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SPACE DESIGN LEARNING. An Innovative Approach of Space Education Through Design

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Abstract

Design is a method of actions, a "problem-creating" approach that drives innovation and develops business success exploring and understanding the users and their needs for a more sustainable society.

The reason why the contribution of *Space Design* becomes important today is due to the interest of space agencies to attract the private sector in space exploration, build multidisciplinary relationships and generate new business. In this context the design approach can be a powerful engine for the space economy able to translate space inspiration into new products involving both Space and non-Space industries.

In this paper is presented a new program in space education and outreach focussed on the emerging area of *Space Design* - led by the authors at the Design School of Politecnico di Milano and supported by the European Space Agency (ESA) - with the aim to bring the young generations closer to the Space, educate professionals with a multidisciplinary attitude capable to deal with emerging technologies and future scenarios, create new cultural and business models crossing knowhow and research, explore and expand alternative design solutions, both in Space and on Earth. The idea of creating a *Space Design* discipline was born of conviction that Space innovation will have a strong influence on how people behave and perform. Considering that the principal task of a designer is to anticipate future scenarios, the opportunity to look at Space can really inspire students and help them to understand better how to become more conscious of the transformation technology brings. Moreover *Space Design* courses are an unique opportunity to develop a powerful capacity of visioning moving into one of the most innovative areas of knowledge and technology that could help people to increase the quality of life.

The program includes different *Space Design* courses developed during 2016, 2017 and 2018 that will be described as innovative didactics & research case studies in which teaching and practice are strongly interconnected. The unusual and extraordinary environment offers the designers the chance to increase their creativity thinking out-of-the-box (like astronauts experience looking at the Earth from another point of view) and the ability to imagine and design new objects, tools and environments starting from a perspective completely unknown. Describing the case studies, the emphasis will be placed on evaluating the learning outcomes of the *Space Design* program considering both expected goals and design methodologies applied to the design process.

Keywords: space design, space economy, space fashion, technology transfer, smart materials, spin-offs.

1. Introduction

The educational program in *Space Design* presented in this paper is the result of our collaboration with the European Space Agency (ESA) started in 2016 thanks to the project *Couture in Orbit* and grew up quickly expanding the good results gained from the experience with different *Space Design* courses and workshops developed during 2017 and 2018 - *Fashion in Orbit, Space Fashion Design and Space4InspirAction* - that will be described as innovative didactics & research case studies. The learning outputs are based on a methodology in which teaching and practice are strongly interconnected with the aim to take inspiration by space scenario and technology and to find innovative solutions using the language of design. The field of design that we consider when working for Space is very huge and can be resumed in three principal area: the 1st area around the body, like a second skin, Fashion Design; the 2nd area in which the body interacts with objects and tools, Product Design; and the 3rd area that concerns the space and the environment around the body, like a third skin, Architecture and Environmental Design. Nevertheless the areas of design are vast and transversal, they have a common language based on the same words - beauty, function, shape, strategy, technology, vision – according to the market and the users needs. The aim of the new program in *Space Design* is to use all the competences of the areas briefly described to increase the well being of the people living in Space, from the design of clothing systems and

equipments to the architecture of space ships, considering that a best performances affects directly to a better result of space missions. The new interplanetary exploration programs need innovative solutions to allow humanity moving on other planets where living and working in comfortable, efficient and safe way. But not "only" that. One of the tasks of design approach is to find new applications of space technologies and behaviours to generate spin-offs and spin-ins, from Space to Earth and vice-versa.

Furthermore the new space economy is looking for attractive ways of communicating Space. In an age crowded with digital innovation mainly involving the movements of our fingers, the space community must find a new "tool" to entice the public and help explain why space research and its impact is so important: for this reason design approach can really be the new space tool and we explain here why.

2. What is Design and what it can do for Space?

The definition of design given in this paper is the results of the author's experience working with astronauts since twenty years and constantly interact with while designing tools for them [1].

