ALTA SCUOLA POLITECNICA

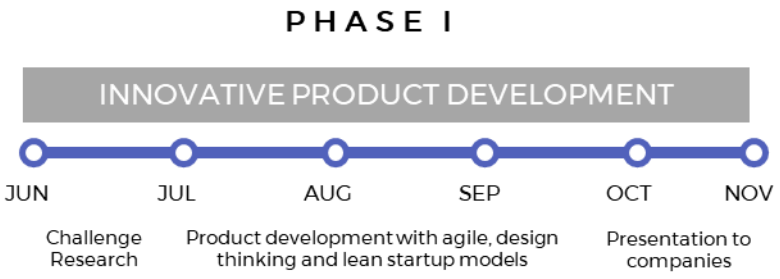
POLITECNICO DI MILANO | POLITECNICO DI TORINO

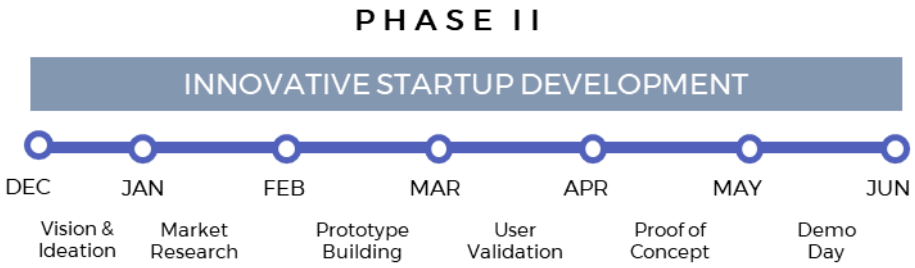
2019/2020

ASP XV Cycle Project Book

Project 1 – AI SEI
Artificial Intelligence - SEI Pioneer

Type of project	□ Demand pull
Objectives	SEI Pioneer is a one-year program in partnership with ASP that aims to create the next generation of deep tech entrepreneurs and innovators in Italy. One of the five fields of focus of this program is Artificial Intelligence. In the initial part of the program, the team is paired with a Partner Tech Product Challenge assigned from industrial partner like **[Reply]** on the macro theme of Artificial Intelligence and will work on the development of an innovative product to address this Partner Tech Product Challenge over the first half of the project. In the subsequent seven months the students will work on developing their own entrepreneurial idea, in the same field of ST but addressing different applications/directions compared to the one of the Partner Tech Product Challenge. Artificial Intelligence is becoming strategically more important for driving enterprise value creation and is currently one of top five technologies predicted to disrupt the various industries significantly within the next 10 years. Machine Learning, Deep Learning Platforms, Natural Language Processing & Generation, Hardware Integrated AI & Neural Networks are just some of the recent trends in this industry. Artificial Intelligence based solutions are currently being implemented with noteworthy results in industry and the major image that pops up in their heads is that of a robot gliding around and giving mechanical replies. Nonetheless, there are many forms of AI but humanoid robots are one of the most popular forms. The level at which humanoid robots can interact with humans is still quite limited, and AI is critical. It can help decipher commands, questions, statements and understand random, ambiguous human ramblings. This project aims to explore the Partner Tech Product Challenge is to apply technologies derived by **AI, Machine Learning, Computer Vision e Robotics, in order to develop the capabilities of a Humanoid Robot called "Pepper" and to develop a solution or a value proposition,** linked to the Humanoid and applied to Retail and Concierge. Students will have the opportunity to use the humanoid Robot called "Pepper", made available by Sprint Reply, to study and implement different dynamics of human-machine interaction and by exploiting the sensors (mostly visual) and the robot actuators to interact with a human interlocutor. Within the project, the learners will explore and experiment with different technologies for the realization of computer vision dynamics (OpenCV, TensorFlow, etc.) as well as working on the operating system (naoQI) and the API (QISDK) of the "Pepper" robot made by Softbank Robotics, as well as strive to design a business model and value proposition for the same application.

Description	**Artificial Intelligence - SEI Pioneer:** The initial objective for the first five months of the program will be defined by the partner company together with SEI, who are going to double the ASP budget available for students, as a reward towards the development of the Partner Tech Product Challenge by the students and for the IP developed for the external partner provider of the Partner Tech Product Challenge. Students will be initially guided through an intensive product development phase where their sole objective will be to build this innovative product using methodologies like Value engineering, Agile methodologies, etc. They will also be trained by SEI personnel and mentored by company experts, professors from Politecnico di Torino & Milano and innovation & business experts from SEI. During this product development phase, they are put through the following workshops that last a weekend each once per month over five months • Challenge Research • Project Feature List • Product Prototyping • Feedback & Validation • Pitching & Presentation • Product Demo-day Once this is completed and presented in November 2019, the teams will start working on their own start-up ideas that they will then build over the following workshops • Problem Definition • Vision & Ideation • Customer Definition • Prototype Building • Market Validation • Startup Demo-day In the Start-up phase they are introduced to models like design thinking, lean startup, fast prototyping, etc. Also, in this phase the workshops will take place over the weekend (one workshop over one weekend per month over seven months) and start on Friday to conclude on Sunday. The first phase helps the team to develop sectorial expertise while being guided in a concrete direction by the company and SEI to resolve the Partner Tech Product Challenge and the second phase is dedicated to the creative expression of this expertise built during phase one using the learning models and the core subjects learnt. 

	
Expected results	SEI Pioneer has a total duration of twelve months and has two main results produced by the teams which are structured as two separate demo-days. The first demo-day is related to the product innovation responding to the company challenge and is scheduled for November 2019 with the presentation of the results to the companies that have launched the Partner Tech Product Challenge. The second demo-day takes place in June of the following year during a public demo-day in which the results of the startup phase are presented to an audience of investors, companies, entrepreneurs and partners. In both cases a team comprising of company partners, innovation experts and professors from the universities will be helping evaluate the quality of work produced by the teams.
Stakeholders	**School of Entrepreneurship and Innovation** [www.sei.it] is a school created by **Fondazione Agnelli** for enabling the next leaders in Entrepreneurship & Innovation and will be responsible for the workshops and entire organization of the program for the participating students. SEI Pioneers [https://sei.it/en/school/pioneer/] is the module of SEI dedicated towards deep tech innovation for Alta Scuola Politecnica students. **[Reply]** [https://www.reply.it/] is a consulting, system integration and digital services company, with a focus on the design and implementation of solutions based systems. Reply's offer covers three areas of competence: Processes, Applications and Technologies. Along the many industries they serve, they focus also on Industry 4.0 through Brick Reply, a MOM (Manufacturing Operations Management) platform for the management and control of a "Smart Factory" using technologies as Big Data.

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Reference external tutor	
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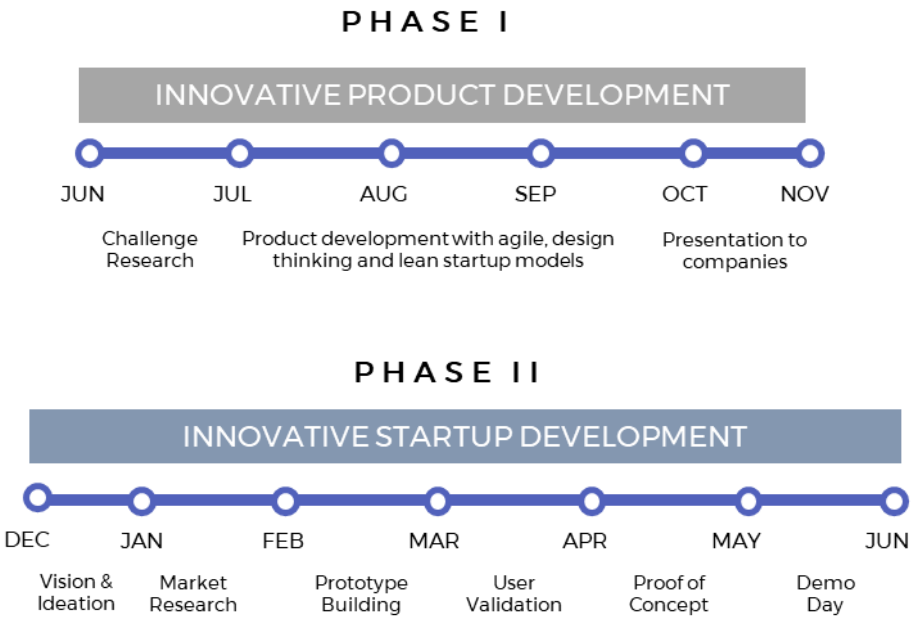
Project 2 – AVMR SEI
Augmented, Virtual & Mixed Reality - SEI Pioneer

Type of project	□ Demand pull
Objectives	SEI Pioneer is a one-year program in partnership with ASP that aims to create the next generation of deep tech entrepreneurs and innovators in Italy. One of the five fields of focus of this program is Augmented, Virtual & Mixed Reality. In the initial part of the program, the team is paired with a Partner Tech Product Challenge assigned from industrial partner like **[]** on the macro theme of Augmented, Virtual & Mixed Reality and will work on the development of an innovative product to address this Partner Tech Product Challenge over the first half of the project. In the subsequent seven months the students will work on developing their own entrepreneurial idea, in the same field of Augmented, Virtual & Mixed Reality but addressing different applications/directions compared to the one of the Partner Tech Product Challenge "Augmented, Virtual & Mixed Reality" is mostly associated with entertainment industry. After all, a VR headset seems on the surface to be essentially a very high-tech video game. The truth is, that this technology goes far beyond that: not everyone plays videogames, but everyone loves to learn and interact in a different way. Educational Technology (EdTech) is going through several changes in the last years, including also the mass-marketization of educative and recreational games; Schools and universities are changing their traditional teaching methods and it will completely revolutionize the way teachers teach and students learn together, while also Industries and Corporates. are adapting their learning methods This project aims to explore the challenge of **developing applications for new learning methods and for addressing a mass market usage, both on a B2B or B2C level** [tbc]. Classrooms are not the only place people can learn, and remote learning & remote visualization is becoming more and more effective. 360° cameras are quite accessible and affordable these days as also AR kits. Everything from cooking recipes to dog training guides can be addressed through this technology and the immersion and sense of presence added by the new technology makes them more effective than ever before; yet it can also be used to enhance collaborative tasks in several industries, as well as encouraging different ways of learning or stimulating equal gender participation in STEM activity up to stimulate socializing and inclusive activities for people with special needs. Part of the challenge should focus on: - Develop reading and writing skills in a creative way; - Turn diverse school or domestic areas into interactive learning spaces; - Improve training tools within different Industries

Description	**Augmented, Virtual & Mixed Reality - SEI Pioneer:** The team is paired with a challenge provided by a company coming from Entertainment / Education / Telcom industry, working on the development of an innovative product to address this challenge over the first half of the project. The topic of the challenge is **developing applications for new entertaining learning methods for addressing a mass market usage**. The initial objective for the first five months of the program will be defined by the partner company together with SEI, who are going to double the ASP budget available for students, as a reward towards the development of the Partner Tech Product Challenge by the students and for the IP developed for the external partner provider of the Partner Tech Product Challenge. In the subsequent seven months the students will work on developing their own entrepreneurial idea, in the same field of AVMR but addressing different applications/directions compared to the one of the Partner Tech Product Challenge. Students will be initially guided through an intensive product development phase where their sole objective will be to build this innovative product using methodologies like Value engineering, Agile methodologies, etc. They will also be trained by SEI personnel and mentored by company experts, professors from Politecnico di Torino & Milano and innovation & business experts from SEI. During this product development phase, they are put through the following workshops that last a weekend each once per month over five months • Challenge Research • Project Feature List • Product Prototyping • Feedback & Validation • Pitching & Presentation • Product Demo-day Once this is completed and presented in November 2019, the teams will start working on their own start-up ideas that they will then build over the following workshops • Problem Definition • Vision & Ideation • Customer Definition • Prototype Building • Market Validation • Startup Demo-day In the Start-up phase they are introduced to models like design thinking, lean startup, fast prototyping, etc. Also, in this phase the workshops will take place over the weekend (one workshop over one weekend per month over seven months) and start on Friday to conclude on Sunday. The first phase helps the team to develop sectorial expertise while being guided in a concrete direction by the company and SEI to resolve the Partner Tech Product Challenge and the second phase is dedicated to the creative expression of this expertise built during phase one using the learning models and the core subjects learnt.

