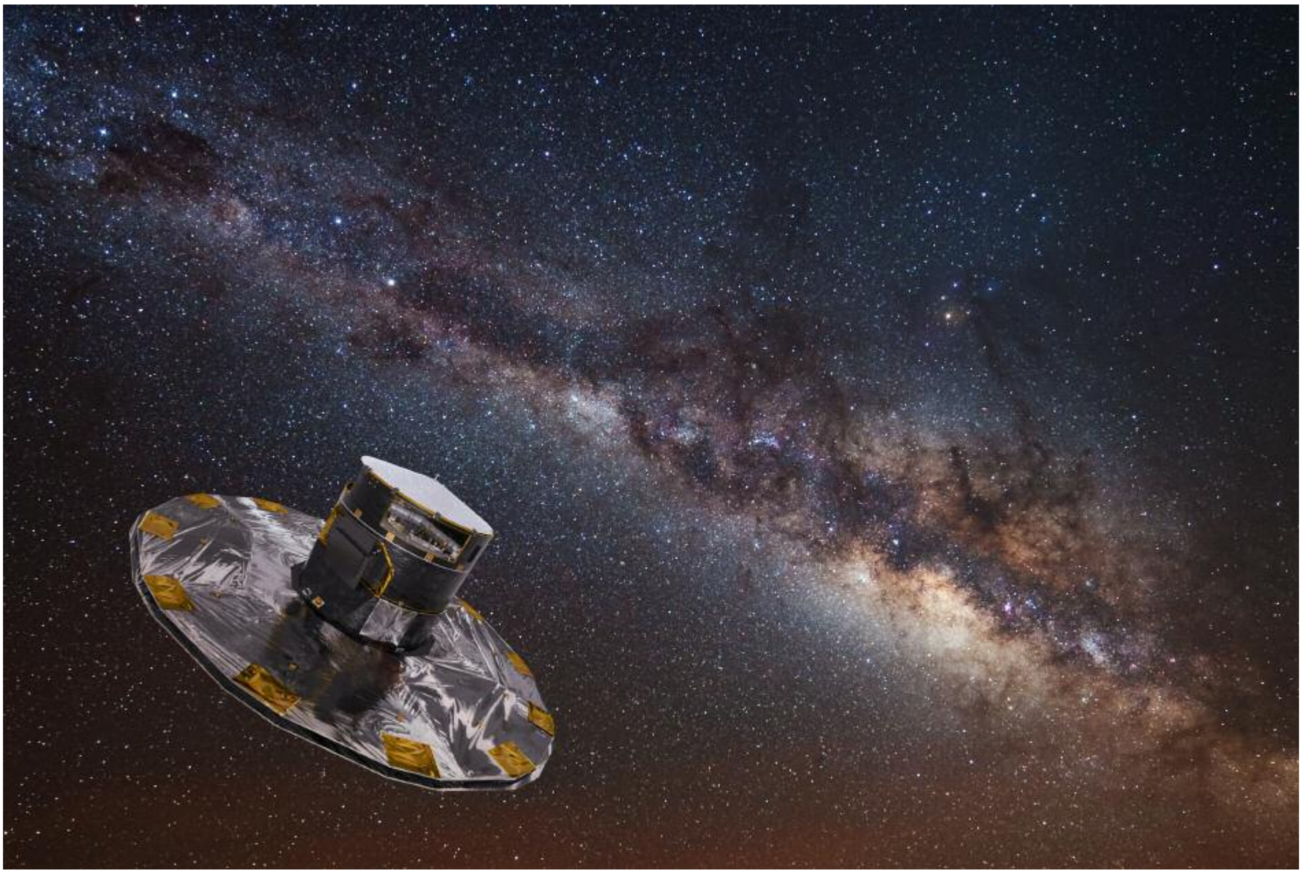
GAIA BILLION-STAR MAP HINTS AT TREASURES TO COME

14 September 2016

The first catalogue of more than a billion stars from ESA's Gaia satellite was published today – the largest all-sky survey of celestial objects to date.
On its way to assembling the most detailed 3D map ever made of our Milky Way galaxy, Gaia has pinned down the precise position on the sky and the brightness of 1142 million stars.
As a taster of the richer catalogue to come in the near future, today's release also features the distances and the motions across the sky for more than two million stars.
"Gaia is at the forefront of astrometry, charting the sky at precisions that have never been achieved before," says Alvaro Giménez, ESA's Director of Science.
"Today's release gives us a first impression of the extraordinary data that await us and that will revolutionise our understanding of how stars are distributed and move across our Galaxy."
Launched 1000 days ago, Gaia started its scientific work in July 2014. This first release is based on data collected during its first 14 months of scanning the sky, up to September 2015.
"The beautiful map we are publishing today shows the density of stars measured by Gaia across the entire sky, and confirms that it collected superb data during its first year of operations," says Timo Prusti, Gaia project scientist at ESA.



Gaia's first sky map



Gaia mapping the stars of the Milky Way

ROSETTA ENDED ITS LONG LIFE BESIDE PHILAE ON THE COMET 67P/CHURYUMOV-GERASIMENKO ON 30 SEPTEMBER 2016 AT 11:19 GMT

On 30 September 2016, Rosetta mission has conducted as planned the end of its mission by landing on the comet 67P at a region it had been investigating for more than 2 years. Confirmation of the end arrived at European Space Operations Centre (ESOC) of ESA in Darmstadt (Germany) at 11:19 GMT with the loss of Rosetta's signal upon impact.

Rosetta carried its final manoeuvre on 29 September at 20:50 GMT setting it on a collision course with the comet from an altitude of about 19 km. The targeted point of impact is close to an area of active pits in the Ma'at region: as a matter of fact pits are of particular interest because they play an important role in the comet's activity and they provide a unique window into its internal building blocks.