The role of design for the space industry derives from the need to carry out research in confined spaces and microgravity conditions, performed by human beings, in order to test out new scientific equipment and investigate environmental-behavioural dynamics in relation to crews. We need to increase knowhow and experience to design inhabitable systems for long interplanetary voyages and missions, to colonise other planets, starting from Moon and Mars. Design can play a crucial role in making everyday activities much easier in any setting or context, helping us perform more efficiently and also enhancing our mental and physical well-being. Design discipline studies surrounding reality and interprets all those signals we receive from the environment by focussing on how people live, behave, move, show their emotions, interact with each other. A designer is capable of leaping "out-of-the-box" and developing a new and different line of thinking translating latent demands not yet expressed by the people into projects designed to help astronauts, serving emotional as well as practical purposes.

Task of Design in Space is to be a "bridge" between science and culture, finding a common language that can help the hi-tech research and industrial worlds communicate and collaborate. Nowadays a designer is no longer a problem-solver asked to come up with solutions, but we love to say he is rather a "problem-creator" [2] capable of calling into question the world in which we live, exciting and amazing the general public just like an artist, thanks to his ability to explore the complex and delicate process of interaction between people, objects and environments.

What Design can do for Space? It increases the comfort and the efficiency when living and working in reduced gravity; it explores and understands the astronauts and their needs finding innovative solutions to make easier human performances; it finds new applications for space technology, adding also an aesthetic value to the final project, and drives the development of business models.

Space exploration offers fantastic scenarios of experimentation that can be transformed and reinterpreted by the language of design, an area that is far removed from the scientific world and yet has an important role to play by finding new products or applications for space technologies that can enhance the performance of people and the quality of life.

3. Case Study 1: Couture in Orbit

ESA has already experimented the value of design with the project *Couture in Orbit* [3] to mark the missions of five European astronauts - from Italy, the UK, France, Denmark and Germany - between 2014 and 2016 and organized an innovative event in May 2016 at the London Science Museum involving a fashion design school from each of the astronaut's home countries.

Fig. 1. Couture in Orbit, final catwalk at the London Science Museum

We were invited by ESA in 2016 to led our students - of School of Design, Master of Science in Fashion Design, Politecnico di Milano - with the aim to create a capsule of garments inspired by space scenario, using ESA technologies, and designed to be worn every day on Earth [4]. Working with *Couture in Orbit* was a great challenge for us to explore fashion in the age of technology and understand better how we can be more conscious of the transformation technology brings. Space innovations will have a strong influence on how people behave and perform in the future.

Couture in Orbit is the first important step to communicate to a huge public the role of ESA in developing innovation and inspiring people through the fashion language that celebrates space exploration and

research exploitation and their impact in many fields of our life.

3.1 Learning Goals

Our principal aim was to find relations between life in Space and life on Earth connecting the two environments and considering not only technological spin-offs or spin-ins, but also emotional language and usability. We transformed inspirations into shapes and textures by looking at astronaut postures and movements in microgravity and considering their activities in Space in relation to the objects in order to generate new gestures and ideas for our projects.

From the aesthetic point of view we were inspired by space images [5], choosing colours like silver and white in all the lunar nuances, looking at materials such as aluminium and reflective surfaces, selecting curved shapes and imagining textiles printed with wonderful pictures taken by astronauts looking out of the International Space Station (ISS) towards Earth as well as by satellites, with marvellous colours, patterns and phenomena of light.

But we pushed even further, trying to imagine new uses of space technologies that they do not yet have applications other than the original, but they could in the short period of time become very interesting. Translating high fashion concepts into the language of technology was an essential skill for an endeavour like the project *Couture in Orbit*.

Fig. 2. Couture in Orbit ESA_POLIMI, innovative use of space cooling technology to deliver fragrances.