	
Expected results	SEI Pioneer has a total duration of twelve months and has two main results produced by the teams which are structured as two separate demo-days. The first demo-day is related to the product innovation responding to the company challenge and is scheduled for November 2019 with the presentation of the results to the companies that have launched the Partner Tech Product Challenge. The second demo-day takes place in June of the following year during a public demo-day in which the results of the startup phase are presented to an audience of investors, companies, entrepreneurs and partners. In both cases a team comprising of company partners, innovation experts and professors from the universities will be helping evaluate the quality of work produced by the teams.
Stakeholders	**School of Entrepreneurship and Innovation** [www.sei.it] is a school created by **Fondazione Agnelli** for enabling the next leaders in Entrepreneurship & Innovation and will be responsible for the workshops and entire organization of the program for the participating students. SEI Pioneers [https://sei.it/en/school/pioneer/] is the module of SEI dedicated towards deep tech innovation for Alta Scuola Politecnica students. **[Fondazione Agnelli]** is a non-profit foundation which carries out in-depth research, seminars and publications, experiences of economic development, research in particular on on school and education issues.

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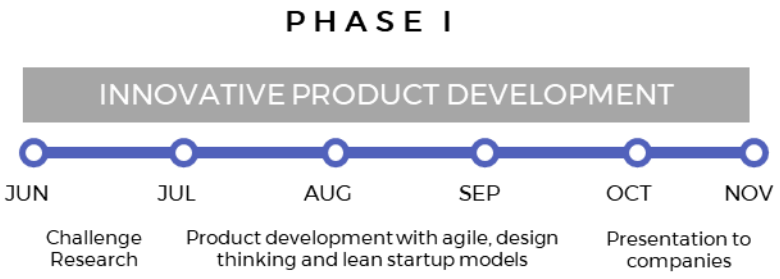
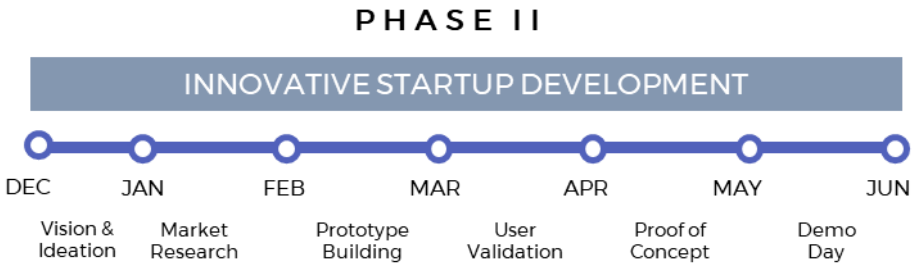
Project 3 – BE SEI
Bio Engineering - SEI Pioneer

Type of project	□ Demand pull
Objectives	SEI Pioneer is a one-year program in partnership with ASP that aims to create the next generation of deep tech entrepreneurs and innovators in Italy. One of the five fields of focus of this program is Bio Engineering. In the initial part of the program, the team is paired with a Partner Tech Product Challenge assigned from industrial partner like **[]** on the theme of Bio Engineering and work on the development of an innovative product to address this partner tech product challenge over the first half of the project. The topic of the Partner Tech Product Challenge is - **transformation of CO_2 to develop new solutions and applications of value.** In the subsequent seven months the students will work on developing their own entrepreneurial idea, in the same field of BE but addressing different applications/directions compared to the one of the Partner Tech Product Challenge. As Fossil resources are becoming a less desirable feedstock for the realization of many product, an alternative bio-economy transforming renewable resources in valuable products can provide viable solutions to the global challenges posed by environmental, economic and societal sustainability. Synthetic compounds (e.g. carbon dioxide, methane) originating from human industrial activities are negatively affecting the natural greenhouse. However, they could potentially be up-cycled in a wide variety of industrial applications displacing fossil fuels as a raw material. Nature displays an enormous diversity of microorganisms which fix and transform a carbon feedstock into potentially useful platform chemicals (e.g. biopolymers, biosurfactants, and bio-flavours, biofuels). Chemical engineering, (bio-)chemistry, microbiology and metabolic engineering collectively nowadays enable the rational engineering of efficient bio-processes. On the other hand, extraction and purification of obtained products from microorganisms often requires high efforts that could compromise the economic revenue and the environmental benefits of the proposed biotechnological process. The use of ionic liquids (defined as salt fused below 100°C) could help to overcome these issues providing a selective solvent not toxic for the microorganism and for the environment. Moreover the low volatility and high termal stability allows to recover the target product simply by distillation with low energetic cost. The focus is to develop an innovative value chain whose novely elements depend on photobioreactor design affording direct bacterial conversion of CO2 into a chemical widely expendable in the food and cosmetics industries, on the optimization of the product extraction and purification by ionic liquids. The partner tech product challenge will go in the direction of transformation of CO2 to develop new solutions and applications of value.

Description	**Bio Engineering - SEI Pioneer:** The initial objective for the first five months of the program will be defined by the partner company together with SEI, who are going to double the ASP budget available for students, as a reward towards the development of the Partner Tech Product Challenge by the students and for the IP developed for the external partner provider of the Partner Tech Product Challenge. Students will be initially guided through an intensive product development phase where their sole objective will be to build this innovative product using methodologies like Value engineering, Agile methodologies, etc. They will also be trained by SEI personnel and mentored by company experts, professors from Politecnico di Torino & Milano and innovation & business experts from SEI. During this product development phase, they are put through the following workshops that last a weekend each once per month over five months • Challenge Research • Project Feature List • Product Prototyping • Feedback & Validation • Pitching & Presentation • Product Demo-day Once this is completed and presented in November 2019, the teams will start working on their own start-up ideas that they will then build over the following workshops • Problem Definition • Vision & Ideation • Customer Definition • Prototype Building • Market Validation • Startup Demo-day In the Start-up phase they are introduced to models like design thinking, lean startup, fast prototyping, etc. Also, in this phase the workshops will take place over the weekend (one workshop over one weekend per month over seven months) and start on Friday to conclude on Sunday. The first phase helps the team to develop sectorial expertise while being guided in a concrete direction by the company and SEI to resolve the Partner Tech Product Challenge and the second phase is dedicated to the creative expression of this expertise built during phase one using the learning models and the core subjects learnt. the core subjects learnt. 

	
Expected results	SEI Pioneer has a total duration of twelve months and has two main results produced by the teams which are structured as two separate demo-days. The first demo-day is related to the product innovation responding to the company challenge and is scheduled for November 2019 with the presentation of the results to the companies that have launched the Partner Tech Product Challenge. The second demo-day takes place in June of the following year during a public demo-day in which the results of the startup phase are presented to an audience of investors, companies, entrepreneurs and partners. In both cases a team comprising of company partners, innovation experts and professors from the universities will be helping evaluate the quality of work produced by the teams.
Stakeholders	**School of Entrepreneurship and Innovation** [www.sei.it] is a school created by **Fondazione Agnelli** for enabling the next leaders in Entrepreneurship & Innovation and will be responsible for the workshops and entire organization of the program for the participating students. SEI Pioneers [https://sei.it/en/school/pioneer/] is the module of SEI dedicated towards deep tech innovation for Alta Scuola Politecnica students.

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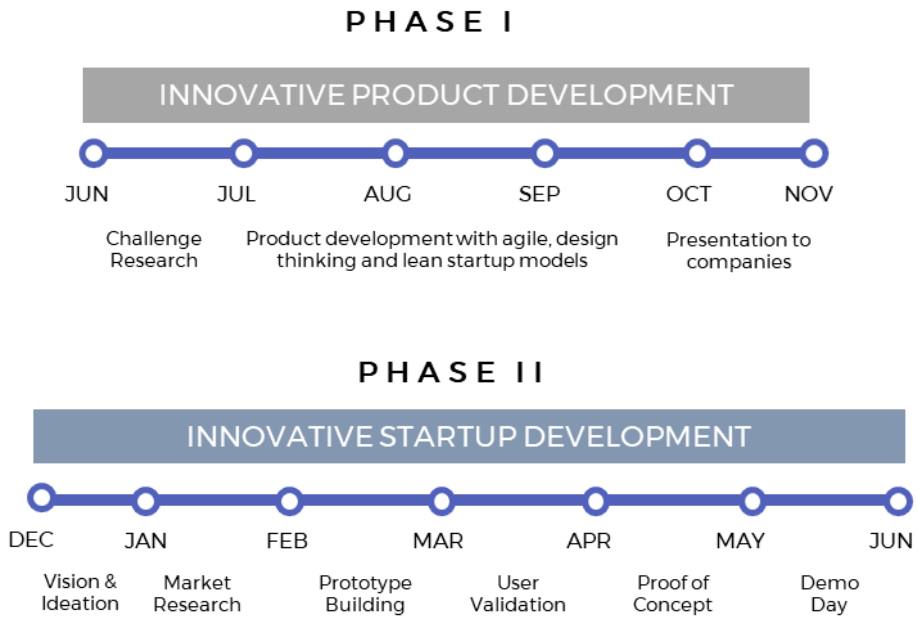
Project 4 – ST SEI
Space Tech - SEI Pioneer

Type of project	□ Demand pull
Objectives	SEI Pioneer is a one-year program in partnership with ASP that aims to create the next generation of deep tech entrepreneurs and innovators in Italy. One of the five fields of focus of this program is Space Tech. In the initial part of the program, the team is paired with a Partner Tech Product Challenge assigned from industrial partner like **[]** on the macro theme of Space Tech and will work on the development of an innovative product to address this Partner Tech Product Challenge over the first half of the project. In the subsequent seven months the students will work on developing their own entrepreneurial idea, in the same field of Space Tech but addressing different applications/directions compared to the one of the Partner Tech Product Challenge Space is still a significant scientific frontier for human kind. There is so much to explore and discover and we are just getting started. In the past, only governments of leading nations had enough resources to develop space technologies. Now we are seeing a change as space is becoming more accessible due do miniaturization of components, development of new technologies and powerful software advancements. Now private companies, universities and individuals have a chance to develop innovative space technologies and applications. New platforms for conducting microgravity research are being created which will provide an open platform for testing in microgravity. Furthermore, the development of small Nano satellites has given us a cheaper, easier way to launch payload into orbit and to improve our understanding of the Earth and space conditions. These small, highly flexible satellites can support a wide range of mission objectives; from pure research to technology demonstrations and space qualifications tests. The aim of the project is to work with a selected partner to explore and develop an innovative technology or application related to **advanced communication solutions between micro/nano-satellites constellations and/or between micro/nano-satellites and ground stations**. The development may be a software, hardware or service solution potentially enabling new satellite services, facilitating the control, management and/or monitoring of networks of nano and micro satellites, and/or improving communication reliability and security. The development may have a potential connection to programs related to European Space Agency and in particular with focus on free-flying applications and experiments in microgravity, in-orbit technology demonstration and validation for applications with a focus on exploration, earth observation, telecommunication and surveillance.

