2014

FONDATION AIRBUS GROUP

RESEARCH TAKES FLIGHT DAY 2014

« Robotics in the Factory of the Future »

Press contact:

Airbus Group Corporate Foundation

Eve Humbert

E-mail: eve.humbert@airbus.com

Tel: +33 1 46 97 33 65

www.fondation.airbus-group.com

Twitter: @AirbusGroupFond

Table of contents

1. The Research Takes Flight Day of the Airbus Group Foundation

1.1 Presentation of the Airbus Group Foundation

Founded in 2004, the Airbus Group Corporate Foundation aims to develop ties between public research and private research and invests in scientific projects of excellence. It also pursues corporate patronage activities, asserting its societal and ethical commitment in the scientific field.

Since its creation, the Airbus Group Corporate Foundation has supported over 120 scientific and technological research projects and has established 12 teaching and research chairs, and honored nearly hundred men and women of sciences.

1.2 What is the 'Research Takes Flight Day'?

The 'Research Takes Flight' day is the Airbus Group Foundation's yearly highlight. This event features a number of conferences and round-tables opening a new door for dialogue between the corporate and research world, and for debate about the key issues shaping society. It also provides an opportunity for Foundation grand holders to meet and discuss their projects. In addition, the Foundation hands out the three Foundation Prizes (which it awards in association with the Academy of Science) and its six Best Thesis Prizes.

1.3 Why focusing on robotics?

Between electronics, embedded software, and artificial intelligence, robotics is now seizing upon every domain, including of course industry.

Current research aims to create collaborative robots that can assist humans in complex tasks. Easier to implement and easier to use, these 'cobots' are changing the way robots can be used in production environments, expanding automation possibilities and offering smart solutions for today's industries (car, aviation, space industries...). If implemented, they will allow manufacturers of all sizes to have more flexibility in automating diverse tasks and bring major changes in the aviation industry.

It seemed logical to focus on this technology at the cutting edge of industrial and academic research.

The Research Takes Flight Day devoted to Robotics and Factory of the Future

Aiming to promote exchanges and reflection among actors of public research and private research, the 'Research Takes Flight Day' was held on Monday 31st March 2014 in Paris in the presence of researchers and experts in this field.

During the opening conference, Jean-Paul Laumond, Director of Research at LAAS-CNRS, took stock of "50 years of research in robotics" and spoke of the "new opportunities" in this field: "*Manufacturing represents a big potential market for robotics, especially in large-scale industries such as aircraft manufacturing.*"

During the round-table on "Factory of the future: what degree of autonomy can we expect from robots in the development of their actions?", various experts gave an update on the latest developments of industrial robotics and the challenges that remain. "*The new challenge is to have an autonomous flying vehicle - I'm not speaking about tele-operated drones, but about autonomous drones*" stated Bruno Siciliano, Coordinator of the FP7 NMP-ICT-FoF EuRoC Project - University of Naples Federico II. Christoph Borst, Head of Department Autonomy and Teleoperation, Institute of Robotics and Mechatronics, German Aerospace Center (DLR), said the complete autonomy of robots was not for the immediate future: "*In the coming years, we will see robots in the factory that interact directly with humans, but real autonomy of robots is not for now, I rather expect to see robots able to imitate what they have seen or learned through demonstrations.*" Adolfo Suarez Roos, Airbus Group Expert - Robotics, Coordinator of ANR project ICARO preferred to speak of adaptability rather than autonomy: "*In the factory of the future, we want more flexibility, robots that have the ability to reconfigure their task if they encounter an unexpected situation*". Mariusz Baldyga, Project Officer - Robotics Unit - European Commission, DG Communications Networks, Content and Technology (Programme H2020) added: "*We have launched projects on the flexibility and autonomy of robots under the Horizon 2020 program, but with regard to completely autonomous robots, it will be after 2020*".

This discussion was followed by a conference on "Robotics in Space" by Gianfranco Visentin, Head of Automation and Robotics Section at ESA, which stressed the specificity of robots used in space: "*Space robots must meet the very demanding constraints of Space (high radiation, low power, different gravity), which makes them very different from ground robots and requires the development of appropriate technology*".