3.2 Syllabus

The project *Couture in Orbit ESA-POLIMI* started with our students of Master of Science in Fashion Design, and we word six months with the aim to arrive to the definition of many concepts of garments inspired by Space scenario and enriched with space technology and materials given by ESA and its technical partners.

At the end of this first phase we presented the concepts at the Science & Technology National Museum *Leonardo Da Vinci* in Milan to ESA experts and we selected together the three best ideas to implement for the capsule collection.

The work continued as research project with the support of Fashion Lab, for the realization of the whole garments, and finished with the photo shooting at the Immagine Lab, both of Politecnico di Milano.

3.3 Design Methodology

In our courses we consider the whole class as a "design bureau" in which each student collaborate in a unique teamwork with his or her own talents to achieve the same goal. The greatest gift for our design bureau was to have the opportunity to research and work for such a prestigious client as ESA and all the students were thrilled for this experience.

We have been the go-between, with the students on one side and the industries involved by ESA on another, among which Rina Consulting, the Italian partner of ESA for Technology Transfer Solutions, and Extreme Materials, a small company specialised in textile-related technologies, which has in the past included such innovations smart materials embedded in textiles and composites.

The students have sought a clear explanation of how these technologies are used in practice, and in other cases consulted with the companies involved into the project to find original solutions and developments to the problems they have posed. We wanted to encourage the students to come up with apparently crazy applications – to stay as crazy as possible – while we were the ones with our feet on the ground, to take into consideration the feasibility of implementation of ideas in a concrete, workable way [6]. For instance, could a wearable cooling system be modified to gradually deliver fragrances instead? And could an innovative ESA patent for a 3D antenna can be printed directly on textiles with conductive ink?

3.4 Learning Outcomes

Couture in Orbit ESA-POLIMI allowed students to discover the potentialities of Space as source of inspiration to reach new ideas and to imagine new scenarios on Earth in which space technology can be applied in different ways to increase the quality of life, combining aesthetic values with functional aspects and society's needs.

They focused on a design vision with an out-of-the-box approach – like an astronaut looking at Earth from Space – but developed a real capsule collection starting from design concepts to the garments prototypes.

An important part of the project was the relations of students with ESA's partners and companies of the private sector during the development of the design concepts that allowed them to be more conscious of space technologies and smart materials applied in the capsule collection.

In addition to the project they learnt how to create and organize a catwalk and an exhibition participating to all the phases of the event *Couture in Orbit* at the London Science Museum and going in depth into this experience with a strong enthusiasm.

Fig. 3. Couture in Orbit ESA_POLIMI, space 3D antenna printed on textiles with conductive ink.

3.5 Dissemination

The results of our capsule collection *Couture in Orbit ESA-POLIMI* were spread through the most important newspaper and magazines crossing the fields of science and fashion, from Vogue to Il Sole 24 Ore, and we received many invitation to present our project during international events, exhibitions, symposia and scientific TV programs among which:

Space for Inspiration, event-talk by ESA, London Science Museum, 2016;

Couture in Orbit ESA-POLIMI, event-catwalk organized with ESA-ESRIN for the European Researchers Night, Rome 2016;

Fashion in Space, lecture at the AIPAS National Conference Space4Sustainability, Macro Museum, Rome, 2016.

We received also the awards:

ADI Design Index 2017, the prestigious selection of the best products of the year by *Compasso D'Oro* [7];

Lombardia's Excellences Award 2017.

4. Case Study 2: Fashion in Orbit

The extraordinary results of the project *Couture in Orbit* presented in London have since generated over 100 million media feedback responses and this inspired us, along with ESA, to create a specific Higher Education Course called *Fashion in Orbit* at Poli.Design (the consortium of Politecnico di Milano) in February 2017 and based on the same idea of capsule collection of garments to be worn on Earth that integrates space technologies and innovative materials.

Fashion in Orbit is not a curricular course, but is open to young professionals who want to develop innovative products in fashion inspired by Space and technology research in order to find new applications and spin-offs for materials and textiles.