Description	**Space Tech - SEI Pioneer:** The team is paired with a Partner Tech Product Challenge from industrial partner on the theme of Space Technologies and will work on the development of an innovative product to address this Partner Tech Product Challenge over the first half of the project. The topic of the challenge is the development of **advanced communication solutions between micro/nano-satellites constellations and/or between micro/nano-satellites and ground stations**. The initial objective for the first five months of the program will be defined by the partner company together with SEI, who are going to double the ASP budget available for students, as a reward towards the development of the Partner Tech Product Challenge by the students and for the IP developed for the external partner provider of the Partner Tech Product Challenge. In the subsequent seven months the students will work on developing their own entrepreneurial idea, in the same field of ST but addressing different applications/directions compared to the one of the Partner Tech Product Challenge. Students will be initially guided through an intensive product development phase where their sole objective will be to build this innovative product using methodologies like Value engineering, Agile methodologies, etc. They will also be trained by SEI personnel and mentored by company experts, professors from Politecnico di Torino & Milano and innovation & business experts from SEI. During this product development phase, they are put through the following workshops that last a weekend each once per month over five months • Challenge Research • Project Feature List • Product Prototyping • Feedback & Validation • Pitching & Presentation • Product Demo-day Once this is completed and presented in November 2019, the teams will start working on their own start-up ideas that they will then build over the following workshops • Problem Definition • Vision & Ideation • Customer Definition • Prototype Building • Market Validation • Startup Demo-day In the Start-up phase they are introduced to models like design thinking, lean startup, fast prototyping, etc. Also, in this phase the workshops will take place over the weekend (one workshop over one weekend per month over seven months) and start on Friday to conclude on Sunday. The first phase helps the team to develop sectorial expertise while being guided in a concrete direction by the company and SEI to resolve the Partner Tech Product Challenge and the second phase is dedicated to the creative expression of this expertise built during phase one using the learning models and the core subjects learnt.

	
Expected results	SEI Pioneer has a total duration of twelve months and has two main results produced by the teams which are structured as two separate demo-days. The first demo-day is related to the product innovation responding to the company challenge and is scheduled for November 2019 with the presentation of the results to the companies that have launched the Partner Tech Product Challenge. The second demo-day takes place in June of the following year during a public demo-day in which the results of the startup phase are presented to an audience of investors, companies, entrepreneurs and partners. In both cases a team comprising of company partners, innovation experts and professors from the universities will be helping evaluate the quality of work produced by the teams.
Stakeholders	**School of Entrepreneurship and Innovation** [www.sei.it] is a school created by **Fondazione Agnelli** for enabling the next leaders in Entrepreneurship & Innovation and will be responsible for the workshops and entire organization of the program for the participating students. SEI Pioneers [https://sei.it/en/school/pioneer/] is the module of SEI dedicated towards deep tech innovation for Alta Scuola Politecnica students. **European Space Agency** [http://www.esa.int/] is an intergovernmental organisation of 22-member states dedicated to the exploration of space. ESA's space flight programme includes: human spaceflight (mainly through participation in the International Space Station programme); launch and operation of unmanned exploration missions to other planets and the Moon; Earth observation, science and telecommunication missions; designing launch vehicles; and maintaining a major spaceport, the Guiana Space Centre at Kourou, French Guiana.

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Other inst.	
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Reference external tutor	
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Affiliation	SEI

Project 5 – PN Relay

Peripheral Nerve Bypass Nanotechnology for Neuroprosthetic Applications

Type of project	☒ Demand pull
Objectives	Peripheral neural system (PNS) is responsible for conveying information between the central nervous system (CNS) and target organs (such as muscles). PNS can lose its function due to physical trauma (excessive stretching or pressing) or general medical conditions (such as diabetes and Guillain-Barre syndrome). PNS impairments can dramatically affect and individual's quality of life (both physically and psychologically), as the simplest tasks may become unattainable or overly burdensome. Goal of this project is to conduct simulation and modeling studies aimed at bypassing the damaged portion of the nerve by means of an external electronic system (encompassing signal acquisition, processing and extraction of information). The acquisition system would cue an external muscle stimulation would be employed to restore lost body movements. Recent advances in nanotechnologies and microfabrication enabled the realization of miniaturized sensors for an intra-body monitoring of vital functions. These devices perform simple tasks, but their information must be transported toward an elaboration center (e.g., a wearable device). Cuff electrodes are the most popular strategy for long-term implants in PNS, having proven stable and compatible for long spans of time. Many setups for cuff design and contacts arrangements have been tested, and so a large body of literature on the sensing strategy using nerve cuff electrodes is available, as well as on the signal processing techniques and surgical procedures. The objectives are: 1) Create an innovative cuff electrode model to be optimized through simulations. 2) Design an electronic system for nerve bypassing including for pre-processing steps such as filtering, AD conversion, miniaturization, energy-budgeting. 3) Design a post-processing algorithm to classify nerve activity and discriminate between activation of the three sciatic nerve fascicles (related to activation of sural, personal and tibial muscles). 4) Gain experience from off-line processing of neural data (e.g., PC-based processing system) for future real-time tests (if real data is not available, use simulated data). 5) Possibly, design a muscle stimulation protocol and an ultra-sound wireless protocol for communication and power transmission between the electrode, an external transducer and the stimulator, in agreement to what said above. 6) Possibly, prototype the designed cuff electrode and conduct further experiments. Beneficiaries are: health industry for care and patient rehabilitation, lower limb amputees using functional prosthesis, PNS injury or disabled patients that lack mobility of a lower limb (but it could be used for different nerves).

Description	Electroneurography (ENG) is a branch of electrophysiology that deals with recording electric potentials from peripheral neural system (PNS) structures of the body, such as nerve trunks emerging from the spinal cord. ENG could be also used in combination with functional electrical stimulation (FES) of muscles or functional neuro-electrical stimulation (FNS), in case of a peripheral nerve injury, to recover a natural control over motion (efferent), restore sensorial perception (afferent) or modulate neural activity to ameliorate specific (e.g. bladder incontinence). When these strategies are used to compensate a damage that is purely neurological (no amputee), the device is named neuro-prosthesis. There are many different designs of electrodes that could be used to measure ENG signals and/or stimulate the nerve (LIFEs, FINEs, UEAs…). They can be roughly divided in two categories: extra neural and intraneural, depending on whether they rest on top of the membrane enclosing the nerve (epineurium) or they penetrate it. Intraneural electrodes offer better performances in terms of signal quality but suffer from biocompatibility problems, as their invasivity causes the body to react with inflammation, swelling and formation of fibrotic (scar) tissue. This dramatically jeopardizes long-term stability and recording quality, which is unacceptable for chronic implantation, as it would be needed for functional recovery. Extra neural electrodes offer weaker and noisier signals but are more tolerated by the body. Amongst those, the so-called “cuff electrodes” are the most popular ones. Multi-contacts cuff electrodes have been successfully employed to selectively stimulate different portions of the nerve, and consequently elicit different responses (e.g. movement of a selected muscle). On the other hand, the problem of how to discriminate the activation of different portions of the nerve is still open. A multitude of post-processing strategies have been applied in order to identify the activated portion of the nerve (Bayesian filters and classifiers, ANN, Blind source separation with ICA…). In order to successfully control movement with ENG, it is essential to correctly identify the nerve sub-structures (“fascicles”) related to each muscle. New and improved processing strategies are currently progressing in this direction. The project will comprise these steps: 1) Creation of a simulation model of a multi-contact spiral nerve cuff electrode. 2) Analysis of the above-mentioned model under various conditions/with different configurations to define an optimal setup. 3) Implementation of a classifier (strategy to be defined) to discriminate between activated fascicles (i.e. muscles) in the nerve (with neural signals from databases or simulated) and assessment of classifier performance. 4) Economic and social impact analysis of an IBN system and development of a business-plan for start-up. Required components (software and hardware) to implement the test-bed 1) Multiphysics Modeling SW to simulate nerve and electrode interface and dynamics under various conditions (e.g. COMSOL®). 2) Signal processing and data mining SW to implement classifying algorithms (e.g. Mathworks Matlab®). 3) Neural recordings data to validate the models and classifiers (possibly *in vivo* experiments from online databases or similar sources, otherwise artificially created *in silico*). **Timeline (in months)** M0-M1: State of the art (both electrode design, sensing and classification strategies). M1-M4: Definition of the requirements. M4-M7: Design of electrode model, simulations to optimize the setup. M4-M10: Implementation of the classification algorithm. M10-M12/14: Data processing and classifier validation.

Expected results	The project aims at performing simulation in order to boost the development of minimally invasive spiral cuff electrodes and related processing framework, to be potentially used to restore hind-limb functionality in case of PNS injure. In order to achieve this, the sensing part (cuff electrode) needs to be integrated with the following: 1) A wireless power transmission and communication interface that will ensure the implanted nerve cuff electrode receives power from an external transducer and transmits back relevant information. In this regard, ultra sound (US) wireless power and signal transmission has proven successful and promising in the biomedical environment. 2) An embedded strategy to perform classification of the signal with real-time constraints. 3) A suitable actuator (FNS or more likely FES) for the target muscles that communicates with the transducer and processing device (not considered in this project). The main expected result from these first experiments is to obtain a more thorough understanding of the design of a nerve cuff electrode and implementation of related processing framework in order to retrieve significant information aimed at restoring motor functions, with specific concern for real-time and compactness constraints. Furthermore, the team is expected to be aware of the economics of the entire system and analysis of the costs, and possibly the management of a highly interdisciplinary engineering team, including the design of a business plan for a start-up devoted to the manufacturing and marketing of the project's results. The results will stand as starting point for researchers (both engineering and medical) and developers to improve current strategies for ENG-controlled robotic prosthesis or neuro-prosthesis.
Stakeholders	The stakeholder involved in this project proposal is San Raffaele Scientific Institute, in the person of Dr. Carla Taveggia, with specialization and strong background in the treatment and study of myelination of axons in PNS. The treatment of nerve injury in PNS is a relevant and timely topic both in medicine and engineering. Dr. Carla Taveggia will have an active role in in the project for providing the support to understand the fundamental mechanisms at the basis of propagation of nerve pulses in the axons. Starting from this knowledge, the suitability of the two different transmission technologies considered for IBN will be considered to evaluate their suitability to preserve the main characteristics of axon signals. University of Milano-Bicocca and San Gerardo Hospital (Monza) will be a second stakeholder, in the person of Dr. Paola Alberti (MD, PhD, Board in Neurology). Her research is focused on peripheral nervous system diseases on a clinical and preclinical level (see her publication track record: https://www.scopus.com/authid/detail.uri?authorId=7103068082). She is a certified Neurologist/Neurophysiologist and will give support in devising a system/approach suitable to be transferred to a translational research setting. This would enable to promptly translate, in future, these data in a clinical application. WISE Srl is a Milan- and Berlin-based biomedical company developing a genuinely new generation of implantable leads for neuromodulation and neuromonitoring. WISE's electrodes are highly biocompatible, foldable, stretchable and minimally invasive that allow to improve the treatment of patients that are already profiting from neuromodulation. The electrodes are produced through an innovative technology that embeds metal nanoparticles inside a preformed polymer base in order to form a conductive metal-polymer skin on its surface. The project is highly interdisciplinary bringing together competencies in medicine, communication engineering, biology, and computer science and opens new perspectives for medical treatment of serious injuries and diseases of PNS. The results of this project will set the basis for the application of engineering approaches to optimize the design and implant of a nerve cuff electrodes and related processing procedure to identify specific active neural fascicles.