Conference participants were then able to discover the projects supported by the Foundation through an exhibition and to applaud the winners of the Foundation Awards and Best Thesis Awards.

2. Robotics in the Factory of the future

2.1 « 50 years of robotics research: new opportunities » by Jean-Paul LAUMOND, Research Director at LAAS-CNRS.

Robotics is about moving computer controlled machines to manipulate objects or explore the world.

50 years of research in Robotics

Robotics is born in the early 1960's with the introduction of the Unimate robot in the General Motors factory by George Devol and Joseph Engelberger who are recognized as the fathers of robotics. In France at the same time, Jean Vertut was developing the Computer Aided Tele-manipulation at CEA. That kind of research has opened a route towards the fixed-based robots that operate today in automotive industry or in computer aided surgery.

The early stage in locomotion started in the 1970's with the Shakey Robot at SRI, the very first mobile robot. This was also the period when artificial intelligence and robotics were connected. In France, Georges Giralt started a project on the Robot Hilare at LAAS-CNRS. Today, locomotion is used for exploration, servicing (Mars Rovers, Cleaning Robots, iRobot, Toyota Google Car). Robotics research has developed in the 1980's with the structuration of the community and the creation of the main foundations like IFR (International Federation of Robotics), IEEE Robotics and Automation society, and some international programs to coordinate research at international level.

Humanoid robotics started in the 1970's but has successfully developed in the 1990's mainly driven by the Humanoid Research Project (HRP) at AIST and Japanese technology (Kawada). LAAS-CNRS has been working on humanoid robotics for several years now. In 2007, a first experiment showed it was possible to coordinate locomotion and manipulation. In 2009, another experiment showed embodied action was possible: the HRP2 robot grasped an object on the floor without stepping dedicated program. Finally, in 2012 a third experiment showed that dynamic motion control was possible: HRP2 went through a wall. These experiments have been done in laboratory and show the capabilities of the robot of the future.

Robotics: success story, current developments, new opportunities

Regarding the applications, in terms of manufacturing, robotics is a success (cars built by robots), and there is a huge development of the robotics industry worldwide. Currently, new markets include entertainment (Paro robot from AIST, Japan), servicing (Reem robot from Pal Robotics, Spain), and education (Nao and Romeo robots from Aldebaran, France).

Regarding the new opportunities, manufacturing remains a market for robotics and Japanese companies like Kawada perfectly understood the importance of this market ("The Glory Factory"). There is a renewed and growing awareness about robotics potential when speaking about the Factory of the Future. The European Commission is supporting very big challenges on the introduction of robots in manufacturing cells, logistics, plant inspection and servicing (FP7 Euroc Project). Other challenges, like the "Darpa Grand Challenge", show that robots are also able to act in an unstructured environment or "extreme worlds" and can therefore be interesting for big companies: Google bought the robots Schaft and Atlas, winners of the Darpa Grand Challenge first phase. Finally, robotics has a huge potential in "Large-Scale Manufacturing": in 2014 the very first results showed it is possible for a humanoid robot to adapt itself in a moving environment where operators are working. Today there is a compromise between safety and power. The next stage will be to make robots safer in order to let them work close to humans. The best solution would be to develop a platform both safe and powerful, in other words to develop a true humanoid robot

industry. This can only be supported by huge companies and this is why Google is investing a lot in that area.

2.2 Round-table and discussion on "Factory of the future: what degree of autonomy can we expect from robots in the development of their actions?"

Towards new industrial robots

Adolfo Suarez Roos:

"We have industrial robots traditionally doing the same thing over and over; we want to have more flexibility. We are no longer looking at the same tasks repeatedly. Production has shifted to more diversified products and we need robots that can rebuild their activity more often: therefore we look at their capability to reconfigure the task easier and faster. The second trend is to have collaborative robots working very close to people. Here the big issue is safety. Then we have this aspect of cooperation, when the human is very close to the robot, they need to understand each other, to accept each other, to anticipate each other, to feel comfortable."