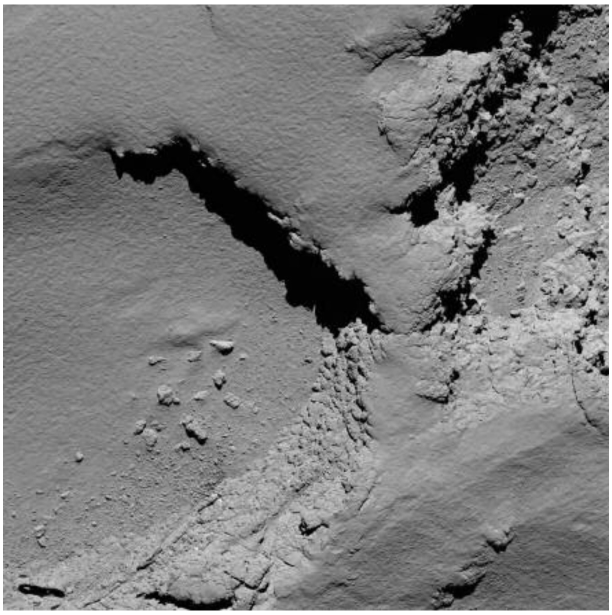
The descent gave the opportunity to study the comet's gas, dust and plasma environment very close to its surface, and also to take very high-resolution images. The information data collected during it were returned to Earth before the impact. *See llustrations 1, 2 and 3.*

ESA's Director General **Johann-Dietrich Wörner** declared: "*Today we celebrate the success of a game-changing mission, one of that continues ESA's legacy of "Firsts at the comet.*"

ESA's Director of Science **Alvaro Giménez** said:
"*Thanks to the huge international decades-long endeavour, we have achieved our mission to take a world-class science laboratory to a comet to study its evolution over time, something that no other comet-chasing mission had attempted*."

It is obvious that the enormous amount of data returned since the launch – 2 March 2004 at 07:17 GMT – will keep generations of scientists busy for decades to come.

1. OSIRIS wide-angle camera image taken at 11:49 GMT on 29 September 2016, when Rosetta was 22.9 km from Comet 67P. On 30 September, Rosetta descends to the surface of the comet, targeting a region on the small comet's lobe. © ESA/Rosetta/MPS for OSIRIS Team MPS/UPD/LAM/IAA/ SSO/INTA/UPM/DASP/IDA



2. Rosetta's OSIRIS narrow-angle camera captured this image of Comet 67P/Churyumov-Gerasimenko at 08:18 GMT from an altitude of about 5.8 km during the spacecraft's final descent on 30 September. The image scale is about 11 cm/pixel and the image measures about 225 m across. © ESA/Rosetta/MPS for OSIRIS Team MPS/UPD/LAM/IAA/ SSO/INTA/UPM/DASP/IDA

ROSETTA/PHILAE MISSION OVERVIEW – THE MAIN MILESTONES

See illustration 4

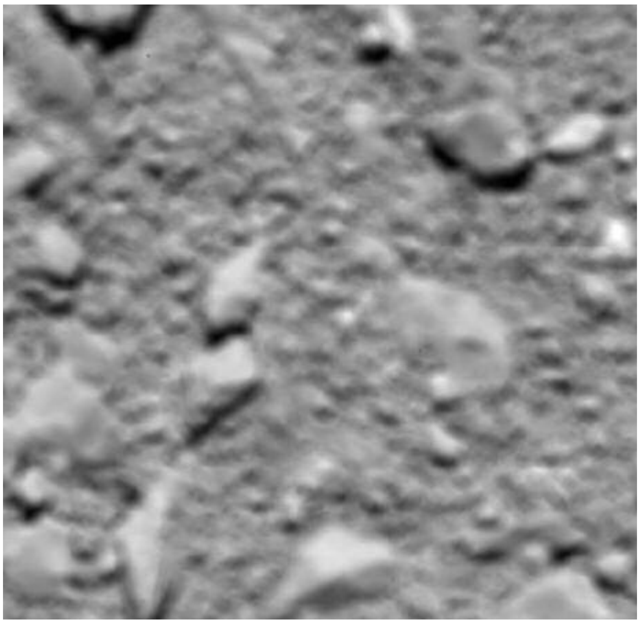
• **THE LAUNCH OF ROSETTA** – Rosetta was launched on 2 March 2004 07:17 GMT from the Guiana Space Centre on an Ariane 5G+ V-158.

Spacecraft properties *(Illustrations 5 and 6)*:
– Manufacturer: Astrium
– Payload mass: Orbiter (Rosetta) = 165 kg – Lander (Philae) = 27 kg
– Dimensions: 2.8 X 2.1 X 2 m
– Power: 850 W at 3.4 AU

The Rosetta Orbiter featured 11 scientific instruments.
The Philae Lander featured 9 scientific instruments.

■ 2005

• 4 March: Rosetta executed its first planned close swing-by (gravity assist passage) of Earth. The minimum altitude above the Earth's surface was 1,954.7 km.



3. Rosetta's last image of Comet 67P/Churyumov-Gerasimenko, taken with the OSIRIS wide-angle camera shortly before impact, at an estimated altitude of about 20 m above the surface. The initially reported 51 m was based on the predicted impact time. Now that this has been confirmed, and following additional information and timeline reconstruction, the estimated distance is now thought to be around 20 metres, and analysis is ongoing. The image scale is about 2 mm/pixel and the image measures about 96 cm across. © ESA/Rosetta/MPS for OSIRIS Team MPS/UPD/LAM/IAA/SSO/INTA/UPM/DASP/IDA

■ **2007**

• 25 February: Low-altitude Flyby of Mars, to correct the trajectory.