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Project 6 – HypérTracker

HypérTracker – Solar tracker for automatic installation of photovoltaic modules with robots

Type of project	X Demand pull
Objectives	In order to reduce the overall cost of electric power produced by photovoltaic plants COMAU develop a robot that can automatically install PV modules on solar trackers or on fixed structures. The use of these robot permits a strong reduction in the construction time of large scale PV plants. However the use of the robot should be more efficient if the complete PV support system was designed four automatic installation. The project focuses on the design of a new kind of solar tracker that allows fast automatic installation. The project intends to consider all the aspects related with the complete lifecycle of the tracker, including manufacturing, installation, construction supply and management and end-of-life 1. Conception and design of a solar tracker that allows photovoltaic modules installation in synergy with Hypérion, a mobile robot designed and industrialized by COMAU for this application 2. PV module clamping system for automatic installation: integration of the clamping system in the manufacturing process of the tracker, simplification of clamping system 3. Vision systems: improvement of robot guidance 4. Development of manufacturing process oriented to simplified logistics and tracker on-site installation, guaranteeing time and costs effectiveness 5. Solar tracker structural strength and foundations compatible with 140 km/h wind speed 6. Construction process optimization in terms of logistics, vehicle and operators management, materials handling 7. Manufacturing and testing of solar tracker prototype: all manufacturing activities will be carried out by COMAU with a support from the student team 8. Life cycle analysis Innovation: • disruptive revolution in renewable energy field through the introduction of a technology that can notably accelerate its diffusion improving productivity and safety in the construction of large PV plants • first outdoor robot-integrated system in the world • design-to-manufacturing oriented to robot process optimization Multidisciplinarity: the project requires different competences ranging from functional and structural mechanics, construction and logistics to automation and programming to manufacturing and production. In order to achieve every single objective it is necessary that those competences are mixed and integrated. Interested parties: • Politecnico di Torino / Politecnico di Milano • COMAU • World energy production companies

Description	During last 2 years, Comau has exploited all its industrial automation competence, technology and experience to develop a mobile robot for automatic installation of photovoltaic modules in outdoor environment, Hypérion. PV modules are mounted on a solar tracker that is constituted by a main central beam with orthogonal crossbars on top, where modules are fixed using bolts or screws; the central beam is supported by vertical pillars and its rotation is controlled by an electrical motor with an algorithm that follows sun movements. To enable robot automatic installation, bolts and screws must be replaced with quick couplers that permit modules clamping with just a simple robot movement. Actual solar trackers are remarkably optimized for manual installation but they lack some essential features to support and enhance automatic installation: • quick couplers are an add-on of the structure requiring an assembly operation to mount them on crossbars instead HypérTracker must have them integrated so its design must be reinvented and the manufacturing process restructured; • Comau machine, Hypérion, features some of the most advanced vision systems to guide the robot in the desired position for installation over the solar tracker, but HypérTracker is supposed to improve vision systems performance including repeatable easily-recognizable frames; • HypérTracker structure must have a stable geometry and dimensions tolerances compatible with automatic process. The objective of the project is to conceive, design and realize a new solar tracker that integrates those requirements, using a comprehensive approach that takes into account also manufacturing, construction and logistics aspects of this complex challenge. The project will be structured in four main phases. During first phase, that will last 5 months (July 2019 – November 2019), a model of the tracker featuring all the requirements of automatic installation must be studied and delivered. Second phase, that will last 4 months (December 2019 – March 2020), will be focused on the manufacturing and on the installation strategy of the solution studied, always considering that large part of tracker installation includes construction activities. During this phase, the tracker can still be optimized, but at the end the design and manufacturing and installation strategies must be frozen. During third phase, that will last 3 months (April 2020 – June 2020), a prototype of the solution developed will be manufactured and installed in a test field and during last phase, that will last 2 months (July 2020 – September 2020), HypérTracker will be tested with Hypérion. All manufacturing and construction acitivities will be carried out by COMAU with a support from the student team
Expected results	<u>Renewable energies – solar plants</u> The success of this project could push Comau penetration of renewable energy market, in field where automated construction is not an option today. The achievement of objectives 1, 2 and 3 could result in the design of a tracker that deeply improves PV modules installation with mobile robot by shifting some difficult tasks that are now in charge of the machine, such as tracker position recognition and module clamping, to a structure that is manufactured for these purposes. <u>Design-to-manufacturing for logistics</u> Building a solar plant requires a huge quantity of resources that must be packed, handled, transported, unpacked and assembled: one of the main goal of the project is to realize a product that is optimized to make all these operations lean, time and cost effective. Fulfilling the targets of objectives 4 and 6 represent a goal for Politecnico di Torino e Milano most talented students and could strongly impact Comau way of managing solar plants installation.

	Smart foundations Foundations are one of the most ancient technology humanity exploits for construction and represent the basis for any successful building but in this project, with objective 5, it is required to envision smart foundations that can be used with any kind of soil and are simple and quick to manufacture. It is a further dare to Politecnico di Torino e Milano competences instead for Comau could open a new area for investments, construction automation.
Stakeholders	COMAU – leading the project, providing specifications and controlling project targets and timing Politecnico di Torino – academic support Politecnico di Milano – academic support

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Project 7 – Kuoleva Jäätikkö

Kuoleva Jäätikkö

Type of project	**x Technology push**
Objectives	The objective of this project is to develop a protocol for monitoring the health conditions of one of the southeast glaciers of Alpine chain: The Belvedere glacier (Kuoleva Jäätikkö). In the last years, it has shown huge mass reductions. The Belvedere glacier represents a precious source of water for the region, a key element for the winter and summer tourism, and an important resource for the hydropower production during the summer period. The key idea is to develop and use some technological devices to detect glacier changes including morphological, geo-structural, chemical, hydraulic-hydrological ones, to retrieve information in terms of ice thickness, glacier permeability, water movement, water age, crevasses, glacial lakes, not adequately investigated in the past, but now of fundamental importance to make future predictions of glacier behavior and existence. In particular the focus here is on ice feeding and ice melting influencing the ice balance. The problem complexity and difficulty require different kinds of expertise through a multidisciplinary team including students with civil or/and environmental engineering, mathematical, physical, chemical, and electronic engineering background.
Description	In order to achieve the project objectives, 1) one avenue is to test and use optical sensors like network of cameras mounted on sticks, or camera mounted on drones, or laser scanners to evaluate temporal and spatial glacier changes in correspondence of glacier feeding and terminal zones, in order to make an evaluation of ice feeding and melting. 2) Another avenue is to use geophysical devices like vapor probe, seismic, radar techniques in order to make an evaluation of ice thickness and relative variations and to detect internal features. 3) An additional avenue considers development and use of temperature sensors like a network of thermometer probes mounted on sticks, in order to investigate the variability of the equilibrium line altitude (ELA) and distinguish between the accumulation area and melting areas. The work is organized as follows: - in the first three months (July-September), read some key references, and acquire basic knowledge concerning the problem; - in October (around the 1st week) 1st field campaign on Belvedere glacier, problem formulation, and data collection with the help of the tutors; - in the second three months (October-December) device identification/development and proof of concept; - in the period January-May device testing, and tuning; - in June (around the 1st week) 2nd field campaign on Belvedere glacier, data collection; - in June and July data processing; project summary, report writing and review; - in September, Project presentation.

Expected results	The main project's result is the development of a protocol to glacier monitoring which could be tested/applied also in other glaciers (result portability). The project's results could be extrapolated to provide future perspectives of glacier existence (environmental value). The project's results can be of importance for the management of the water resource under ice formand from the technological point of view because the protocol could become a market product. The project's results will provide fundamental information for stakeholders, water Users (like EDISON and ENEL) and Water Authorities (like ARPA Piemonte and ADB Po) as the results will be casted in hydrological models to predict future scenarios of water availability and scenarios of hydropower productions.
Stakeholders	ARPA Piemonte (Dipartimento del Verbano Cusio Ossola) – support in the realization of hydrologic measurements; AUTORITÀ DI BACINO DEL FIUME PO – support in the realization of hydrologic measurements; EDISON – logistic support in the realization of geophysical measurements; ENEL – logistic support in the realization of geophysical measurements; ADPM Drones – technological support in the development of the multiple drones system.

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Project 8 – TraP
Pallet Tracker

Type of project	x Demand pull
Objectives	The Procter & Gamble Company is focused on providing branded consumer packaged goods to consumers around the world. The Company operates through five segments: Beauty; Grooming; Health Care; Fabric & Home Care, and Baby, Feminine & Family Care. In traditional warehouses, position of pallets is determined through manual or automatic scanning of pallet labels. The pallets' positions are recorded in the material system of records. The vision is to eliminate this scanning procedure and be able to identify and track pallets' movement through an affordable tracking system for large scale operations. On one hand, it would reduce the number of individuals needed on the floor; on the other hand, it would reduce the number of errors for mis-placed products
Description	1. Understand the current P&G environment – get to know what is happening today and penetrate the business need. Visit Pomezia's distribution center and observe how operations are currently carried on 2. Assessing the landscape: review the current process, assess what competition does and what are the available tools in the market. Work on the financials to prove reduction of overall TDC (Total Cost of Ownership). 3. Opportunity identification: identify out-of-the-box tools that could fulfill the need and develop comparative analysis including financials 4. Proposal definitions and idea selection: ASP team and P&G management will identify the best of breed tool and concentrate the work on it. Pilot will be considered if investment is affordable 5. Plan definition: what needs to be true to make it live also including cost affordability and scalability to multiple warehouses On site visits will be planned based on project developments'
Expected results	Based on the results of the analysis the outcome of the project can be either a full recommendation on how to implement a new pallets' localization solution or, if financially viable, a fully fledged pilot in a P&G Warehouse. The recommendation will include the financial and technological analyses of the proposed solution, and an analysis on the scalability of the solution on multiple warehouses.
Stakeholders	The possible stakeholders involved in the project will be the following: ➢ The different P&G key resources (Product Supply, IT Warehousing) will be providing company's expertise, what is happening today and what is envisioned for the future; ➢ P&G finance organization to validate affordability; ➢ 3rd Party Logistics that are operating external warehouses (e.g. Agnadello)

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Project 9 – RECOURSE SHANGHAI
REcycling COncrete for a Soft Urban Regeneration in Shanghai

Type of project	X Demand pull
Objectives	As demonstrated by Vaclav Smil in his *Making the Modern World* (Wiley, 2014), China is the largest consumer of cement and concrete in the world. From the viewpoint of environmental preservation and effective utilization of resources, it is beneficial and necessary to reuse waste concrete as recycled concrete aggregate (RCA) for new concrete. In the recent years, intensive researches on this topic have been carried out in Europe, USA, and China. The city of Shanghai in its Master Plan 2016-2035 is proposing the vision of a "more dynamic, more attractive, more sustainable" city, developing pilot projects for "healthy and low-carbon way of life". The multidisciplinary project "RECOURSE SHANGHAI" aims to propose a pilot project for the soft regeneration of an urban district of Shanghai, based on *in situ* recycling of concrete from demolished buildings. The main innovation would be to imagine a process of circular economy based entirely on the transforming neighbourhood, eliminating the transport of waste in recycling plants outside the city. In this process of "kilometre zero" self-regeneration, the recycling plant would need to be designed as a leading player: a green and silent factory in the middle of the city, for the production of prefabricated concrete panels, rebirth bricks and blocks as well as structural frameworks. This would be also an answer to a 2017 governmental regulation, that prescribes that in the future an ever increasing proportion of new buildings in China should be realized with the use of prefabricated elements (for structural and non-structural parts) to limit the polluting emissions generated by a traditional cast-in place concrete castings. The multidisciplinary nature of the project will be guaranteed by the team of teachers and students, coming from the disciplines of architecture, urban design and landscape architecture, materials engineering, industrial eco-design, environmental engineering, civil engineering, management engineering, built environment management, urban economics. Potential beneficiaries would be the City of Shanghai (in relation with the "Shanghai 2035" Urban Plan), the SICES (Sino-Italian Center for Sustainability) based at the Tongji University in Shanghai (with the possibility to use this project as a start-up research platform), and the industrial sector of concrete recycling plants as well as international producers of formwork and Chinese real estate developers.
Description	The multidisciplinary project will be developed according to the "research by design" method: students from different backgrounds actively collaborate addressing an urban vision characterized by soft regeneration tools proposed by the teaching group. The vision of a "soft regeneration" of an urban district in Shanghai is opposed to the current restructuring practices based on the *tabula rasa*. A progressive substitution strategy is proposed, maintaining some buildings and infrastructures (for reasons of economic opportunity and not only for historical memory). According to this vision, it is also possible to imagine the *in situ* maintenance of a part of the population that would be relocated in the new buildings, according to a phasing process, similar to the positive results with the urban restoration interventions of the Italian historical centers in the 1980s -90. Consistent with this model of intervention, the multidisciplinary project should define a regeneration strategy as a "continuous building site", as an alternative to the strong spatial and temporal discontinuities produced in the demolition-reconstruction process routinely used in China. Particular attention will be also given to the design of green open spaces, considered as key elements to implement the strategies for urban resilience and sustainability being developed in China. Such strategies are based on a new relationship of the city with its urban waters, as expressed by the government initiative Sponge City programme launched in 2015 that aims at a new joining of urban and natural systems, implemented by embedding a continuous network of green areas in the urban organism.

