

4D HYBRID



Newsletter n°2



www.4Dhybrid.eu

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 723795

PROJECT OVERVIEW

From aeronautics to oil & gas, complex metal parts embrace major challenges across their lifecycles from the green field intensive manufacturing to the numerous maintenance and repairing operations worldwide distributed. The synergic combination of additive and subtractive processes could overcome individual shortcomings, going beyond the simple succession of steps. 'Plug and produce' modular approach is a key factor to success for such hybridization. In this scenario, 4D Hybrid will deliver 4 disruptive breakthroughs:



- A set of four elementary modules specifically designed for AM that embed the control and monitoring systems which can be integrated on new or existing concepts of machines and robots to realize different processes ranging from the DED (powder and wire) to ablation and cold spray;
- A new concept of CNC, constituting a high level software layer which can be integrated on the top of commercial CNCs, and it is conceived as open to embed portions of the 4D modules control;
- A validated process model to fully exploit the synergistic interactions among elementary processes;
- A dedicated 4D Engineering CAD/CAE/CAM Platform, which covers the lifecycle of the reference product family where multiple processes and hybrid resources are integrated for the (re)manufacturing stage. Innovation will be physically demonstrated at three possible levels of hybridization: the modules, where small hybrid modules are integrated on new special machines, focusing on portable units for certified in-situ repair operations; the Hybrid Machines, where there is the Hybridization on existing robots and machines; Production lines, the Hybridization of a flexible production line focusing on new concepts for AM mass production.

Potential impact: >30% lifecycle cost reduction, unprecedented possibility to customize process applications by combining several processes on several different machines, concrete business perspective supported by detailed business plan with deep market and cost analysis: payback 3y ROI>20%.

PROJECT IMPLEMENTATION

Three **DEMO** parts were considered in this project. In particular:

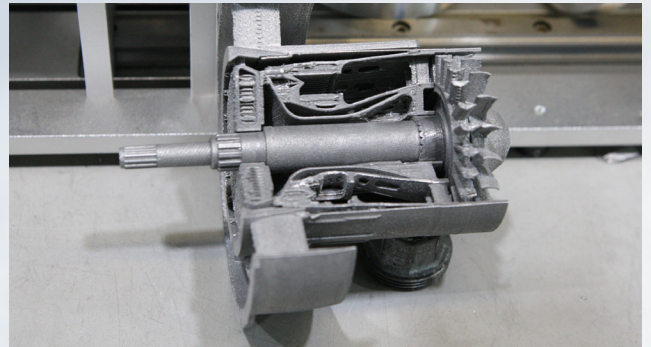
- 1) GE demo part – Turbine case;
- 2) Siemens demo part – Gas Turbine component;
- 3) Globotics demo part – Cylindrical storage.

All the three demo parts are currently manufactured by casting, machining, automatic/manual finishing process and needs to be stocked to make spare parts available despite of their very long lead time. At the basis of the RTD activities developed so far, there is the definition of the use cases and main requirements to be respected, in particular:

GE AVIATION



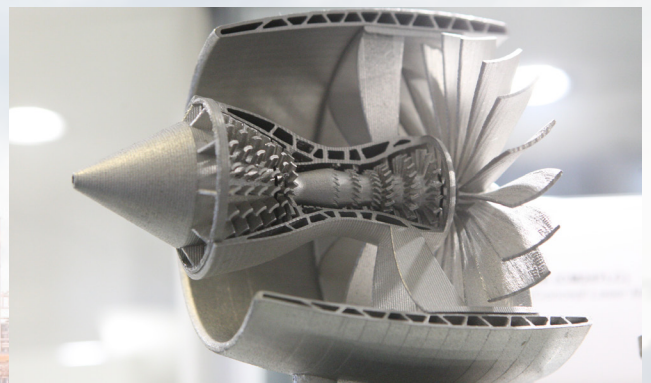
GE use case is related to aeronautics and space applications from medium to large. The part has been considered also to perform repairing with the 4DHybrid solution. Components' materials will be mostly based on Titanium and Aluminum alloys.



SIEMENS



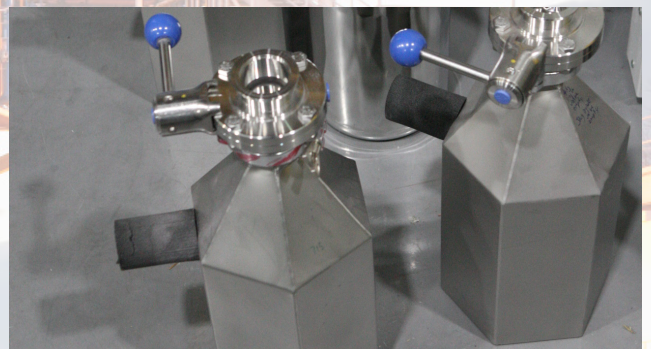
The user has provided a case that involves maintenance and repair of gas turbine blades, as used in electric power generators installed in power generation plants. Parts are usually medium to large scale, subjected to high heat loads. Materials involve Ni-based alloys (IN718, cupronickel) but may also involve carbon steels.