• 13 November: Second swing-by (gravity assist passage) of Earth at a minimum altitude of 5,295 km, travelling at 45,000 km/h.

■ **2008**

• 5 September: Flyby of asteroid 2867 Steins – Rosetta passed the main-belt asteroid at a distance of 800 km.

■ **2009**

• 13 November: Third and final swing-by (gravity assist passage) of Earth.

■ **2010**

• 10 July: Rosetta flew by and photographed the asteroid 21 Lutetia.

■ **2011**

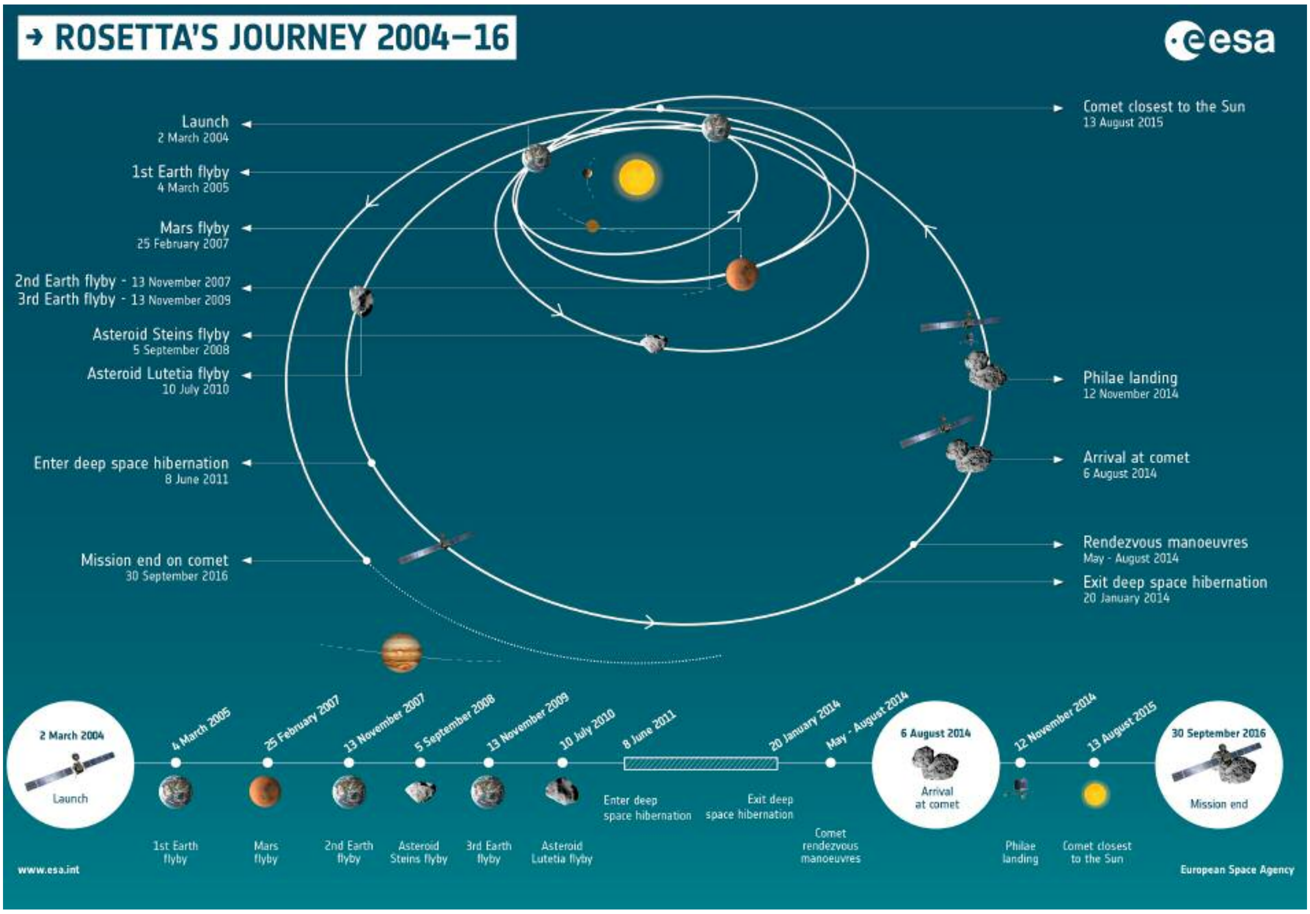
• 8 June: Rosetta enters a long dark hibernation.