	Phases of design **Phase 1 _ May – June 2019** - First meetings with the students. **Literature review**, following the students' specific disciplinary skills, on different topics, i.e. urban regeneration in China (and especially Shanghai), state of the art of the technology of concrete recycling, policies and technical regulations for the use of prefabricated concrete in China, the territorial dimension and impact of circular economy, models of circular economy in China, urban planning regulations in China ("Shanghai 2035"). - **elaboration of the urban regeneration scenario**, selection of the project area in Shanghai. **Phase 2 _ July 2019** - First meetings with the stakeholders. Visit of concrete recycling plants and producers of prefabricated structures in concrete in northern Italy. - **First review of the project**, with the supervising team and stakeholders. - Definition of the budget. **Phase 3 _ September 2019 – January 2020** - Project development, on the basis of the feedback of stakeholders. - **Design Workshop in Shanghai** at the SICES Headquarters, meetings with teachers and research labs of Tongji University, with representatives of the public administration, and with representatives of Italian and Chinese companies for recycling concrete (date to be defined) and producers of prefabricated structures in concrete (RC and GRC). - **Second review of the project**, with the supervising team and stakeholders. **Phase 4 _ February - March 2020** - Project development. - **Third review of the project**, with the verification of progress with ASP Board members during the Winter School **Phase 5 _ April - September 2020** - Final project development. - Final submission and final examination.
Expected results	The application fields of the disciplinary project are three: the city of Shanghai, the SICES research center, the concrete recycling industry. For the city of Shanghai, the application could be the elaboration of a pilot project coherent with the objectives of "Shanghai 2035" to become a more adaptable and resilient eco-city. For the SICES (Sino-Italian Center for Sustainability) based at the Tongji University in Shanghai, the application could be the development of a long-term research platform for concrete recycling plants in an urban context, with the contribution of researchers and PhD students from Politecnico Milano and Politecnico Torino. For the concrete recycling industry, the application could be the study of future smaller recycling plants, to be installed locally, with low acoustic impact, compatible with the residential functions, in order to lower the transport costs of materials. To meet the objectives of the project, it will be necessary to carry out quantitative assessments, in relation to the mass of the demolished buildings and of the recycled materials, with the accumulated energy savings, together with qualitative assessments regarding the improvement of the environmental conditions of the district under the process of soft regeneration.

Stakehoders	An important role of mediation will be played by **Roberto Pagani**, as the Attaché for Science and Technology at the Consulate General of Italy in Shanghai, facilitating relations between Chinese and Italian academics and the productive world of Italian industries based in China. As a physical location for workshop activities, we will use the **SICES headquarters at Tongji University in Shanghai**, following the mission of the Sino-Italian Center for Sustainability to be a catalyst of innovative research excellence in green economy. Founded as a cooperation framework between the Italian Ministry for the Environment, Land and Sea (IMELS) and Tongji University, the SICES will offer the possibility of creating links between the ASP students and Italian researchers present in China and coming from different universities, together with specialized research groups at Tongji University. The mission of **the LafargeHolcim Foundation for Sustainable Construction** is to select and support initiatives that combine sustainable construction solutions with architectural excellence and enhanced quality of life beyond technical solutions. Every 3 years, the Foundation organizes the LafargeHolcim Awards for Sustainable Construction, the world's most significant competition for sustainable design (the next competition will close in February 2020). The Foundation will offer the possibility to access to the database of all the entries of the previous editions of the Awards, and we will verify with the students the possibility to submit the project to the Awards. As a construction industry, LafargeHolcim pursues the goal of reusing high volumes (10 million tons worldwide) of waste from construction sites or other aggregates by 2020, and we will verify the possibility to open a dialogue with some components of the technical offices.

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Project 10 – ALZGAR

ALZheimer's GARden: enhancing social relations of Alzheimer's patients in open spaces

Type of project	X Technology push
Objectives	"Il paese ritrovato" is a small village in Monza where patients with dementia and Alzheimer lead an almost normal life, but in a protected context where they can get the necessary treatment. The village hosts 64 patients, monitored by a technological infrastructure. In particular, a localization system continuously monitors their position in the buildings and in the garden. The aim of the project is twofold: a) localization data can be analyzed to understand the social behavior of the patients; b) the garden and the open spaces can be redesigned to promote social relations and to support appropriate activities/therapies (like, e.g., aromatherapy, wandering, physical activities, etc.). The project requires a strong multidisciplinary approach, involving ICT and data analysis competences; expertise on open spaces architecture design to study new garden solutions; management and economics competences. This list is not exhaustive and other backgrounds can be taken into account. The Italian experience of "Il paese ritrovato" (Monza) will be the case study for the data analysis and the new solutions proposal.
Description	The project is in the contexts of Ambient Assisted Living and Architectural Design and will be carried out in partnership with "Il paese ritrovato" (Monza). From the technological point of view, it will exploit data obtained from a localization systems that is able to locate people (or possibly also objects) in the environment, both indoor and outdoor. The analysis of the data collected over different seasons, will allow to understand the typical behavior of the patients and possibly their social relations, but also the usage of the different parts of the environment. The focus will be on the analysis of patient's positions in the open space, which includes a small garden, a little orchard, some streets around a central nucleus of shops. In this project, the students will first learn the organizational model of "Il Paese Ritrovato" and of other similar solutions for Alzheimers' patients; they will analyze the target users' needs and typical activities, as well as gardens' designs for Alzheimers proposed in the literature or in other villages. As a second step, algorithms for the analysis of the data will be implemented: this is the first village of this type where it is possible to analyze the patients' movements and understand the possible relations with the environment. This will allow to identify possible issues/gaps of the current open spaces of "Il Paese Ritrovato", to enhance the current design or to propose innovative solutions. The main tasks of the project will therefore include: - June-August 2019: Learning of the organization model of "Il Paese Ritrovato"; analysis of the background of the state of the art of social behavior analysis and of Alzheimers garden's design; - September-December 2019: Implementation of the data analysis algorithms, identification of the needs of target persons that are under-satisfied and might benefit from new solutions; - January-February 2019: Identification of innovative scenarios combining different solutions/technologies; proposal of an innovative idea. - February-End of project: Development of the idea; possible development of a proof-of-concept. The activity of the students will be monitored by the tutors through the organization of periodical meetings with brainstorming on the different steps of the project.

Expected results	Students will learn innovative technologies/solutions and organizational models that can help our ageing society. Expected results include: - Analysis of the state of the art of: a) recent innovative care models to support patients with dementia or Alzheimer's; b) data analysis techniques to understand social behaviors; c) Alzheimer's gardens designs. - Analysis of the current organizational model of "Il Paese Ritrovato" taking into account the different multidisciplinary points of view; target users' analysis; interviews with medical staff. - Data collection, cleansing and data analysis: implementation of algorithms for social relations. - Analysis of the usage of the outdoor environment in a real case study. - Proposal/design of a new environmental solution to enhance social relations and outdoor activities. Cost analysis of the solution. External partners will guarantee the expected results, supporting students with their experience.
Stakehoders	**LA MERIDIANA** is a social cooperative operating in Monza and engaged in the design and management of innovative structures for the elderly and complex neurological patients. They experiment new models of care for the patients and the elderly. In particular, they have recently opened first Italian village for the treatment of Alzheimer (http://www.cooplameridiana.it/il-paese-ritrovato/). They will support the students with their knowledge and experience in the village for Alzheimer patients. Il Paese Ritrovato collaborates with the main stakeholders of the project that include: patients, doctors, caregivers, patients' families.

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Project 11 – EnerChain
Blockchain for Smart Energy Applications

Type of project	Technology push
Objectives	The **energy sector** has been facing important transformations from the demand and the supply side: in addition to few, big energy providers, now there are prosumers contributing with their private power generation plants based on renewable sources, while power consumption is becoming less predictable due to the mobility of users (e.g. electric cars, wireless charge). The resulting ecosystem implies bi-directional energy flows, dynamic sets of users, and an increased complexity that must be properly managed to provide a solid accountability. **Smart metering solutions** have been proposed to improve this accountability, yet a lot of work is required to increase the trust in a system that is currently based on centralized entities. The goal of this project is to investigate the applicability and the benefits of smart contracts and **blockchain technology** in the energy sector to enable new business models for an Italian utility like Edison. Knowledge about blockchain needs to be combined with the understanding of how the Italian energy system works and which are the challenges of the growth of distributed energy sources and electrical mobility. At the same time, stakeholder requirements, which are provided by Edison, must be assessed to develop an effective value propositions and to design new services for customers.
Description	The project is structured into three major phases, each representing a different level of understanding and development of project objectives: 1. **Technology scouting and understanding (JUN-OCT)** In line with the technology push approach of the project, the first important step is understanding the technical underpinnings, capabilities and limitations of blockchain and smart contracts in state-of-the-art applications. This understanding is crucial for the development of credible and technically feasible application scenarios. Indeed, “blockchain” is often abused as attractive buzzword, even though its applicability may be questionable. A thorough confrontation with the state of the art is paramount to success. 2. **Application selection and business model development (NOV-FEB)** The next step is the identification of an innovative product/service able to demonstrate both the applicability of blockchain and smart contracts and the benefit it may produce to its stakeholders, including potential customers and energy utilities. This phase expects an iterative process that alternates between two core activities: ● **Business model generation** Different product/service concepts and business models that leverage on the data and capabilities provided by the energy utility and that are able to bring the product/service to the market must be explored and compared. Special attention is paid to the sensible use of blockchain technology and smart contracts and the potential business value of the application. ● **Stakeholder requirements and benefits analysis** Each identified product/service must be equipped with a suitable analysis of the involved stakeholders (including the external partner Edison), their specific requirements (including technical, organizational and legal requirements), and the possible benefits that the product or service may produce for the stakeholders.