4.1 Fashion in Orbit 1st Edition 2017

The first edition involved ESA and specific companies of technology focussed on sensors system and data collection together with many others companies coming from smart textile and luxury.

Colmar, an Italian brand of sportswear, was the main sponsor, while the other companies – Alcantara, Caimi Brevetti, Coats, Limonta, Luxury Jersey, Omniapiega, Sitip, Soliani, Thermore - supplied materials, fabrics, accessories and fabric processing systems to realize the capsule collection.

4.1.1 Learning Goals

The course was tailor-made for those who want to explore fashion in the age of technology and better understand how to become a more aware protagonist of this transformation process, knowing that space innovations will have more and more influence in the near future on behaviours and people's performance.

It offered a unique opportunity to build transversal relationships with experts from the most technologically advanced sector in the world and to explore how research conducted in Space can inspire fashion and create new opportunities for social and business growth [8].

Fig. 4. Fashion in Orbit, when luxury and tech cross their knowledge.

Participants had the opportunity to create a capsule collection characterized by a high level of innovation, thanks to the collaboration with leading industrial partners in the fields of smart textiles, technologies and wearable, and to present it through a professional portfolio with a strong and recognizable image.

4.1.2 Syllabus

The Course *Fashion in Orbit* consisted of two main modules, the first made of theoretical content, the second about design and visioning to support the development of the capsule collection and the realization of clothing and accessories.

Fig. 5. Fashion in Orbit, 3D fabric can be used in different ways exploiting the structure potentialities to suggest a poetic thought.

The first module was addressed to professionals and companies operating in the fashion field and who intend to get in touch with ESA and the most qualified realities that make innovation and provide the results of their research to inspire new products. Lectures were led by scientists and researchers from ESA who presented space technologies, including specific case studies in fashion, and indicated the most innovative applications to explore possibilities to create a capsule collection according to the brief given by the main sponsor, in agreement with the other companies involved.

The second module concerned the development of the capsule collection thanks to a highly qualified tailor's workshop supervised by us together with ESA and the other companies. We started with the transposition of the concepts in paper, then in canvas, then the realization of the garments using fabrics, technologies and materials provided by the technical sponsors going in depth into details to design the executives drawings of the various projects.

Once the collection was complete, participants were involved into a co-designing experience of the fashion photo shooting at Immagine Lab of Politecnico di Milano which integrated the project of mood, lights and the overall image, useful for the creation of the digital portfolio of the whole collection, tackling the various aspects of communication design with the support of external professionals.

4.1.3 Design Methodology

The capsule collection was developed on the basis of a precise brief that took inspiration from space technologies among those presented in the first part of the course. Participants worked both in classroom, for the presentations of the companies products and technologies, and in the Fashion Lab of Politecnico di Milano, with innovative textile materials reproducing the real dynamics of a fashion brand, from the presentation of the product to the communication system. Crossing different knowledge we can achieve innovative ideas: taking inspiration by Poincaré definition of creativity [9], that is the ability to combine existing elements in new combinations, we believe involving in the same project many companies with different background, technologies and products was a good methodology to generate innovation. In this course it happened to be surprised by the ideas emerged during the gathering with all the companies together with ESA thanks to the crossover of knowhow and experiences.

Fig. 6. Fashion in Orbit, realizing prototypes at Fashion Lab of Politecnico di Milano.

4.1.4 Learning Outcomes

Participants acquired design and vision skills useful to collaborate with design companies and studios specialized in fashion design and innovation-oriented products. They practiced all the phases of the concept development for a new product of fashion, from the first ideas to the realization of the prototype, experimenting new material behaviours and technology applications. Also, they learnt how to create an innovative portfolio to present their work and how to valorise products through digital photo using light as a value to underline the principal aspect of the project.