■ **2014**

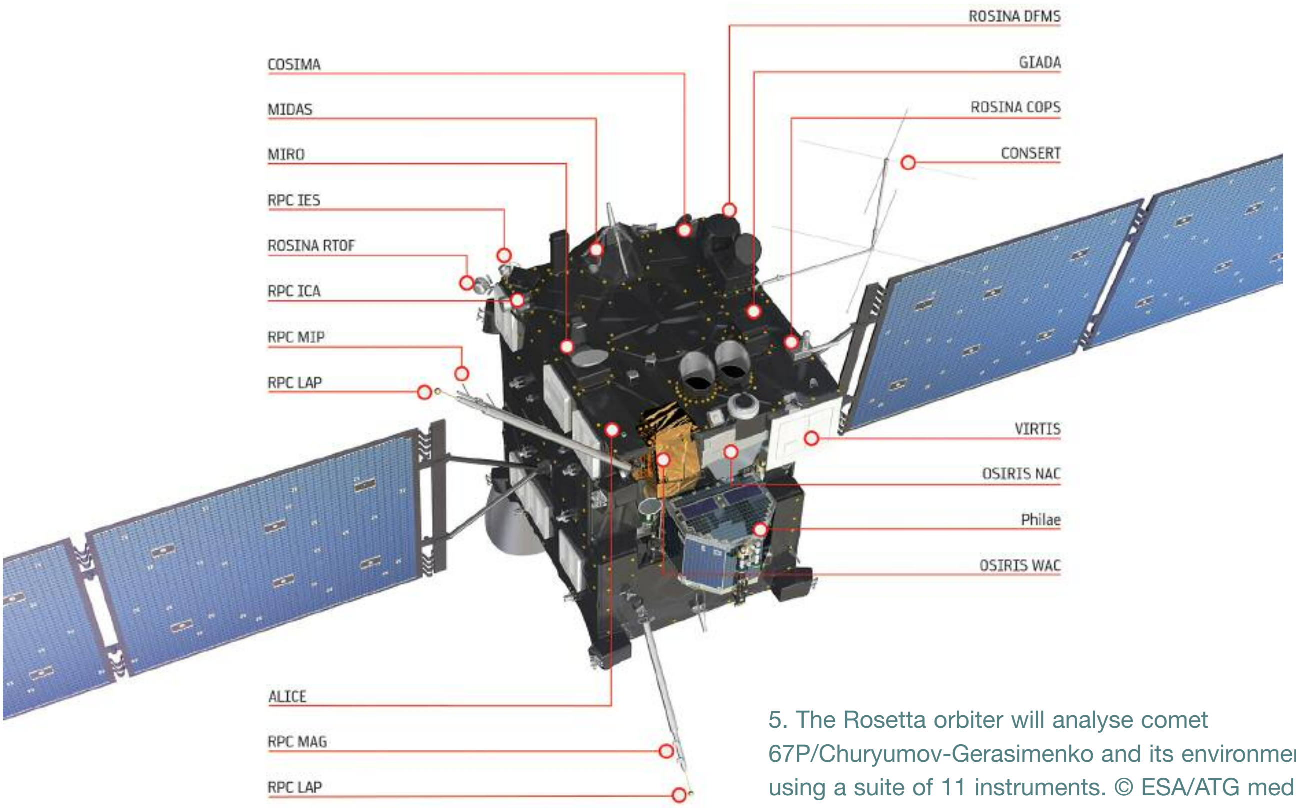
• 20 January: Rosetta was taken out of a 31-month hibernation mode as it approached comet 67P.

• 7 May: Rosetta began orbital correction manoeuvres to bring itself into orbit around 67P.

• 6 August: Rosetta arrives at 67P, approaching to 100 km and carrying out a thruster burn that reduces its relative



4. Infographic and timeline summarising the milestones of Rosetta's journey through the Solar System, from launch in 2004 to mission end in 2016. © ESA



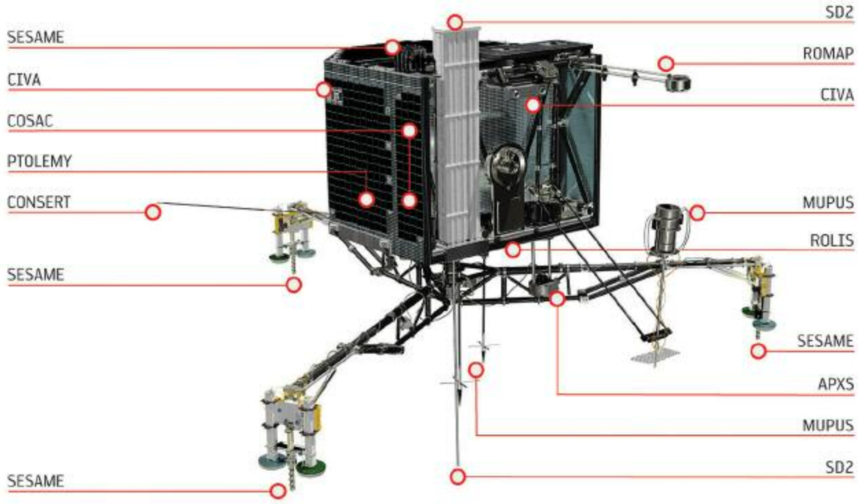
5. The Rosetta orbiter will analyse comet 67P/Churyumov-Gerasimenko and its environment using a suite of 11 instruments. © ESA/ATG medialab

velocity to 1m/s. Commences comet mapping and characterisation to determine a stable orbit and viable landing location for Philae.

• 14 August: Rosetta rendezvoused with 67P and commenced a series of manoeuvres that took it in two successive triangular paths, averaging 100 and 50 km from the nucleus.

• 10 September: Rosetta enters the Global Mapping Phase, orbiting 67P at 29 km altitude.

• 12 November: Philae lands on the surface of 67P *(illustration 7)*.



6. Rosetta will deploy the Philae lander to the surface of comet 67P/Churyumov-Gerasimenko for in situ analysis with its 10 instruments. © ESA/ATG medialab

■ **From November 2014 to December 2015:** Rosetta escorted the comet 67P around the Sun.

■ **2016**

• 27 July: ESA switched off the Electrical support System processor Unit aboard Rosetta, disabling any possibility of further communications with the Philae Lander.