	This phase ends with the selection of the most promising product/service and business model to be further developed. 3. **Product/service implementation and validation (MAR-JUN)** The final phase aims to develop a MVP (minimum viable product, including the blockchain itself, the communication infrastructure and the user interface) to realize the chosen product/service and to test it in real life.
Expected results	The expected outcome of the project is the development of a **blockchain-based product/service** that supports the most promising energy-centric business model identified and complies with the requirements of the external partner Edison. The project aims to realize a **working prototype**, including the code of the software, the infrastructure to guarantee communication among the different nodes of the network, and the interface towards end-users. Moreover, it is expected to investigate how this initial setup can be scaled-up to reach to a **commercial application**, both from a technical and a business perspective.
Stakeholders	The main external partner is **Edison**, one of the oldest energy utilities in Italy. Its Business Innovation unit is focused on investigating potential new business models enabled by digital technologies and disruptive trends in the energy sectors, such as electrical mobility, storage and batteries, Internet of Things applications, and similar. As such, Edison has a **genuine and strategic interest** in the success and viability of the project and contributes to the project with first-hand knowledge and competences. Depending on the application scenario developed throughout the project, **other stakeholders** originate from the proposed business model and may range from energy consumers, energy prosumers, other energy utilities, local/national government agencies, startups developing and operating the application, credit institutions or banks, and similar.

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Project 12 – ENEHRVIT
Energy Harvesting for Internet of Things

Type of project	☑ Technology push
Objectives	The development of the internet of things paradigm poses impressive new challenges, in particular concerning the problem of powering small, wearable, or remote electronic systems. Old fashioned solutions, i.e. disposable batteries, are not viable because of the limited power density, short life and practical impossibility of replacement once exhausted. An alternative solution could be the use of a system able to gather energy where and when available. Energy harvesting refers to a set of technical solution to collect energy from the surrounding environment, so that it can be used both to supply power to systems, or to the extend the battery lifetime when continuous operation without maintenance is highly desirable. The main objective of the ENEHRVIT project is to evaluate the potential of novel principles for the development of innovative devices capable of harvesting energy from the environment and transforming it into electrical energy, available for powering the next generation of autonomous information and communication technology devices.
Description	Real world systems are always open, because they exchange energy with the surrounding environment. Fluctuation-dissipation theorems establish that, in an open system, an energy flow must exist from macroscopic to microscopic (thermal) degrees of freedom due to dissipation. The flow in the opposite direction manifests itself as fluctuations of the macroscopic variables. In nonlinear systems fluctuations are not expected to be isotropic. As a consequence of nonlinearity, preferred directions exist along which fluctuations are amplified, while in other directions they are quenched. The result is a net, not null contribution to the expected values of macroscopic variables. The far reaching consequence is the conceptual possibility to realize a “Maxwell demon”, capable of extracting energy from the environmental noise and convert it into usable power. Part 1: Modelling and analysis. Irrespective of the working principle, most energy harvesting systems rely upon oscillators to convert random environmental energy into usable electrical power. The main model will be reviewed and analyzed using state of the art methods. Different technical solutions will be compared in different scenarios (linear oscillators vs nonlinear, white noise vs colored) using different analytical tools, i.e. time domain Monte Carlo simulations, stochastic calculus, statistical-probabilistic methods based on Fokker-Planck equation. Software tools for the simulation and analysis will be developed to test the validity of the models. Part 2: Development of new technical solutions. The problem of energy extraction from noise and its conversion into electrical power will be addressed. Physical models, mathematical methods and simulation tools developed in part 1 will be used. Students will review state of the art solutions for energy conversion and for the improvement of energy, efficiency such as stochastic resonance. Students will be asked to suggest improvements and/or innovative solutions. These solutions will be implemented and tested in the software tools, and their practical feasibility will be discussed. Part3: Design. Using models and simulation tools developed in part 1, and having identified improvements or new solutions, a methodology to optimize the response of energy harvesting systems will be designed. In particular, the device parameters associated to significant physical properties (such as shape, dimensions, material, electrical properties, etc.) should be identified and properly optimized. We expect that this task will require the development of a software tool oriented to numerical optimization techniques and design.

Expected results	The bottleneck of energy harvesting technology is the limited available power, because of the small power density of environment noise. Scientific objectives: gaining better understanding on the role of different kinds of noise sources (white and colored) in electrical and mechanical systems. The project also aims at understanding the role of nonlinearity in the dynamics of noisy systems. Technological objectives: developing innovative solutions for powering wearable wireless device, monitoring systems, etc. Although the energy that could be extracted from noise is very limited (of the order of microwatts), it may still be relevant for low power, wireless sensors and actuators. Moreover, the development of software tools for simulation of stochastic process, noise analysis, optimization and design may raise the interest of both academia and industry. Didactic results: students are expected to work on stimulating topics (energy efficiency, power saving, renewable energy), in front-end technological areas. Not only they are expected to gain expertise in industrial and technological areas such as MEMs, electronic devices, and programming skills, but also on more theoretical topics such as stochastic processes, thermodynamics, and optimization techniques. Last but not least, their problem solving skills and team working attitude will greatly benefit participating the project.
Stakeholders	The project stakeholders are part of both the academia and the industry. From the academic standpoint three different research groups are involved: • PoliTO – DET, a theoretical group that is active since several years in the area of stochastic analysis of nonlinear oscillators. Bring expertise in modelling and analysis of stochastic process and nonlinear system. This group is responsible of Part 1 • PoliTO – DISAT, a group active in the design, realization and characterization of MEMs and memristive devices. Bring expertise in design and measurements of MEMs systems. This group is responsible of Part 2 • PoliMI, a group with a solid experience in the development of nonlinear circuit design approaches. Bring expertise in numerical methods for analysis of nonlinear systems, noise in electronic systems and stochastic process. This group is responsible of Part 3 Each group will be leader in one part of the project, but they are expected to collaborate and contribute during the whole project duration. From an industrial perspective, a recent start-up based in San Diego (CA), mainly active in the unconventional computation arena, is participating to the project providing a product-oriented view in the development of the innovative energy harvesters.

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Project 13 - Drive - en

Energy as a driver for territorial regeneration: the case of the Olivetti complex in Ivrea

Type of project	X Demand pull
Objectives	The project investigates the topic of territorial regeneration, with particular emphasis on the role of energy requalification operations. The research considers the case of the industrial buildings belonging to the Olivetti complex in Ivrea. The proposal explores alternative scenarios for the requalification of the complex able to restore the buildings, re-thinking at the same time their functions. In the project, innovative models in the domain of energy production and distribution will be investigated in relationship with different scenarios of transformation with the objective of creating a sustainable district able to provide energy at affordable prices, minimizing also the environmental impacts. The reduction in energy costs will constitute an attractive factor for productive activities in the site, thus allowing a new life for the complex and, more generally, for the town. According to this vision, energy has a primary importance and it constitutes a fundamental driver for the regeneration of the Ivrea territory and for its socio-economic development. Moreover, taking into consideration the cultural relevance of the buildings and their recent inclusion in the Unesco list, the proposal has also a symbolic and iconic value able to reinforce the role of innovative energy models for the development of depressed areas.
Description	Phase 1: Survey and preliminary investigation The first phase of the research is related to the development of knowledge about the buildings belonging to the Olivetti complex through on-site surveys and preliminary meetings with local stakeholders. Specific literature, available documents and materials related to the complex will be also explored in this phase. (Months 1-2) Phase 2: Energy-economic-environmental auditing The second phase consists in the analysis of the buildings by means of specific multidimensional indicators related to energy consumptions, environmental emissions, occupant health and well-being etc. that will allow to understand the global performance of the complex. (Months 3-4) Phase 3: Design of alternative requalification scenarios Alternative scenarios will be explored, considering different solutions from the point of view of the project configuration and the combination of energy retrofit measures. Particular attention will be devoted to the analysis of restoration interventions, to possible options for the destination of the spaces and to potential solutions in terms of energy management and building/plant system. (Months 5-7) Phase 4: Integrated evaluation The alternative scenarios defined in phase 3 will be evaluated from the point of view of their global costs and related impacts. Of special interest will be the estimation of the co-benefits and externalities provided by the alternative scenarios. To this purpose, questionnaires and interviews to stakeholders and potential users will be developed in order to collect their preferences. The results of the estimation will be included in complex evaluation frameworks that will allow to compute synthetic indexes able to rank the alternative scenarios from the point of view of the overall sustainability. (Months 8-9) Phase 5: Validation of the project and guidelines for the intervention The best performing solutions highlighted in phase 4 will be further examined and

	discussed in order to formulated specific guidelines for the intervention. (Month 10) Phase 6: Dissemination of the results and finalization of the project The final phase of the study will be devoted to the dissemination of the results by means of specific meetings with the stakeholders and to the finalization of the study for the final presentation. (Months 11-12)
Expected results	The result of the research is a design driven tool for supporting the definition of the requalification operations of the Olivetti complex, able to consider the different aspects (energy, economic, environmental, social, territorial etc. elements) and the opinion of the different stakeholders involved. It is worth mentioning that the results of the research assume particular importance as the phenomenon of the re-use of abandoned industrial building is getting more and more important, especially in Italy. In fact, the social and technological changes that have characterised our recent decades have significantly altered the national productive system and today in Italy there are thousands of cultural assets of architectural quality which constitute a real resource for the territory. In this sense, the outcomes of the proposed project could be generalized and extended to other abandoned industrial areas with similar characteristic of the complex under investigation.
Stakeholders	Different stakeholders are involved in the proposed research at the different phases of the project that can be described as follows: 1) AEG Coop: the society is based in Ivrea and it works in the domain of the selling and distribution of energy and gas in the territory. The society is the owner of part of the Olivetti complex investigated in the research. 2) Local entrepreneurs: the economic and productive activities in the Canavese area could be involved in the research with the aim of exploring alternative solutions for the future transformation scenarios of the complex and for validating the final proposals. 3) Municipality of Ivrea: the municipality will provide information about the territorial context under examination and specific insights useful for framing the topic. 4) Regional and Provincial Authorities: they could be interested in the framework for the application to other territories. The participation of real actors and stakeholders of the territory allows to share knowledge and understand the feasibility of the explored solutions.

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Project 14 - MoBe
Morphable Building Envelopes

Type of project	☒ Demand pull
Objectives	Bio-mimicking has recently emerged as the way to attain unprecedented performances of smart structures, in terms of e.g. load-bearing capacity, durability, resilience (namely, adaptation under or immediately after adverse events) and energy efficiency. In recent ASP projects we proposed to students the idea of exploiting features of origami- and kirigami-inspired geometries to design morphable or kinetic building façades, able to passively or adaptively react in real-time to changing external/internal environments. The main goal was to reduce the energy footprint linked to the attainment of the indoor comfort. In our opinion, such goal can be effectively attained only if building/civil engineering, mechanical and materials engineering, and electronics engineering do provide a backbone to architecture and interior/spatial design, in a truly multidisciplinary environment. Allowing for the aforementioned perspective on a timely topic within our smart city age, in this multidisciplinary project the new goal is to depart from the demand of even more energy efficient buildings to understand how new materials and micro and nanotechnologies can disruptively modify the shape of morphing, adaptive façades.
Description	Within the present multidisciplinary project, the work can be supposed to be chronologically organized as follows: 1. identify some of the main challenges that buildings in smart cities have to face; 2. provide a study of the state-of-the-art in the field of adaptive structures and specifically of morphing, kinetic building envelopes, highlighting the strengths and weaknesses of each approach and the attainable results; 3. propose a novel approach to efficiently actuate and induce the morphing of the envelopes; 4. quantitatively study the energy efficiency of the proposed solution, through digital models; 5. build a small-scale prototype of the proposed solution, to also discuss relevant technological details. In the past, structures have been typically conceived with invariant geometry and mechanical properties to withstand the environmental excitations. To self-adapt under a continuously changing external environment and to also self-monitor their health, bio-mimicking can be considered as a natural development. Accordingly, the goals of making the structures adaptive under variable environmental conditions and of optimizing their behavior are pursued by inducing changes in their geometry of spatial configuration, as typical for the smart structures. To adapt the structure layout for sensing, actuating and possibly energy harvesting and harnessing processes, functional materials and control strategies have to be suitably applied. A specific focus is proposed on polymeric films, since they allow a significant deformation which might be used to change the system configuration to withstand the variable exciting conditions, while the action they require are conversely limited. Hence, very flexible spatial configurations can be investigated by focusing on lightweight structures, whose capability of self-adapting under changing environmental conditions and due to the interaction with humans is strongly based on an embedded smartness, tailored on customer needs. The technologic goal of this work is to somehow close the gap between the fields of soft stimuli-responsive smart materials and compliant morphing structures, also exploiting parametric design tools.