4.2 Fashion in Orbit VS Space Fashion Design 2nd Edition 2018

The second edition, compared to the previous *Fashion in Orbit*, extended the field of application to product design, in addition to fashion design, to follow the fast changes of these two worlds that increasingly overlap and lose their original boundaries by embracing more fluid dimensions of project and technology.

We involved the main sponsor of the first edition, the Italian sportswear company Colmar, defining a precise brief tailored on needs and interests of the company in connection with ESA Technology Transfer Network – Rina Consulting. The focus was on new concepts of ski garments taking inspiration by space technology with the aim to find new applications to increase the clothing performances.

4.2.1 Learning Goals

Participants had the opportunity to work together with ESA experts and a big companies of fashion design like Colmar learning how to develop a whole project, from the first ideas to a detailed 3D concept, in which technologies and materials are defined together with fabrics and colour palette. *Space Fashion Design* offered a unique opportunity to build transversal relationships with experts and to explore how research conducted in Space can inspire fashion and create new business models created on innovative applications.

4.2.2 Syllabus

The second edition was built on a *workshop* of 2 weeks full time (8 hours a day) structured as a design bureau, with a group of young professionals and researchers led by us, with the partnership of ESA for the space technology inspiration, and with the support of Colmar to allow us to deepen the know-how of the company in terms of vision, strategy and products and understand better the brief's inputs. The concept was focused on the design of clothing, accessories and innovative products for ski field according to the needs of the company. Within the *workshop*, a session was devoted to the development of practical and strategic skills for the final presentation of the projects.

Fig. 7. Space Fashion Design, smart fibers and auxetic materials application for Colmar.

4.2.3 Design Methodology

In this *workshop* we applied the five principal methodologies that are the pillars of our design research and practice, plus others two specific for *Space Design*:

1. User Centered Design (UCD);
2. User Experience Design (UXD);
3. Design to Recicle; Design to Cost; Design Thinking;
4. Usage Gesture Design (UGD);
5. Space Earth Design (SED).

The five methodologies belong to design discipline and are focussed on the user needs with the aim to design a complete experience made of smart products, able to integrate technology and increase the performance while taking into account a sustainable design process [10].

The last two *Space Design* methodologies consider fundamental to design a new product imagining since to the beginning of the development of the idea gestures and movements (UGD) which astronauts could be in microgravity with it (how to use it, in which way etc.). Making this effort of imagination we have an expansion of the context with more elements to integrate into the project and it is more easy to create connection between living in Space and on Earth (SED).

Fig. 8. Space Fashion Design, event-talk at Il Bello dell'Italia organized by Corriere della Sera's newspaper.

4.2.4 Learning Outcomes

One of the best skill participants learn is to make research activity for industry comparing information collected with the goal to achieve, moving in between intuition and feasibility, imagining new possibilities to use innovative technologies according to people's needs, for example, integrating space cooling technology for thermo regulation, or electro osmosis process to extract sweat while skiing. Space technology by ESA is a strong motivational input that push them to find alternative and creative solutions for terrestrial projects starting from a perspective completely unknown. They experiment the importance to present their ideas with concept, images and words able to catch the attention of the companies leaders and they practice the power of story-telling to increase the value of the projects.

4.3 Dissemination

The results of *Fashion in Orbit* and *Space Fashion Design* were spread through the most important newspaper and magazines crossing the fields of science and fashion and we received many invitation to present our project during international events, exhibitions, symposia and scientific TV programs among which:

Fashion in Orbit, special guest at the exhibition organized by ESA and DRL *Living in Space*, Techtextil, Frankfurt 2017;

Fashion in Orbit, event-talk at *Il Bello dell'Italia*, organized by the newspaper *Corriere della Sera*, Mantova 2017;

Space Fashion & Science, TV program *Passi di Scienza*, Milano Design, RAI Scuola 2017.