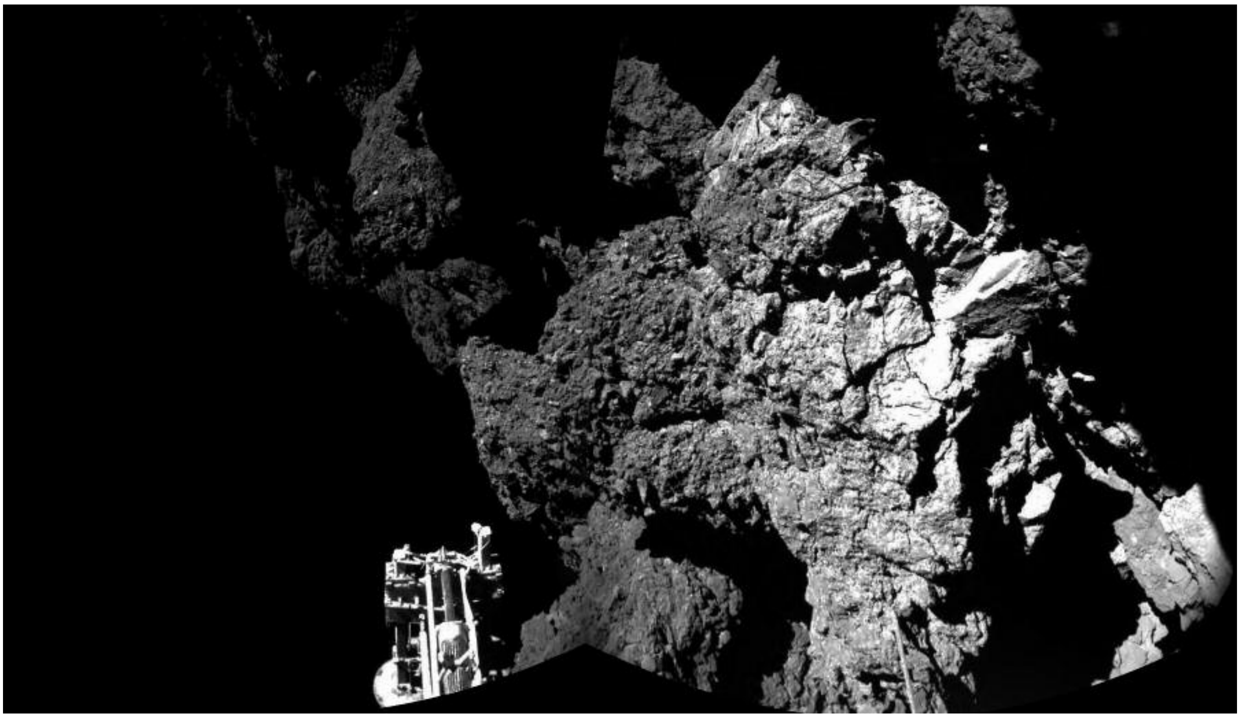
• 5 September: ESA announced that Philae was discovered by the narrow-angle camera aboard Rosetta as the orbiter made a 2.7 km pass over the comet showing Philae sitting on its side wedged into a dark crevice of the comet, explaining the lack of electrical power to establish proper communication with the orbiter.

• 30 September: the Rosetta spacecraft ends its mission by landing on the comet 67P at the Ma'at region.

IN TOTAL ROSETTA HAS MADE A 12.5 – YEAR / 8 MILLIARDS KM JOURNEY IN SPACE, WITH 6 ORBITS AROUND THE SUN, INCLUDING 3 EARTH FLYBYS, 1 MARS FLYBY AND 2 ASTEROID ENCOUNTERS.
IT WAS THE FIRST MISSION IN HISTORY TO RENDEZVOUS WITH A COMET AND ESCORT IT AS THEY ORBITED THE SUN TOGETHER.
IT WAS ALSO THE FIRST MISSION TO DEPLOY A LANDER TO A COMET'S SURFACE AND LATER TO END ITS MISSION IN A CONTROLLED IMPACT ON THE COMET.

NOTABLE RESULTS

Many surprising discoveries have already been made during the mission (786 days of operation in the environment of the comet), not least the curious shape of the comet that became apparent during Rosetta's approach in



7. Rosetta's lander Philae is safely on the surface of Comet 67P/Churyumov-Gerasimenko, as these first two CIVA images confirm. One of the lander's three feet can be seen in the foreground. The image is a two-image mosaic. The full panoramic from CIVA will be delivered in this afternoon's press briefing at 13:00 GMT/14:00 CET. © ESA/Rosetta/Philae/CIVA

July 2014. Scientists now believe that the comet's two lobes formed independently, joining in a low-speed collision in the early days of the Solar System.

Long-term monitoring has also shown just how important the comet's shape is influencing its seasons, in moving dust across its surface, and in explaining the variations measured in the density and composition of the coma – the comet's atmosphere -.

Some of the most unexpected and important results are linked with the gases streaming from the comet's nucleus, including the discovery of molecular oxygen and nitrogen, and water with a different flavour to that of Earth's ocean.

Rosetta has detected the amino and glycine, which is commonly found in proteins, and phosphorus, a key component of DNA and cell membranes.

Numerous organic compounds were also detected – not only by Rosetta in orbit, but also by Philae in situ on the surface.

The results delivered by Rosetta so far paint comets as ancient leftovers or early Solar System formation, rather than fragments of collisions between larger bodies later on, giving an unparalleled insight into what the building blocks of the planets have looked like 4.6 milliards years ago.

The vast trove of Rosetta spacecraft data is changing our view on how comets and the Solar System formed.

This Synthesis Paper has been written by J.-P. Sanfourche from ESA provided documentation.

TRAINING THE NEXT GENERATION HIGHLY SKILLED WORKFORCE

Prof. Dr Hester BIJL, Dean faculty of Aerospace Engineering, Delft University of Technology (NL)

Three trends will impact the education of aerospace engineers. Online education increases the number of people with aerospace knowledge, improve on-campus education and makes specialist knowledge accessible worldwide. Internationalisation calls for students prepared for a global workplace. Innovation ecosystems will lead to students learning in an environment of open innovation and co-creation.

TRAINING THE NEXT GENERATION HIGHLY SKILLED WORKFORCE

Figure 1: Multi-fuel blended wing body aircraft by ahead.euproject.eu

"Training the next generation highly skilled workforce for the aerospace sector and beyond: that's exactly what we do at the faculty of Aerospace Engineering at Delft University of Technology in the Netherlands.