Bruno Siciliano:

"The four of us are engaged in the Project called SAFARI with Alessandro de Luca (Roma). In this project, we look at the issues of safety and dependability. We need cognitive robots, social interaction between the robot and the human."

"Regarding industrial robots, we have manipulation, mobility, now the challenge is to have mobile robots in the 3rd Dimension. The new challenge is to have an autonomous flying vehicle, and there is a large number of industrial applications where you can have the 3 Dimensions: in parallel to Google, Amazon is speaking of sending packages with drones. If we speak about manufacturing we have a number of servicing applications where you can add a third dimension. I really foresee a massive increase of interest in manufacturing thanks to robots and I'm not speaking about tele-operated drones, but about autonomous drones like the Google car."

Christoph Borst:

"I would like to stress the point that robots coming to factory now have some interaction capabilities. For the last 50 years, we have mainly developed motion capabilities and now we're starting to develop a language of interaction, but we need to start with simple paradigms. Anticipating what a human thinks is really complicated. If we think about collaboration with animals

like dogs, this provides basic interaction and collaboration schemes that you we could apply to mobile robots in the near future."

Mariusz Baldyga:

"One task of the European Commission is to support the competitiveness of the European industry, and this is done by supporting European research and European science. The Commission has set up research support tools in the form of 7 programmes under the Horizon 2020 initiative, which is the biggest EU Research and Innovation programme ever with nearly €80 billion of funding available over 7 years (2014 to 2020). One of the prominent domains supported is robotics. Some cluster projects try to develop more autonomous mobile manipulators. There are many developments regarding autonomy, however truly mobile autonomous manipulators are still not in place."

What are the main challenges today for the aerospace industry when compared to other industries like car manufacturing?

Adolfo Suarez Roos:

"In the car industry they produce a vehicle every minute, meaning a thousand cars are manufactured a day. A robot has 40 seconds to do its job so you program the robot for 40 seconds: the programming takes one month. At Airbus we produce 1.5 planes per day, so we have to look at tasks that will last for some hours, and this is very difficult in terms of programming. We have high quality requirements and large parts, but we need mobile, collaborative robots and a very simple, efficient way to program the robot; we cannot take one month to program one minute."

Interaction between men and robots

Christoph Borst:

"The more complicated things should be done by humans; I think we have to keep humans in the production lines and whenever it is possible to delegate to the robot, the worker on site should be able to do it. We should have programming schemes to interact and guide the robot in some way, programming by demonstration. The big problem is to gain some adaptability: if you are working on something and then you move to another task, you need some task knowledge – the robot should know its position and the motion he can do, and then be able to translate the task knowledge given by the worker directly into robots programs. This is main challenge: learning by imitating.

Perception of humanoid robots by other workers

Adolfo Suarez Roos:

"In Japan, humanoid robots are well accepted; in Europe it is more difficult. Regarding interaction, humanoid robots are very interesting because 50% of the communication comes from the gesture. Humanoids can best interact with people in the way that people understand. Another interesting point is that humanoids have two arms and some of the tasks require two arms. Also, legs allow the 3D movement – you can go upstairs, downstairs, access difficult places that you can't access with wheels. However walking is a very complex task and falling down for the robot is fatal. We need humanoids that could fall down without breaking and this is very challenging."

Christoph Borst:

"We are now looking at areas where the work space is designed for humans: if we want to place a robot that takes over all those tasks, it's easier if the robot looks the like a human, otherwise you have to redesign the whole manufacturing process, and if the robot fails, humans cannot intercept or take over."

Are robots going to replace humans?

Adolfo Suarez Roos:

"Robots are not replacing humans, we see them more as tools – we look at the sequence of tasks that humans perform in the factory, some are very simple and some are complex: the simple tasks, we can try to delegate them to robots, whereas the complex tasks will still be performed by humans.

In the picture we saw at the beginning, the human is doing something, preparing the work for the robot, and the robot has a different task: we try to split roles and to differentiate between things repetitive or heavy to do, and things requiring a lot of dexterity."

Bruno Siciliano:

"Robot has become a tool that can be used in a friendly way; the worker can work with a fully compliant cell."