5. Case Study 3: Space4InspirAction

After the experience of the first edition of *Fashion in Orbit* we decided to lunch a new *Space Design* Course named *Space4InspirAction* at the School of Design, Politecnico di Milano, in March 2017. It is a teaching in the area of *Concept Design Studio* at the 1st year at 2nd semester of the Master of Science in Integrated Product Design, which includes courses of product cultures and product-system design. It is an international course and the language is English. We have 70 students (maximum number allowed) attending the course.

At the moment it is the 1st and the unique course in *Space Design* with the partnership of ESA.

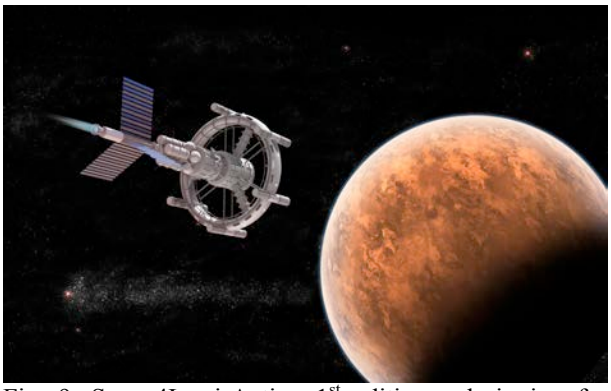

Fig. 9. Space4InspirAction 1st edition, designing for Interplanetary Missions: Moon and Mars.

This course is an interesting opportunity to develop a strong capacity of visioning looking at Space and moving into the most innovative areas of knowledge. Space helps us to generate new visions for the future and new scenarios that could help people to live better in a sustainable way.

We believe that space innovations will have a strong influence on how people behave and perform. We also believe that Space can really inspire designers and help to understand better how we can be more conscious of the transformation technology brings.

5.1 The value of the partnership with ESA

For that reason we decided to involve ESA working with us as official partner. The partnership with ESA foresees the participation of experts and scientists who define together with us the themes of the projects to develop together with students, according to the strategic programs of the space agencies and integrate their experience and know-how with lectures useful to the development of the projects.

Fig. 10. Space4InspirAction 1st edition, designing for EVA Suit.

ESA's support is a big value because a theme like Space allows students to develop creativity with intense visioning activities by confronting with confined and microgravity environment that is not part of our common experience. Thanks to ESA we are be able to compare our design vision with real conditions and requirements and find innovative solutions designed for Space, but that can be also transferred to daily life on Earth becoming spin-offs.

5.2 Learning Goals

The course has a dual purpose: on the one hand pushes students to get inspired by Space and define new visions, however, starting with real conditions and requirements, on the other to imagine new spin-off, or terrestrial applications, that can be transferred to our daily lives improve them. For this reason design companies from the private sector are involved to the projects, together with space companies, with the aim to translate space inspiration and vision into spin-offs generating new concepts of products.

5.3 Syllabus

The frame of *Space4InspirAction* course is composed by two parts which interact with each other:

_a theoretical and explorative part which provides lectures with ESA experts and scientists as well engineers by space industries who integrate their experience and know-how useful to the development of the projects;

_a practical part, the real project, developed with professors and supported by ESA and space industries in which is required a disruptive capacity of visioning.

The sequence of activities is planned to introduce progressive levels of complexity and to give students the opportunity to use previous knowledge and that they are learning in parallel in the theoretical integrated part with the aim to increase their capacity to manage information with different skills.

The topics of the course changes every year, following the ESA's space strategic programs, with the aim to find connections between "living in Space" and "living on Earth" and suitable solutions for two both, looking at astronauts activities in microgravity and the alterations of body postures and movements in relation to their objects that can generate new gestures and ideas for our projects. Space knowledge, space research results, experimentations, new materials and technologies suggested by ESA are important drivers to increase the innovation value of the projects.

Fig. 11. Space4InspirAction 1st edition, presentation of the results at Planetarium, Milan.