We currently deliver T-shaped engineers: professionals who've learnt a broad base of aerospace engineering disciplines, basic sciences and project skills in their Bachelors and who've specialised in a particular subject in their MSc. This educational philosophy is highly valued by employers of our alumni. Even in the harsh economic climate we've had in the past years more than 80% of our graduates found a good job within 3 months. 98% of them were employed within 12 months. A contact person for our interns at Airbus Hamburg said: "I am very keen on working with TU Delft students since they have an excellent toolbox that enables them to solve any engineering problem."

But enough already of the sales pitch.

As the Dean of the faculty it's my task to ensure that we keep on training the engineers and scientists who will exceed the industry's expectations, now and in the future. That means adapting our curriculum and our learning environment to the constantly changing trends and developments in the world whilst at the same time staying true to the core task of a university: training people to become independent thinkers, adult professionals. Not people who know how to use a particular kind of rivet, but people who come up with the technology to make a morphing aircraft instead.

In this speech I will address three important trends in the world that will have a tremendous impact on educating the next generation of highly skilled aerospace engineering professionals: online education, internationalisation and the disappearance of the innovation chain.

1. Online education

Online education is a trend that has enormous impact and offers enormous chances for university education. University-run platforms such as EdX and Coursera offer Massive Open Online Courses at a multitude of universities worldwide on many different topics for massive audiences, bringing education in every nook and cranny of the world as long as there's an internet connection. Prof Eds bring paid online specialist courses to professionals engaged in life-long learning or training for the job.

How will online education affect education of the next generation of highly skilled professionals?

- Well, first of all: there will be growing number of people who have a decent base in aerospace engineering. Think about the free online courses (MOOCs) for instance. They make knowledge available to a large audience. In the MOOC we offer – Introduction to Aeronautical Engineering – so far 47.135 online students have enrolled. Many of them would otherwise not have been able to learn the material.
- Second: the professionals trained on campus will receive better education and will have better access to specialist knowledge worldwide. In other words online education improves on-campus education to bachelors and masters. Blended learning classes are a combination of on-campus and online education. It enables students to view classes and explanations of material online. Contact time can be used for quality interactions with fellow students and lecturers. In addition, what we've noticed is that teachers start to innovate and renew their classes and material once they start putting lectures online. And online education makes it much easier for students to follow parts of their study elsewhere, e.g. do a minor at MIT.
- And thirdly professionals already in the workforce can update and deepen their knowledge more easily. Professionals who would normally skip a master programme because it conflicts with work, can now follow a particular selection of courses from a master programme online. Companies can buy particular Prof Ed courses to keep their staff up to date on new knowledge and technology.

Having said that, we will keep on seeing students in on-campus environments in the future as well. Especially the BSc students who are still 'coming of age'. They are shaped into professionals not alone by teaching them knowledge, but also by being part of an academic community. What works well in Delft is encouraging students to join multidisciplinary Dream Teams, designing and building solar cars, bicycles cycling 113 km /hour, airplanes and electric racing cars to give a few examples. Moreover: these teams compete in international competitions. In October 2015 the students of the Delft Aerospace Rocket Engineers broke the European record launching their homemade StratosII rocket on coffee sweeteners to a height of 21 km.

I see that many universities are improving their campuses to attract the best students. This is for a large part a result of the second trend I'd like to put forward: internationalisation.

2. Internationalisation

A second trend that has tremendous impact on education is internationalisation. What effects will this trend have on education?

- The next generation workforce will be trained in an international environment. Taking the AE Delft student population as an example, where we have taught in English for a long time. At the moment 35% of our BSc students in AE is international, 70% of the AE MSc students is international. The influx into our MSc of students with a BSc from outside the Netherlands has quadrupled in four years. Also our staff is much more international now than ten years ago. 45% of permanent scientific staff is international and 80% of the recently hired tenure trackers.
- We will need to make room in our curriculum for international collaboration skills. Many of the student teams working together on design projects at Delft are international already. But we also stimulate extracurricular collaboration in international teams. In May the TU Delft led MultiFun team, 6 students spread over 4 universities in US, India and Europe won the Airbus Fly Your Ideas competition with electricity generating aircraft wings.
- Students will be prepared for a global rather than a national or European workplace. They will need to compete with alumni from competitive universities worldwide. This means that their curriculum will be adapted more to the needs of a global industry and that international educational trends will have more effect on their education programmes.

For universities internationalisation means participating in a fierce international battle for talent when scouting for the right staff, PhDs and students.

In Europe this is not an easy task: we can't offer the salaries offered in the US or in Abu Dhabi. And that's the reason having an attractive campus with good facilities is so important. I believe such as campus is a place where different parties come together to research, create and implement together. This is the third trend that will impact the way the next generation engineer will be trained: the disappearance of the old innovation chain.

3. The disappearance of the innovation chain

The next generation aerospace engineers will increasingly

Figure 2: Design Synthesis Exercise.
Photo: Guus Schoonewille).

learn knowledge and skills in an environment of open innovation and co-creation with other parties of the innovation chain. Currently, the innovation chain is quite linear. It consists of universities doing fundamental, curiosity driven research, universities of technology focusing on application inspired research on lower TRL-levels, research institutes doing research on higher TRL-levels and the industry bringing new technology to the market mostly in a chronological order. But especially in the aerospace sector disruptive innovations – needed to give the sector a competitive edge - take decades to be developed and marketed. The way currently work on innovation in Europe is too slow and too costly. We need to speed up innovation and use new technology and new ways of collaboration to do that. The student needs to participate to be ready for the market place.