In the future, what degree of autonomy can we expect from robots in the development of their actions?

Christoph Borst:

"I would also expect the robot to be able to imitate things they have seen, they have been taught, they have learned via demonstrations. I don't think they will figure out new solutions yet – real autonomy is when you have a problem, you don't have the right tools to solve it, and you come out

with a new solution, this is the aim of the research we are doing, but I don't see this in the coming years in the factory. What I see is imitation, not robots taking over the factory."

Mariusz Baldyga:

"In a short-term perspective, I expect to see highly flexible 'cobots' (collaborative robots), nearly autonomous robotic systems; other developments will bring us closer to autonomy, however we are aware that truly autonomous robots in industrial settings are still a bit away. For the moment, we try to make the system nearly autonomous."

Bruno Siciliano:

"Robotics has evolved as an Information and Communication Technology (ICT). In order to bring solutions to manufacturing, you have to deal with real issues. I'm not convinced about "one solution", it's in between: for application tasks, we can have a shared autonomy between workers and robots – we just have to make this solution compliant, and also fully tolerant. It might be an issue of safety, redundancy, and dependability. Those are the questions we have to answer to reach progressive levels of shared autonomy in manufacturing applications. Manufacturing people need solutions. Solutions have to be taken from the laboratory to the end user, and all stakeholders have to be involved to increase confidence and shared autonomy in manufacturing scenarios."

Adolfo Suarez Roos:

"Research has been done to develop service robots with a high degree of autonomy to help people with disabilities and the elderly. These robots need to have a high degree of autonomy, but the situation is different in the industry where there is a sequence of operations to be performed… therefore there is no need of creative robots similar to service robots. In the ANR ICARO project, software architecture has been developed to provide a greater ability to robots to adapt to change: if a robot encounters an obstacle on its way from a point A to a point B, in some situations, it should be able to take an alternative way. For the moment, this is the first challenge: we would like to develop a robot which doesn't get stuck at the first unexpected situation – a robot intelligent enough to change its path, to say, 'If I can't do the task this way, I can try something else'. We call this degree of autonomy 'adaptability'."

2.3 Conference on "Robotics in space" by Gianfranco VISENTIN, Head of Automation and Robotics Section - ESA

Space Robots are needed for a variety of tasks: for orbital applications in low earth orbit, to build infrastructure in the space station, or in geostationary orbit for servicing satellites. Space robotics is also used for planetary applications, exploring planets, or small bodies (comets, asteroids). Robots are used for tasks that humans cannot do: robots at the space station are manipulating pieces between 11-15 tones; also it is not yet possible to send humans to mars, whereas robots can be sent with one way ticket.

Space robotics offers many opportunities but also includes problems.

A lot more constraints than on Earth

The very demanding constraints of Space (e.g. high radiation, low power, different gravity) make space robots very different from ground robots. Also the peculiarity of Space makes possible the creation of exotic robot systems, otherwise not possible on Earth.

Space robots have to survive the launch and landing loads and therefore require dedicated mechanical design of supporting structures, hold-down, release mechanisms, specially mounted electronic components, expensive test facilities. They have to function:
- in vacuum (for external applications), which implies only non-outgassing materials, special lubrication means, no brushed motors, clean room integration and testing.
- under "weightlessness", which means no stable rest position - everything must be fastened, altered dynamic effects, very low backlash gearing.
- under radiation exposure, which means limited materials life time, shielding and "hardened" technology. Radiation exposure is the main problem and requires specific processors and special lenses.
- under extreme temperatures in vacuum (for ext. applications) which requires multi-layer insulation, distributed electric heaters.
- in extremely remote environment which implies comprehensive testing before launch, little "maintenance", adequate level of "autonomy", in-orbit calibration and sensor-based control because no "teach-in" is possible, and effective ground operator if needed.

Space robots also have to cope with extreme lighting and contrast conditions, which make vision and image processing difficult.

They are very smart robots dealing with major constraints.