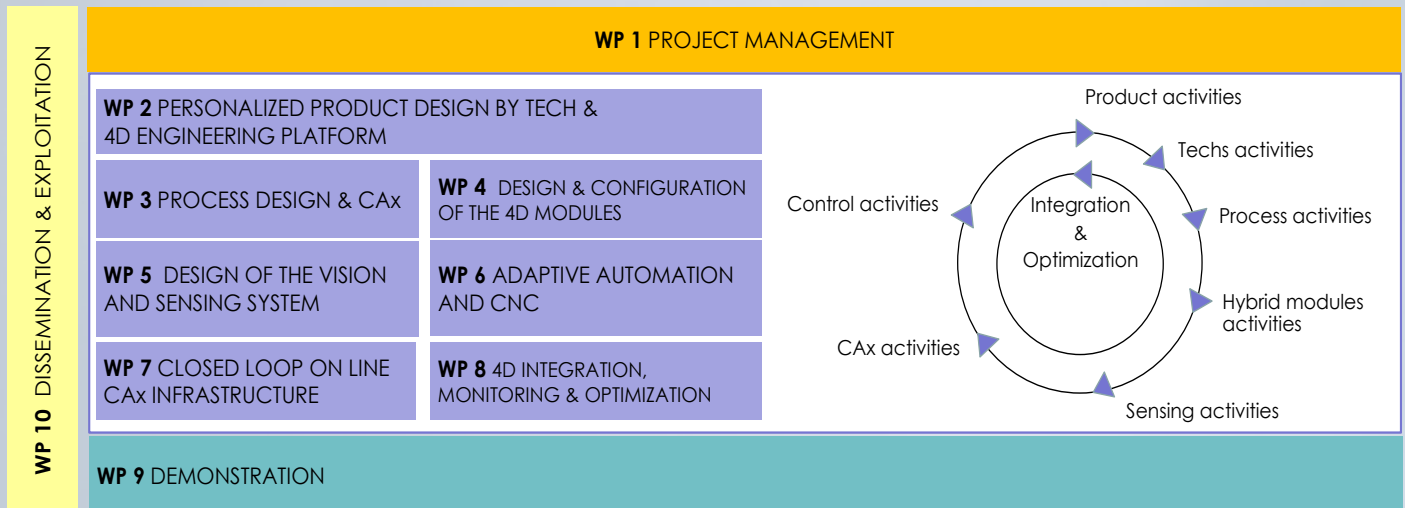


GLOBOTICS



The subject is represented by the huge cylindrical storage tanks used in the oil&gas industry. GLOBOTICS is active in the field of oil & gas industry. As such, the pilot case of 4 Hybrid will involve maintenance and repair of oil & gas-related structures.





4D HYBRID WORK PACKAGES

4D Hybrid consists of 10 Work packages - sets of activities (see figure below).

WPS ON SCIENTIFIC AND TECHNICAL ASPECTS

Hereafter, we present six sets of activities (WP2- WP7), related to the scientific and technical aspects, their brief descriptions and the results achieved in the first 18 months of the project.

WP2 regards product design by technology and 4D Engineering Platform. In particular it frames the current major novelties related to the product design and manufacturing technologies for aerospace, power generation and oil&gas industries with a specific focus on complex shape parts of medium and large size.

WP3 focuses on the 4D process design and CAx. The 4D Engineering architecture realized in WP2 is enriched with a number of rules and algorithms developed in the current work package.