I believe the innovation chain is changing rapidly into an innovation ecosystem where parties collaborate in living labs co-creating new technology. This will be the environment where the next generation aerospace engineer will be trained, will contribute from day one to innovation and where he/she comes back to after starting work for a company. A great plus of this education environment is that the student is already participating in international, multidisciplinary teams in close proximity of the industry. It's a place where lower TRL research, essential as a basis for disruptive innovation, will thrive. Needless to say that this ecosystem will be blended: on site and online. It will bring together universities, institutes and companies in living labs.

Concluding:

I've spoken to you about three trends that will dominate the outlook of engineering education. Online education, internationalisation and the upcoming innovation ecosystem. They will prepare the next generation aerospace professional for a successful career in a global job market.

Let me conclude with an even longer term outlook: let's think about starting joint university – industry topmasters.

This paper is the presentation given by Prof. Dr Hester Bijl, Dean Faculty of Aerospace Engineering, Delft TU (NL) at the Aeroadays 2015 which took place in London on 20-23 October 2015.

CONSULT THE CPMIS : CEAS CONFERENCE PROGRAMMING MANAGEMENT INFORMATION SYSTEM

The aim of the CPMIS is to facilitate the search of the different aerospace events in the world that are programmed at short and mid-term time horizon, and so allowing to optimise the scheduling of future events by avoiding possible overlapping and redundancies, but on the contrary to encourage co-operations and synergies between the actors concerned.

Please note that the new address of the CPMIS: http://www.aerospaceevents.eu

A search engine selects the events according to specific topics and key words. A graphic display (day, week and months view) eases the access and the view.

- 4 TYPES: Conference, Workshop, Lecture, Air Show
- 6 MAIN CATEGORIES: Aeronautical sciences - Aerospace (for events including all aspects of aviation and space) – Civil Aviation – Air power – Space – Students and Young Professionals.
- 64 SUB – CATEGORIES: aeroacoustics – aeroelasticity – aerodynamics, etc.

AUTOMATIC INSERTION OF NEW EVENTS BY THE ORGANISERS THEMSELVES:

- Go to http://www.aerospaceevents.eu
- Click on the "introduction" text
- Redirected on the New Event Form, you have to click on this form and to enter your event related information, validate, click on Save and send.

Point of Contact:

postmaster@aerospaceevents.eu is the general address for any question and requests;

– Jean-Pierre Sanfourche, CEAS, responsible for the Event Calendar permanent updating and validation: **sanfourche.jean-pierre@orange.fr**

END 2016 AND 2017

17-18 October	• **RAeS** – Delivering Sustainable Growth in Aviation – London (UK) - RAeS/HQ www.aerosociety.com/events
18-20 October	• **Aviation Week** – MRO Europe 2016 – Amsterdam (NL) – RAI Exhibition and Conference Centre – www.mroeurope.aviationweek.com/
18-20 October	• **IATA** – 6th World Passenger Symposium – Dubai (UAE) - JW Marriott Marquis Dubai www.iata.org/events/
18-21 October	• **EASN** – 6th EASN International Conference – Porto (Portugal) – www.esan.net
25-26 October	• **EASA** – EASA Annual Safety Conference – Bratislavia (Slovakia) – Crowne Plaza www.easa.europa.eu/
25-27 October	• **IATA** – IATA Safety Management Conference – Abu-Dhabi (UAE) – Ritz-Carlton Gd canal www.iata.org/events/
27-28 October	• **ERCOFTAC** – Uncertainty Mgt & Quantif. in Industrial Analysis and Design – Ghent (Belgium) University – www.ercoftac.org/events
01-03 November	• **NBAA** – NBAA's Business Aviation Convention & Exhibition – Orlando, FL (USA) - Orange County Convention Center – www.nbaa.org/events/bace/2016
01-06 November	• **Airshow China** – 11th China International Aviation & Aerospace Exhibition – Zhuhai Guangdong (China) – www.airshow.com.cn/en/
02-03 November	• **ERCOFTAC** – Best Practices in Combustion CFD – internal Combustion Engines – Darmstadt (Germany) – TU Darmstadt – www.ercoftac.org/events
03-04 November	• **ERCOFTAC** – High Order methods for Industrial CFD – Brussels (Belgium) – NUMECA – www.ercoftac.org/events

END 2016 AND 2017

06-11 November	• **CANSO** – CANSO Global ATM Safety Conference 2016 – Transforming Global ATM Performance Budapest (Hungary) – sofitel Budapest Bridge Chain – www.canso.org
06-19 November	• **Iran** – 8th International Iran Air Show – Kish Island (iran) – www.iranairshow.com
08-10 November	• **SESARJU** – 6th SESAR Innovation Days – Delft (NL) – TU Delft – www.sesarinnovationdays.eu
08-10 November	• **RAeS** – Rotorcraft Virtual Engineering Conference – Liverpool (UK) – University of Liverpool www.aerosociety.com/Events/
08-10 November	• **RIN** – INC 2016 -International Navigation Conference – Glasgow (UK) – University of Strathclyde /Technology & Innovation – http://www.internationalnavigationconference.org.uk/
08-11 November	• **ESA** – 10th Round Table on Micro and Nanotechnologies for Space Applications – Noordwijk (NL) ESA/ESTEC – www.congrexprojects.com/list-of-events
14-16 November	• **FSF** – 69th annual International Air Safety Summit (IASS) – IASS = the largest safety event. Dubai (UAE) – Congress Centre & Hub – www.flightsafety.org/
15-17 November	• **ACI-Europe** – Airport Exchange 2016 – Istanbul (Turkey) – Istanbul Congress Centre www.aci-europe-events.com
15-17 November	• **ICAO** – ICAO Assembly 39th Session and Exhibition on ICAO TRIP – Montréal (Canada) ICAO/HQ – www.icao.int/Meeting
16-19 November	• **Iran** – 8th Iran air Show – Kish Island (Iran) – www.iranairshow.com
21-22 November	• **ESA** – Coordinated Final Presentations Days – Noordwijk (NL) – ESA/ESTEC www.esaconferencebureau.com/2016-events
22-23 November	• **RAeS** – Simulation Based Training – The Key to Military Operations – London (UK) – RAeS/HQ www.aerosociety.com/Events
22-23 November	• **ACI Europe** – ACI Security Summit – Brussels (Belgium) – The Square, Downtown Brussels www.aci-europe-events.com
29 Nov. – 1st December	• **AEROMART** – AEROMART TOULOUSE 2016 – International Business Convention for the Aerospace Industry – Toulouse (France) – Centre des Congrès Pierre Baudis - Toulouse.bciaerospace.com
6-7 December	• **EASA** – 10th Rotorcraft Symposium – Cologne (Germany) – EASA/HQ – www.easa.europa.eu/
14-16 December	• **ESA** – NAVITEC 2016 – Navigating for the Future of Space Transportation – Noordwijk (NL) ESA/ESTEC – www.congrexprojects.com/list-of-events