Space robotics: missions in development, examples of technology developments

ESA developed or is developing a variety of space missions using robots (PHOOTPRINT, Mars Sample Return, ERA, ExoMars), and is implementing the specific technology addressing these demanding constraints (Orbital robotics, Planetary robotics).

For more information, please see the presentation “Robotics in Space” available on this page: www.fondation.airbus-group.com/content/en/The-Foundation/Research-takes-flight-Day/Archives/2014-Edition/

or visit: http://robotics.estec.esa.int/

3. Airbus Group Foundation and Best Thesis Awards Ceremonies

3.1 « Airbus Group Foundation Awards »

As part of its action towards academic research, the Airbus Group Foundation has asked the Academy of Science to create three prizes rewarding milestone scientific work.

For the 2013 edition, the jury announced the following winners:

- **"Information Sciences" Award: Olivier Cappé, CNRS Research Director, Director of LTCI (CNRS / Telecom ParisTech) in Paris.**

Olivier Cappé, Director of the Information Processing and Communication Laboratory (LTCI) is an internationally recognised specialist in the statistical processing of signals. His algorithms are particularly effective for the restoration of audio signals and for speech recognition, analysis and synthesis. Its major contributions are valuable for searching complex information among very large masses of data by online algorithms. They apply equally well to exploration of cosmological models using cosmic radiation maps as to the probabilistic matching of tens of millions of fragments of genomic sequences and to the dynamic adaptation of Web content to users' preferences.

Established in 2007, this Award honors those rising researchers who have already obtained national and international recognition for their originality, the quality and importance of their work, and who have maintained exceptionally productive ties with the industry and/or have made major contributions in areas with remarkable practical impact. The award recipient alternates every year between a Division 1 discipline (physics, mechanics, and universe science) and a Division 2 discipline (chemistry, biology, medicine).

- "Sciences and Engineering" Award: Frédéric Hecht, Researcher at the Jacques-Louis Lions laboratory, University Professor at the Pierre et Marie Curie University in Paris.

Frédéric Hecht is a professor at the Pierre and Marie Curie University in applied mathematics at the Jacques-Louis Lions Laboratory (UPMC/CNRS). He is a specialist in the resolution by computer of physics and engineering partial differential equations and particularly for non-linear problems and the finite elements method. His high performance work in fluid flow simulations have contributed to two widely used software programs, particularly well implemented using the most advanced computing data structures: GHS3D, developed in cooperation with an INRIA team, applied by a large number of aerospace industries and Freefem++, of exceptional complexity but also usability, used by specialists around the world.

Established in 2007, this Award honors the achievements of a scientist or technologist who has contributed to the vitality and influence of Technology Research and maintained exceptionally productive ties with the industry, having a remarkable practical impact in the aerospace sector.

- "Computer Science" Award: Rachid Deriche, Research Director at Inria Sophia-Antipolis.

Rachid Deriche is one of the greatest specialists in the processing and analysis of digital images. After having contributed in a fundamental way to digital image processing and computer vision, Rachid Deriche, redirected his research to neuro-imaging and its clinical applications, particularly diffusion magnetic resonance imaging of dissemination (DMRI). He has, in a few years, revolutionised the basics of the methodology used to process these images, developed and disseminated radically new algorithms of a very high precision and effectiveness, commended by the international community. He currently directs the Athena project-team at the INRIA Sophia Antipolis-Méditerranée centre that is exploring the central nervous system (brain and spinal cord) thanks to computational imaging.

Established in 2007, this Award recognizes the achievement of a scientist in a French laboratory, who has made exceptional contributions to the vitality and influence of computer science research, while building an outstanding cooperation with industry.

3.2 « Best Thesis Awards »

Committed to support the people who are making Science and research, the Airbus Group Foundation has decided to further new generation and create the Best thesis Prize in 2006 to reward top doctoral research work. Theses thesis must have contributed to significant progress by exploring options that are likely to lead to technological and conceptual breakthroughs, and by suggesting new paradigms or new bridges between disciplines.