Expected results	The main expected result of this project is the feasibility analysis and preliminary design of a small-scale prototype of a smart building envelope, or of a whole structure able to interact with the outer environment and the users. First of all, passive adaption will be considered through a proper selection of morphing, or deployable/compliant mechanisms. Further to that, solutions based on active adaption will be explored with the use of sensors and actuators, or stimuli-responsive and shape-memory materials. Inertial sensors and other commercial off-the-shelf MEMS (micro-electro-mechanical systems) devices will be considered to efficiently (even from the energetic standpoint) collect the information governing the morphing strategy. As said, in order to identify an appropriate solution, students will be asked to build small-scale prototypes of the investigated geometries, possibly using low-cost and easily programmable microcontroller units like Arduino. The investigation will be numerically, or digitally driven by resorting to parametric modeling with a software like Grasshopper.
Stakeholders	In our former proposals, it was claimed that “Society, constructors and citizens are getting more and more interested and concerned with the use of smart technologies applied to the urban context, with the attempt to implement sustainable environmental control. Our project inserts itself in the field of smart development and aims to tackle the environmental control issue by an innovative design. The expected changes are mainly technical, especially in the field of smart structures and smart urban networks, and design-related, where a sustainable solution is also studied from an architectonic point of view”. The main stakeholders are identified accordingly. Depending on the major application of the morphable structure to be designed, the stake-interest is supposed to come from the space occupants. In case of the indoor applications, they are identified as the building dwellers or temporary users; in the outdoor case, they are instead identified as the citizens currently and temporarily occupying the public outdoor space. In this project, the main interest is towards the first category of possible users. Further to that, designers and architects, construction and maintenance industries involved in the project implementation, and investors can be also defined as additional stakeholders.

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Project 15 – EMoCy
Emotions Monitoring via wearable Computing System

Type of project	Technology push
Objectives	In recent year we are hearing more and more about stress, anxiety, and how they can negatively affect our way of living. Different physiological manifestations occur in the starting phase of a panic attack and if detected promptly can help in managing the situation. So various solutions have been proposed both to tackle them and to identify useful patterns to recognize them. Therefore, the objective of this work is to combine different skills for developing a wristband and a framework for panic attacks detection. First of all, we need biomedical knowledge to select the most appropriate signals to analyze and to interpret the obtained results. Secondly, computer science skills are required for the implementation and management of the embedded system, for the development of the Machine Learning framework. Finally, for the realization of an innovative and sustainable wristband are needed knowledge in product design in order to develop a fashionable product similar to a common watch. Such a solution is thought to make people who suffer panic attacks to feel comfortable wearing it without the fear of being judged.
Description	First, an analysis of the works already present in the literature is suggested in order to understand what has already been done in this field. This is necessary to properly present the state of the art and select a golden standard to which the proposed solution will be compared. A market and SWOT analysis are strongly suggested combined with the value proposition canvas in order to identify the key points that differentiate the developed solution from the already existing ones and to find the proper go to market strategy. (15% of total given time for the project) Then, the team should define, and equally divide the tasks necessary to reach the final goal. As a milestone for the project we suggest the creation of the first proof of concept of the wristband able to acquire the relevant signals. The decision of the most appropriate signals to be collected should be based on the knowledge acquired during the analysis of the state of the art. Once created a properly structured dataset, the Machine Learning framework must be implemented considering the restriction given by an embedded system; therefore, it is necessary to target an external computing system (e.g. smartphone). The framework must include a preliminary signal processing phase, to filter the acquired signals and select the features necessary for the classifier to learn useful patterns to distinguish panic attacks symptoms. Then, it is necessary to select the most suitable classification method and to train and test it. In addition, a first sketch of the final design of the bracelet should be proposed focusing on the materials chosen along with the motivations behind every stylistic choice. (50% of total given time for the project) For the final delivery of the project is required a fully working product composed by the final version of the wristband, the Machine Learning analysis framework, and a notification system for the user (e.g. an application). The wristband should be able to acquire the necessary signals and to interface with the analysis framework. The framework should be fast and accurate in the identification of the symptoms and the notification system chosen should be as user-friendly as possible. The design of the bracelet should be a non-invasive solution and adaptable to the user day-life activities and customizable (e.g. different choice for colors and materials). (35% of total given time for the project).

Expected results	The obtained results produced by the Machine Learning framework should be accurate enough to identify as fast as possible the panic attack event reducing the number of false positive and false negative cases. The notification system should intervene before the actual beginning of the panic attack, allowing the subject to take the correct actions to prevent its development. An added value could be taking into account the battery duration of the wristband, the energy consumption of both the analysis and notification systems. The developed product, composed by the wristband, the analysis framework, and the notification system should be supported by a reasonable go to market strategy. This is a key point for convincing possible stakeholders in founding this project giving a complete overview of the innovation behind the product. The team is supposed to present one or more version of the wristband and demonstrate the capability of acquiring the signals and to process them. Also, the notification system should be presented and its effectiveness should be proved (e.g with a video or with a recorded signal of a panic attack).
Stakeholders	For the conception, the realization and the validation of the product the team will be supported by e-Novia (a company that creates and grows tech international enterprises in selected and strategic business area). They will leverage their expertise in this field for helping with the market analysis and with the decision of best go to market strategy. They will evaluate the novelty of the proposed solution and they will support the decision-making process regarding the technical challenges that will be faced during the development of the acquisition, analysis and notification system. E-Novia will support the project with a contribution and will evaluate the opportunity to exploit the IP generated, with the goal to bring its results to the market. This will be formalized in a specific agreement between e-Novia and the Alta Scuola Politecnica.

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Project 16 – Sprayin' with Brain
Robotics and AI techniques for sustainable agriculture

Type of project	X To be determined
Objectives	Italian agriculture has the highest use of phytosanitary chemicals in Europe (5.6kg/ha according to ISTAT), 350 different chemicals, 140K ton per year, which accounts as a whole for the 33% of the EU chemicals use in agriculture. Nevertheless, Italy has the lowest number of products in agri-food with chemicals above the limit (0.3%), 5 times lower the EU average (1.5%) and 26 times lower extra EU (7.9%). **Sprain'with Brain** wants to make Italian agriculture more efficient and sustainable by applying techniques from robotics and artificial intelligence in the optimization of the phytosanitary treatment: we believe we can achieve an effective soil/plant treatment reducing chemicals use in greenhouses. Indeed, only 50% of the treatment effectiveness is related to the chemicals while the remaining part is related to deciding **when** to treat, **what** to treat, and **how** to treat. A multidisciplinary team is required to face this challenge. Computer vision, machine learning and IoT sensors will be used to perceive the current state of the plot and decide for the treatment based on data driven models for prediction. A novel machinery will perform the treatment with a varying amount of product applied based on the distribution of the greens. All of this taking into account the final shelf price which should be in line with current "IV gamma" groceries. Novel greenhouses designs could be exploited to make the adoption of the technology cost effective leading to a sustainable business model for "Sprayin'with Brain Ltd".
Description	The Sprayin'with Brain project is organized according to the following pillars: • At first a state of the art analysis study will be performed to understand the techniques, procedures, and regulations which are applied in greenhouses regarding "IV Gamma" products. • Once the technological, phytosanitary, and regulatory limits of current approaches have been understood a possible solution is designed for a better sprayer in greenhouses which is able to perform an effective treatment while reducing the use of chemicals • A prototype implementation of the sprayer will be built with the support of external institutions and tested on the field to validate the idea and understand its main limitations • Considering the constraints, costs, and performance of the proposed sprayer a business model for a fictitious newco producing the sprayer is drafter and possibly proposed to some acceleration program The Sprayin'with Brain Ltd value proposition could also regard the development of user-friendly digital solutions (i.e. an app to be accessed via smartphone by farmers, grocers, chefs, etc) for the optimization of the: • Supply chain starting from the transformation processes of the primary product (from the green-house to table) by increasing trust towards the value chain from demand and supply side, by deploying specific technologies and digital support systems (e.g. augmented reality for remote diagnostic of the production). Implement traceability (e.g. Blockchain for certification) along the whole product lifecycle including quality, quantity, adulteration, authentication, and warehousing. • Green-house production sustainability by considering variable climate and weather condition and monitoring environmental and biochemical parameters • Reduction of waste, by fostering digital circular processes and by using artificial intelligence tools designed for quality control of specific products and related waste.

	• Development of specific business models to value trusted quality, control, sales and marketing, giving the possibility to farmers and customers to monitor and customize production, specifying source, quality, quantity, speed of delivery and other requirements. Definition of Quality of Experience metrics to bridge the gap between the subjective consumer perception and quality standards and predict the level of consumer satisfaction.
Expected results	The project outcome is a novel ICT solution to perform adaptive, variable rate, phytosantary treatments in greenhouses which could reduce pollution and chemicals use while preserving treatment effectiveness. This new solution, depending on the competences, interests, and passions of the team members might foresee different components which we report here as an examples (but which could vary along the project execution): • A predictive system which optimizes treatments on the basis of current culture status and on data coming from the greenhouse • An ICT perception system capable of guiding the treatment implant in an autonomous way, optimizing the rate of the phytosanitary treatment based on the current status of the plot • A new spraying device which could control the rate of water, air, chemicals as from the optimized treatment plan • A novel greenhouse design and layout which allows a cost effective deployment of the proposed solution • A business plan for a newco proposing the designed solution identifying the market size, the target customers and the revenues
Stakehoders	Among the project stakeholdes we have: • companies producing spraying implants such as Caffini (www.caffini.com) and Ricosma (www.ricosma.com), • tractors producers such as SAME Deutz-Fahr (https://www.same-tractors.com/it-it in Treviglio) or CNH-IND (www.cnhindustrial.com branch via Puglia, Torino) • agriculture digital platform and software SME XFARM (www.xfarm.ag/ • "IV gamma" producers such as mioorto (www.mioorto.it) and belgravia (www.belgravia.it) • associations such as OP Maggiolina (https://oplamaggiolina.it/) As project proposers we are already in contat with them so to have their support during the state of the art analysis and requirements collections. In particular Caffini and Ricosma are going to be external institutions supporting the project via their long standing cooperation with the Dipartimento Scienze Agrarie e Ambientali - Universita' degli Studi di Milano.