5.4 Design Methodology

The unusual and extraordinary environment offers the students the possibility to think out-of-the-box, like astronauts experience looking at the Earth from another point of view, and the chance to increase the creativity and the ability to imagine and design new objects and tools starting from a perspective completely unknown.

Microgravity and confined environments are the principal keywords of Space to inspire new projects, stimulate reflections and connections between Space & Earth and find suitable solutions for 2 both [11].

Through a new methodology that we have developed and called *Usage Gesture Design* (UGD) design is not limited to creating objects, environments, architectures, but also new behaviors and gestures of astronauts in relation to the use of designed objects, environments and architectures. Multidisciplinary approach is fundamental for the creation of new professionals who are able to speak different languages of the project and that is why we have involved mechanical engineering students who work in groups with our design students, including Product Design and Interaction Design, to ensure the feasibility of new creative and disruptive ideas and increase the skills of all students.

5.5 Space4InspirAction 1st Edition 2017

The first edition of the Course *Space4InspirAction* was organized proposing three different projects which enhanced the level of complexity: from the human being sphere to the interaction with objects and the extreme environment.

The theme and the brief of the three projects were defined together with ESA according with today needs of the astronauts activities - looking at the International Space Station (ISS) – but extending also the field towards long terms projects: 1. Space Food, 2. EVA Suit, 3. Interplanetary Missions: Moon and Mars. According to the themes, three design companies from the private sector were be involved to the projects together with ESA with the aim to translate space inspiration and vision into spin-offs and design new concepts of products: 1. Argotec for Space Food, 2. Dainese for EVA Suit, 3. Thales Alenia Space for Interplanetary Missions: Moon and Mars.

5.6 Space4InspirAction 2nd Edition 2018

The second edition 2018 involved Thales Alenia Space, Joint Venture between Thales 67% and Leonardo 33% - the world's leading player in the construction of housing modules for the ISS - who asked us to collaborate for one big project: the new cis-lunar Gateway station, on which all the space agencies are concentrated at this time. The collaboration between the *Space4InspirAction* and Thales Alenia Space is not a spot project, but the beginning of a continuous teaching and research agreement to guarantee the development of innovative projects in which the contribution of design is fundamental and strategic to generate ideas and "disruptive" visions for architecture and space habitability, with particular attention to human factors and interactions between operator and instrument.

Fig. 12. Space4InspirAction 1st edition, this spin-in shows how a terrestrial tool for disability can increase the performance on Moon and Mars surfaces.

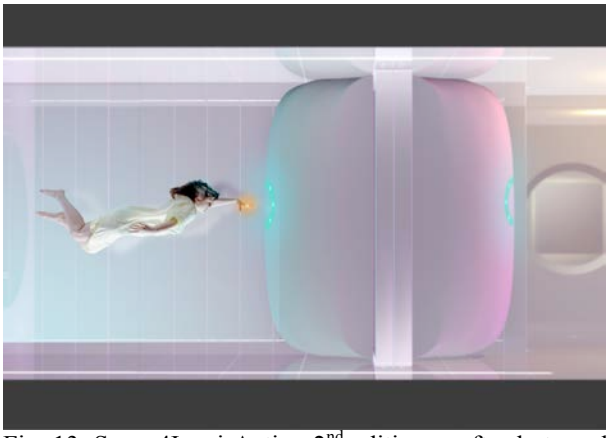

Fig. 13. Space4InspirAction 2nd edition, soft robots and flexible oled technology for the interiors of cis-lunar Gateway station.

5.7 Learning Outcomes

At the end of the *Space4InspirAction* courses students learn what "Space Design" means, and how to apply design research & practice to improve the quality of life in Space through 2 methodologies that we consider fundamental guideline into the design process in Space: *User Centred Design* (UCD) and *Usage and Gesture Design* UGD).