Five young researchers received a Best Thesis Award for the excellence of their doctoral work:

- **Cristóbal Andrés Bertoglio Beltrán** (Mathematics and its Interactions) for his work on "Forward and Inverse Problems in Fluid-Structure Interaction. Application to Haemodynamics", Paris Graduate School of Mathematical Sciences.
- **Emilie Sakat** (Engineering Sciences) for her work on the "Metal-dielectric guided mode resonance structures and applications to filtering and infrared imaging", Doctoral graduate school of Polytechnique.
- **Nacer Chahat** (Science and Information and Communication Technology) for his work on "Antenna, propagation, and interaction with the body for body-centric wireless communications at microwaves and millimeter-waves", Matisse Doctoral School, Rennes.
- **Adeline Pons** (Earth, the Universe and Space Sciences) for her work on "Fluid over-pressures and accretionary prism stability: theory and numerical and experimental validation", Doctoral School of Earth Sciences, Paris-Diderot University.
- **Kévin Jouvin** (Physics, Chemistry) for his work on the "Synthesis of hetero-substituted alkynes via copper catalyzed reaction", Doctoral School of Science and Technologies of Versailles.

4. Appendix

4.1 Guest speakers' biographies

- Mariusz BALDYGA, Project Officer - Robotics Unit - European Commission, DG Communications Networks, Content and Technology (Programme H2020)

Mariusz Bałdyga is Research Programme Officer in the Robotics Unit - Directorate-General Communications Networks, Content and Technology at the European Commission. He holds degrees in Economics from Gdansk University, and Information Technology from Polish - Japanese Institute of Information Technology. In DG CNECT, he is in charge of research programme implementation and project management, and deals with policy development in the area of industrial robotics. Prior to joining the unit dealing with robotics at the European Commission, he worked as Product Manager and Project Manager in the ICT sector.

- Christoph BORST, Head of Department Autonomy and Teleoperation, Institute of Robotics and Mechatronics, German Aerospace Center (DLR)

Christoph Borst received his Computer Science degree from the Technical University of Munich in 1998. He is with the DLR since 1998, and he is now heading the Department for Autonomy and Teleoperation. He coordinates the development of the robotic platform "Justin". His research interests include grasp and manipulation planning and high level reasoning for autonomous robot operation. In the FP7 European Project DEXMART as well as in GeRT he was responsible for the research on dual handed manipulation and the generalization of manipulation actions on different objects and robots.

- Jean-Paul LAUMOND, Research Director at LAAS-CNRS

Jean-Paul Laumond, IEEE Fellow, is a roboticist. He is Directeur de Recherche at LAAS-CNRS (team Gepetto) in Toulouse, France. He received the M.S. degree in Mathematics, the Ph.D. in Robotics and the Habilitation from the University Paul Sabatier at Toulouse in 1976, 1984 and 1989 respectively.

He has been coordinator of two the European Esprit projects PROMotion (Planning RObot Motion, 1992-1995) and MOLOG (Motion for Logistics, 1999 - 2002), both dedicated to robot motion planning and control. In 2001 and 2002 he created and managed Kineo CAM, a spin-off company from LAAS-CNRS devoted to develop and market motion planning technology. Kineo CAM was awarded the French Research Ministery prize for innovation and enterprise in 2000 and the third IEEE-IFR prize for Innovation and Entrepreneurship in Robotics and Automation in 2005. Siemens acquired Kineo CAM in 2012. In 2006, with the support of the EADS Corporate Foundation, he launched the research team Gepetto dedicated to Human Motion studies along three perspectives: artificial motion for humanoid robots, virtual motion for digital actors and mannequins, and natural motions of human beings. He has been the 2011-2012 recipient of the Chaire Innovation technologique Liliane Bettencourt at Collège de France in Paris. His current project Actanthrope (ERC-ADG 340050) is devoted to the computational foundations of anthropomorphic action.