2017

09-13 January	• **AIAA** – AIAA SciTech 2017 Science and Technology Forum and Exposition – Grapevine, TX (USA) Hotel Gaylord Texan – www.aiaa-scitech.org
01-02 February	• **SEE/3AF** – MEA 2017 – Toulouse (France) – Palais des Congrès – www.see.asso.fr/

02-03 February • **ICAS** – ICAS 2017 International Conference on Aeronautical Sciences – Melbourne (Australia) WASET – https://www.waset.org/conference/2017

05-09 February • **AAS/AIAA** – 27th AAS/AIAA Space Flight Mechanics Meeting – San Antonio, TX (USA) – Marriott Plaza – www.space-flight.org/

13-14 February • **ESA** – 3rd ESA International Security Symposium – Frascati (Italy) – ESA/ESRIN www.esaconferencebureau.com/list-of-events

14-18 February • **Aero India** – Aero India 2017 – Bengaluru (India) – Yelahanka AFS – www.aeroindia.in/

28 February – 5 March • **AVALON** – Australian International Air Show – Geelong VIC (Australia) - Avalon Airport www.airshow.com.au/

04-11 March • **IEE** – IEEE Aerospace Conference – Big Sky, MT (USA) – Yellowstone Conference Center www.aeroconf.org/

06-09 March • **AIAE** – 21st AIAA International Space Planes and Hypersonic Systems – Xiamen (China) University Xiamen – www.aiaa.org

07-09 Mars • **CANSO** – World ATM Congress 2017 – Madrid (Spain) – IFEMA Feria de Madrid www.worldatmcongress.org/2017

03-06 April • **ERCOFTAC** – European Drag Reduction and Flow control Meeting – Monte Porzio Cantone –Italy) Villa Mondragone – www.ercoftac.org/events

03-07 April • **EUROTURBO** – 12th European Turbomachinery Conference (ETC) – Stockholm (Sweden) – KTH www.euroturbo.eu

05-08 April • **AERO Friedrichshaffen** – AERO Friedrichshaffen 2017 – Messe Friedrichshaffen - www.aero-expo.com

11-13 April • **NBAA** – ABACE 2017 – Asia Business Aviation Conference & Exhibition – Shanghai (China) – Shanghai Hongqiav Airport – www.abace.aero

22-24 May • **EBAA** – EBACE 2017 – Geneva (Switzerland) – Palexpo – www.ebace.aero/2017

25-27 April • **CEAS** – EuroGNC 2017 – 4th CEAS Specialist Conference on GNC – Warsaw (Poland) – WUT – http://www.ceas-gnc.eu/

29-31 May • **AESS/IEEE** – 24th Saint Petersburg International Conference on Integrated Navigation Systems – Saint Petersburg – Concern Central SRIE – www.elektropribor.spb.ru

29-31 May • **ERCOFTAC** – DLES 11 Direct and Large Eddy Simulation – Pisa (Italy) – www.ercoftac.org/events

29 May-02 June • ESA – 10th International Conference on Guidance, navigation and Control – Salzburg (Austria) – Crowne Plaza Salzburg - www.esaconferencebureau.com/list-of-events

05-10 June • **AIAA** – AIAA AVIATION 2017 Forum - Aviation and Aeronautics Forum and Exposition – Denver, CO (USA) – Sheraton Denver Downtown Hotel – www.aiaa-aviation.org/

05-10 June • **AIAA/CEAS** – 23rd AIAA/CEAS Aeroacoustics Conference – Denver, CO (USA) – Sheraton Denver Downtown Hotel – www.aiaa.org/aeroacoustics/

AMONG UPCOMING AEROSPACE EVENTS - End 017

19-25 June • **ISAE/GIFAS** – IPAS 2017 International Paris Air Show – Le Bourget Airport – www.siae.fr

25-28 June • **EUROMECH** – Euromech Turbulence Conference (ETC) 2017 – Porto (Portugal) – University – Faculty of engineering – www.euromech.org

10-12 July • **AIAA** – AIAA Propulsion and Energy 2017 forum – Atlanta, GA (USA) – Hyatt Regency www.aiaa-propulsionenergy.org

12-14 September • **AIAA** – AIAA SPACE 2017 Forum – Orlando, FL (USA) – Hyatt Regency – www.aiaa-space.org

25-29 September • **IAF** – 68th International Astronautical Congress – Adelaide (Australia) – Adelaide Convention Centre www.aiaa-space.org

16-20 October • **CEAS** – Aerospace Europe 2017 Conference – 6th CEAS Air & Space Conference – Bucharest (Romania) Parliament of Romania – www.ceas2017.org