They are able to design visionary projects of space habitats and tools (space ships for interplanetary missions, lunar and mars bases etc.) thinking out-of-the-box - according to the real requirements given by space agencies and industries - and generate innovation crossing Space and Earth's technologies and behaviours.

Fig. 14. Space4InspirAction 2nd edition, lectures with ESA experts at School of Design, Politecnico di Milano.

We consider a great value to give students the possibility to present and show their works through international exhibitions and events: they learn how to present a work in a short and synthetic way and how to communicate ideas through attractive images and videos, they are all skills very useful in a world in which the power of story-telling is fundamental to catch the attention of people, and hopefully inspire them

5.8 Dissemination

The results of *Space4InspirAction* were spread through exhibitions and international events among which:

Space for InspirAction 1st Edition, presentation of the results at the city of Milan, *Planetarium*, 2017;

Space4InspirAction 1st Edition, exhibition organized with ESA-ESRIN for the *European Researchers Night*, Rome 2017;

Space4InspirAction 1st Edition, exhibition organized with ESA-ESOC *Long Night of the Stars*, Darmstadt 2017;

Space for InspirAction 2nd Edition, presentation of the results at Thales Alenia Space, *Altec*, Turin 2018.

Fig. 15. Space4InspirAction 1st edition, exhibition of the results organized with ESA-ESRIN for the European Researchers Night, Rome.

6. Results

The first results of our experience teaching *Space Design* can be found in each case studies described in this paper which show how design can become a "space tool" and generate innovation applying design methodologies. *Space Design* courses have the principal aim to create a new professional figure able to connect both tech and vision languages.

We prefer to end with some reflections about "lessons learned" hoping the design approach could inspire and be used in other disciplines of space high education to increase creativity and visioning of the young generations.

7. Lessons Learned

This new space era requires a strong capacity of visioning to transform ideas in reality.

Design can be the medium able to translate space technology into beauty.

Academic collaboration including companies with different backgrounds can generate high level of innovation.

7.1 About Space

Space is a good topic to attract students and develop creativity.

Space is a great buster to involve companies interested to innovate though space technology.

Space is ready to business looking at the private sector.

7.2 About ESA

ESA can communicate to a huge public its role in developing innovation and inspiring people through design and fashion language.

ESA can catch young generations supporting academic institutions and promote interaction between research and industry.

ESA can promote public awareness of Space through exhibitions and events showing the results of the projects developed together with Academia.

7.3 About Learning Goals

Students take advantage by the continuum between didactic & research crossing Space & Earth: relation between things, more then things themselves, put always new meanings.

Students learn the importance of a multidisciplinary approach integrating different disciplines.

Students have the opportunity to show their projects to a huge public in prestigious locations and learn how to communicate ideas and projects.

Fig. 16. Space4InspirAction 2nd edition, space helmets for privacy and personal communication for the interiors of cis-lunar Gateway station.

8. Conclusions

In this paper we presented a new program in space education and outreach focussed on the emerging area of *Space Design* with the aim to bring the young generations closer to the Space, educate professionals with a multidisciplinary attitude capable to deal with emerging technologies and future scenarios, create new cultural and business models crossing knowhow and research, explore and expand alternative design solutions, both in Space and on Earth.

Fig. 17. Space4InspirAction 2nd edition, presentation of the results at Thales Alenia Space.

The success of the experiences described through the various case studies shows the strong power of Space, in attracting the young generation, and of Design, in creating a bridge between space technology and private sector to generate innovation. But overall *Space Design* is a big "tool" for students to look "out-of-the-box" and increase creativity and knowledge, comparing ideas and concepts with feasibility, balancing visioning and practice, facing with real goals and real companies.

Our experience is at the beginning of a path we hope will be full of interesting challenges and we would like to end this paper with a thought on how to improve for next: we believe that a more "structured" cooperation between ESA, our academic institution and industry could help us to build an international network of universities and companies interested in *Space Design*, with the aim to intensify research & development through collaborative smart and challenging students projects.

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