- Bruno SICILIANO, Coordinator of the FP7 NMP-ICT-FoF EuRoC Project -University of Naples Federico II

Bruno Siciliano is Professor of Control and Robotics, and Director of the PRISMA Lab in the Department of Electrical Engineering and Information Technology at University of Naples Federico II. His research interests include force and visual control, cooperative and aerial manipulation, human-centered and service robotics. He has co-authored 7 books, 70 journal papers, 200 conference papers and book chapters. He has delivered 100 invited lectures and seminars at institutions worldwide, and he has been the recipient of several awards. He is a Fellow of IEEE, ASME and IFAC. He has served on the editorial boards of several peer-reviewed journals and has been chair of program and organizing committees of several international conferences. He is Co-Editor of the Springer Tracts in Advanced Robotics, and of the Springer Handbook of Robotics, which received the PROSE Award for Excellence in Physical Sciences & Mathematics and was also the winner in the category Engineering & Technology. His group has been granted thirteen European projects in the last five years, including an Advanced Grant from the European Research Council. He is the coordinator of EuRoC, the first big European project devoted to robotics challenges for the Factory of the Future. Professor Siciliano is the Past-President of the IEEE Robotics and Automation Society.

- Adolfo SUAREZ ROOS, Airbus Group Expert - Robotics, Coordinator of ANR project ICARO

Adolfo SUAREZ ROOS joined Airbus Group in 2006 and currently focuses on human-centred robotics and the introduction of collaborative robots on aeronautics production plants. He also assists the group business units on the introduction or use of industrial robots, automated solutions and assistive devices for aircraft manufacturing. He previously developed industrial robot applications and assembly lines for the automotive industry as well as small mobile and service robots.

He graduated as mechanical engineer in 1991 and received a M.S. degree in mechanical engineering, a M.S. degree in robotics and a Ph.D. in robotics in 1992, 1993 and 1997 respectively. He has authored more than 10 publications and 4 patents. He has participated on 4 European projects and is coordinator of the French project ICARO (ANR). He was nominated Airbus Group Expert in 2012 and speaks fluently Spanish, German, French and English.

- Gianfranco VISENTIN, Head of Automation and Robotics Section – ESA

Mr. Gianfranco Visentin has been with the European Space Agency (ESA) for the last 21 years. He had previously worked as control engineer on aircraft flight software and active car body attitude control. Since his beginning at ESA he has been with the Automation and Robotics (A&R) group working in support of ESA robotics projects and in Research and Development (R&D). In supporting ESA projects he has participated to the development of the European Robot Arm (ERA), the Columbus Microgravity Facilities, the EUROBOT system (of which he was the initiator) and the ExoMars project.

His R&D efforts have covered the whole spectrum of technologies needed for space A&R including: conventional robotics platforms (rovers, robot arms), alternative robotic platforms (moles, aerobots, walking robots), robot autonomy, teleoperation and remote control (robot programming stations, exoskeletons), perception (computer vision) and subsystems (robot joints, controllers). He is the inventor of some original space concepts such as 3D digital camcorders (2 flown in the International Space Station), arm exoskeletons for space use, capture of space debris by means of throw nets. Since 2002 he leads the A&R group. In his current post Mr. Visentin is ESA's responsible of the technology domain for Automation and Robotics, role that entails the preparation of ESA's R&D strategy for the field and coordination with other European research organizations.

4.2 Audio-visual resources

- **Presentations and Press dossier** are available on the Airbus Group Foundation website: www.fondation.airbus-group.com/content/en/The-Foundation/Research-takes-flight-Day/Archives/2014-Edition/
- **Pictures** of the event are available:
  - on the Airbus Group Foundation Picasa account:
  https://plus.google.com/photos/115922057221176869460/albums/6002520878551044449
  - on the Airbus Group Flickr account :
  https://www.flickr.com/photos/airbusgroup/sets/72157639115841945/
- **Films** presented during the event are available on the Airbus Group Foundation YouTube account:
  www.youtube.com/user/FondationEADS
  Film 1rst part: Conferences on robotics in the factory of the future
  https://www.youtube.com/watch?v=gOdaxolaRJ8&list=PL5527E4769AF0F458
  Film 2nd part: Awards ceremonies
  https://www.youtube.com/watch?v=bu-FvXG_t0s&list=PL5527E4769AF0F458

More information:
www.fondation.airbus-group.com
Twitter: @AirbusGroupFond