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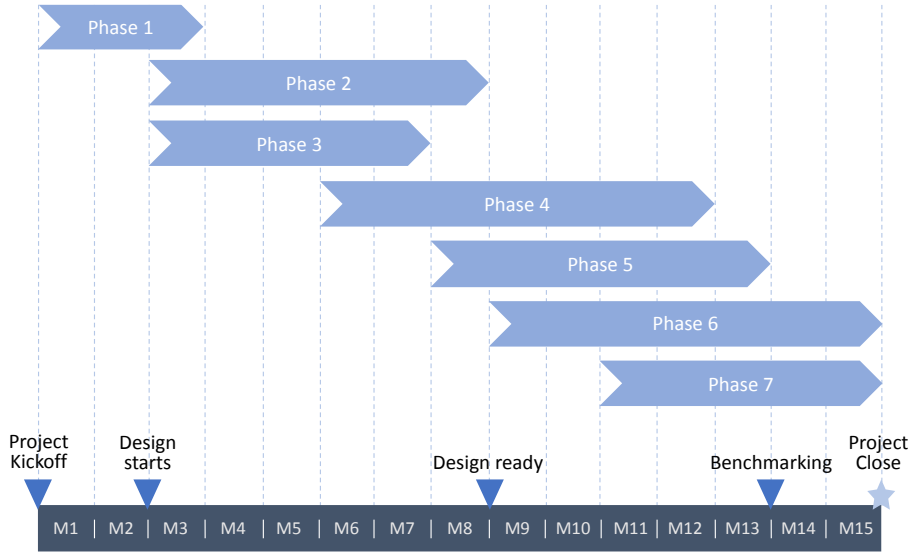
Project 17 – 1SHARE
One-Shot Human Activity Recognition on the Edge

Type of project	x Technology push
Objectives	Sensors and data are increasingly filling the space and time of our lives. A smartphone can collect our position, velocity, temperature, video/audio signals, and medical information (e.g., blood pressure, breathe rate, heartbeat) every second. While data are easily generated, there is a general lack of ability to process data at the edge, i.e., directly at the smartphone without sending information to the cloud, thus preventing issues regarding privacy, security and global energy sustainability. The project 1SHARE aims at enabling data learning on the edge by adopting a novel technology, dubbed in-memory computing (IMC), capable of advanced machine learning with just one operation (< 1 □s). One-shot learning ability can provide the necessary energy efficiency to enable real-time, always-on learning and recognition on the edge. The one-shot learning technology will be applied to human activity recognition (HAR) for real time monitoring of a person activity, including performance and state of health. The system will be amenable to personalization to various scenarios, e.g., sport, transport, industry, security, and healthcare for seniority and disability. The market feasibility and addressable public will be evaluated. The project encompasses a broad range of disciplines, including nanodevice technology, computing architectures, integrated circuit design, data science, and bioengineering.
Description	The project will pursue the objective of demonstrating HAR at the edge via the unique IMC technology, enabling one-shot data analytics with unprecedented speed and energy efficiency. Toward this goal, the project will follow a multidisciplinary path of 7 phases, described in the following: Phase 1 Familiarize with IMC and HAR technology. The team will perform a detailed study in terms of hardware (IMC), software (data analytics, regression, etc.), and experimental scenarios (types of sensors and methodologies). Phase 2 Design a HAR system for the edge. The team will develop a high-level design of the HAR system, including (i) sensors, e.g., accelerometers, gyroscopes, microphones, etc, (ii) feature extraction, (iii) data regression by one-shot learning. Phase 3 Collect human activity datasets. Datasets will be obtained from the internet, from partner institutions, or directly by dedicated experiments, allowing to explore specific scenarios (sport, industry, healthcare), or specific combination of sensors, e.g., to monitor both activity (running, walking, sitting, etc.) and biometrical data (heartbeat, breath rate, etc.). Phase 4 Run simulations of the HAR systems. The team will perform (i) software simulations, where the feature extraction and learning will take place in simulation space, such as Python or TensorFlow, and (ii) hardware simulations, based on a realistic design of the HAR system. Various one-shot learning algorithms will be used, e.g., principal component analysis (PCA), or logistic regression (LR), etc. A hardware demonstrator, namely a battery-operated system including sensors, microcontroller and IMC, will be developed and tested, provided that an IMC prototype is available in time. Phase 5 Benchmark IMC vs. digital technology. The hardware simulations in phase 4 will allow to assess the feasibility of real-time HAR on the edge by considering (i) energy consumption, (ii) learning speed, (iii) learning accuracy, and (iv) required area on the chip. Phase 6 Personalize HAR to the most promising scenario. The HAR system will be extended to multiple scenarios, including sport, transport, health, industry, and

	others. For instance, HAR will be applied to the athletic activity and training, or to the elderly, or the Parkinson disease. Phase 7 Assess the market feasibility. One or two reference products will be considered, addressing their potential customers and competitors. A tentative business plan will be prepared. 
Expected results	The expected results of the project are as follows: 1. Demonstration of energy-efficient HAR on the edge. The assessment will be made for a reference case of simple HAR, such as recognition of running, walking, standing, etc. 2. Identification of more specific applications, such as training/monitoring of athletes, industry operators, patients and disabled. For instance, new applications might include a real-time instructor for athletes, or for specialized industry operator, or for medical surgery, all relying on HAR at the edge. 3. Design of one/two products, e.g., a smartphone chipset, or smartwatch, or a smart T-shirt. The final demonstration will consist of hardware/software simulations with realistic datasets. In addition, a full hardware demonstrator will be targeted, provided that an IMC prototype becomes available by the end of the project. The results will provide the basis for potential exploitation by the semiconductor industry. For instance, the new product may consist of a novel circuit combining MEMS, logic, and IMC all on the same package, to be included in a smartphone and deployed for various applications via specific apps. This might open up new market spaces thanks to the combination of novel algorithm and an application specific hardware with unprecedented energy efficiency.

Stakeholders	The project will be supervised by three Academic Tutors, covering both academic institutions (PoliMI and PoliTO) and the broad range of expertise needed in the project, ranging from memristive computing to bioengineering. The project will also rely on two external stakeholders to ensure the suitable multidisciplinary competences and realistic exploitation of the most innovative technological solutions in the project. STMicroelectronics (STM) is a global semiconductor company with net revenues of US$ 8.35 billion in 2017. In this project, STM will create a collaboration framework to further enhance its surveillance and intelligent embedded system research to a wider range of use cases. STM will provide feedback about the one-shot learning in the field of HAR. Implementation of HAR with commercial STMicroelectronics smart microcontrollers, e.g. the STM32 series with embedded AI, will also be explored and serve as state-of-the-art benchmark for the project. The Institute for Microelectronics and Microsystems (IMM-CNR) of Agrate Brianza is a leading research institution with long-standing collaboration with advanced industries in the field of semiconductors, such as STM. In this project, IMM-CNR will support the materials and device research toward the optimization of IMC for real-time HAR on the edge.

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Project 18 – Team DAPO
Digital Archaeology Project at Oplontis

Type of project	☑ Demand pull
Objectives	For over a decade, an interdisciplinary team of scholars has carefully documented The Villa of Poppea at Oplontis, a Roman imperial building complex near Pompeii, spectacularly preserved by the volcanic eruptions of 79 AD. The research project has resulted in a digital model of the site, an online database and a series of scholarly e-books. However, thus far, emphasis has been placed primarily on *creating* quality content for the scientific community rather than on *communicating* it to the public, limiting the understanding of this important piece of cultural heritage. The Digital Archaeology Project at Oplontis (DAPO) is conceived as a bridge between academic and public realms. The project targets members of the public who, despite harboring an interest in the past, have yet to meaningfully engage with it. The project targets people who, despite having seen Oplontis in person or online, have no real sense of the original spirit of the place, the 'Genius Loci'. The key project objective, therefore, is to find new and immersive ways of storytelling that bring the Oplontis history into focus. The ASP team is challenged to investigate and respond to the questions: *(a) How do on-site and on-line manifestations of the villa differ and how might they be linked? (b) How can varied information streams be overlaid to create an authentic and compelling visitor experience? (c) How might the 'Genius Loci' of the villa be summoned with new visualization technologies?*
Description	The working methodology of DAPO is analogous to the traditional archaeological process. But rather than digging through soil to uncover physical objects, the ASP team will be tasked with digging through digital assets to uncover and share captivating historical narratives – to find innovative ways of bringing history to life for a disperse global audience. The aim is not only to increase the visibility of Oplontis, but to propose a new paradigm of archaeological dissemination that can be emulated by other research teams around the world. It is anticipated that DAPO will leverage emerging visualization technologies including virtual reality (VR), augmented reality (AR) and other mixed audio-visual media. It is critical therefore that the team be multidisciplinary – combining the visual and spatial competencies of designers/architects with the technical and computational competencies of engineers. The ability to manage these varied skill-sets and build an economically viable plan-of-action will require business savvy and leadership. The project will unfold over the course of 14 months, from July 2019 through September 2020, moving through three main phases: 1. COLLECT: Catalog state-of-the-art technologies and sharing platforms; Collect and review digital assets; Tour archaeological site, meeting scholars and target groups; Identify key stakeholders and their needs 2. DESIGN: Build narratives from the existing academic resources; Conceptualize multichannel communication strategy, capable of engaging different audiences; Design exhibition format(s), with an innovative narrative-based approach; Integrate digital and physical content in complementary way; Develop plan-of-action for present and future players 3. SHARE: Provide guidelines for communications strategy; Launch

	demo/pilot for testing user experience; Present findings in journals and/or conferences; Prepare ASP final report and presentation. These phases are not strictly sequential and may be overlapped to create a feedback loop between action and analysis. For example, it may be useful to launch a demo/pilot version of concept early so that there is adequate time to troubleshoot technical issues and fully understand the user experience. The final ASP report should be grounded in both general research and empirical data, including a description of the project conducted by DAPO and a proposal for future interventions by others. While global reach is important, the archaeological site and the local territorial system should be considered the main touchpoints for the experience. On their own, both the digital and physical manifestations of the villa are rife with historical omissions and inaccuracies. Thus, it is important to find opportunities for dialogue between the so-called '*bits'* and '*bricks'* of Oplontis.
Expected results	A successful project will combine hands-on practical considerations with more abstract ruminations on the nature of cultural heritage in the 21st Century. Initial findings are to be directed to *The Oplontis Project* and the *Parco Archeologico di Pompei.* Recognizing strong interest in this topic within the research community, the ASP team will also be encouraged to share their results in relevant journals and conferences. On a practical level, the ASP team will have the opportunity to develop and launch a minimum viable product (MVP) involving the Villa of Poppea, with digital assets and consultation of The Oplontis Project. This may take the form of an innovative exhibition, communications platform or visualization technique, and should be scaled appropriately for quick implementation within the duration of the ASP project. The team will also be invited to think longer-term about cultural heritage in an era of rapid technological change, proposing visionary ideas for 'digital publishing' of the Oplontis materials. These concepts may be codified into grant proposals to institutions like the Mellon Foundation, which are poised to invest in this area of research in the coming years and could transform DAPO into an independently funded startup. Thus, the project is both about solving an immediate real-world problem of knowledge diffusion at Oplontis and about envisioning the future of digital archaeology.
Stakeholders	Project stakeholders include The Oplontis Project team, who knows the archaeological site intimately and cares deeply about the quality of scholarship surrounding it. They will provide the digital assets with which to work and will review any newly generated content for accuracy. Similarly, the Parco Archeologico di Pompei, an extension of the Italy's Ministry of Culture, is tasked with safeguarding and sharing this unique piece of Roman history. If the DAPO project is deemed successful, the Parco Archeologico di Pompei could replicate ideas piloted at Oplontis across the enitre UNESCO world heritage site, reaching millions of visitors each year. The communications concept itself should be addressed toward the general public, who (through government entities) is the ultimate custodian and benefactor of cultural heritage sites like Oplontis. This group may be divided into various sub-groups with differing needs, for example, those able to visit the archaeological site in person and those who are limited to experiencing it from a distance. The DAPO team should find ways of understanding and engaging this key stakeholder group.

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