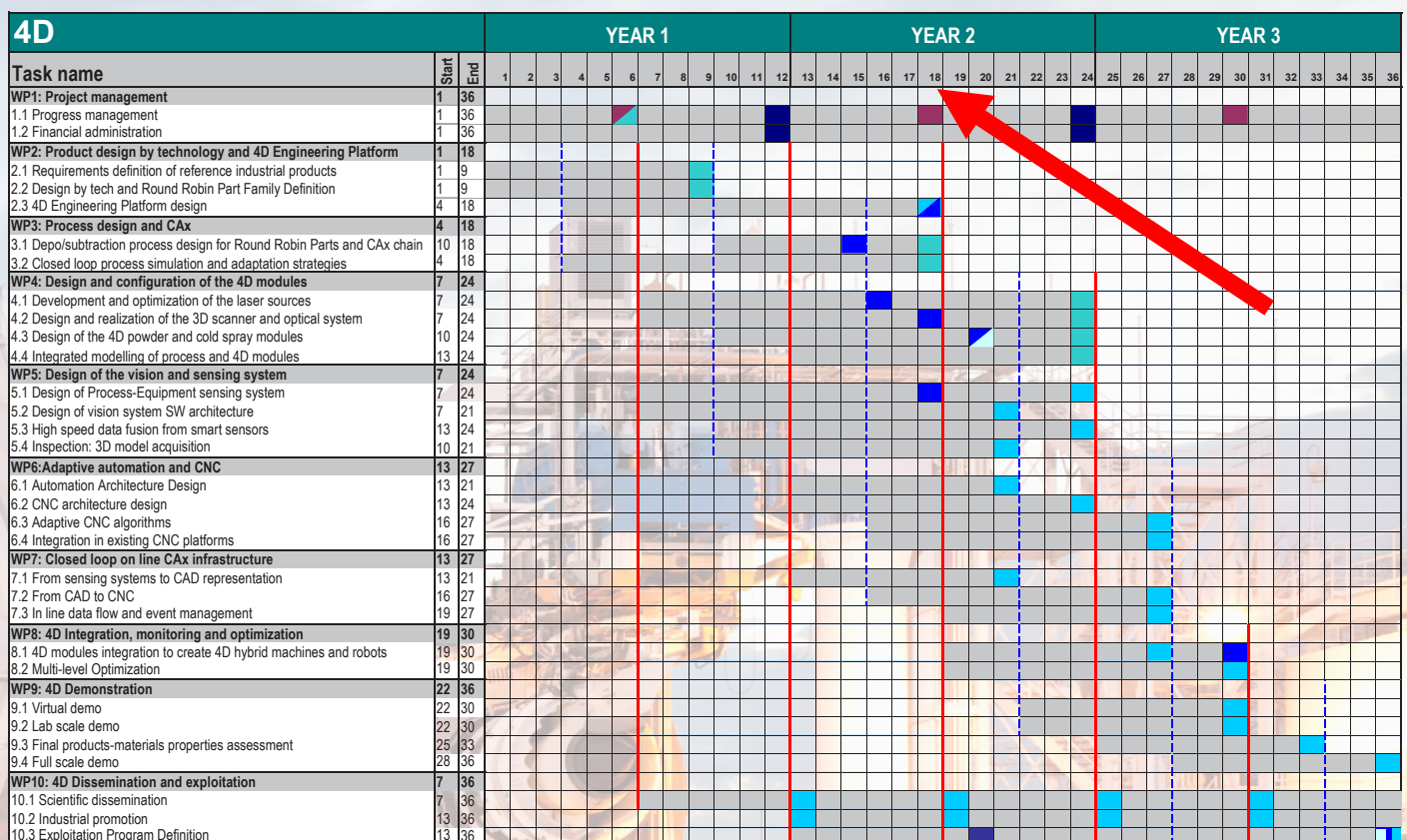
WP4 comprises the design of the 4D simple modules and their composition to form hybrid solutions which will be used for all-in-one machines and robots or utilized as stand-alone devices.

WP5 shows the design of the vision and sensing system. 4D solution refers to the capability to persistently monitor the process and the working environment and collecting information from sensors, contributing to target the performance thresholds under the energy efficiency, product quality, productivity and process quality perspectives.

WP6 addresses the adaptive automation and CNC. This work package concerns the configuration and development of the overall automation solution for 4D which covers the control of the 4D simple modules, the 4D hybrid modules and their integration on existing robots and machine tools.

WP7 focuses on the realization of the CAX software infrastructure to support the seamless product-process-equipment data integration in a closed loop CAX-CNC chain which will enable a persistent monitoring and adaptation of hybrid manufacturing processes. This work will be executed in synergy with WP3 dealing with the CAx design and the process strategy definition and adaptation.

Horizontally, extensive communications, dissemination and exploitation activities are going on to boost 4D Hybrid's industrial solutions in future industrial practice. The dissemination tasks include: scientific dissemination, industrial promotion and exploitation program. In addition: the creation of the website of the project (<http://4dhybrid.eu>), 6 Social Media channels (LinkedIn, Twitter, FB, Instagram, Google+ and YouTube), printed publications (newsletters, brochures, etc.) and Media packages.





GE
Aviation

GE Marmara Technology Center (GE MTC) is one of the 8 engineering sites of GE Aviation Engineering Department, performing research, development and engineering support activities on design, manufacturing, repair and software disciplines and cutting-edge technologies to be used

on aircraft engines. GE MTC has developed its capabilities in a way to support today's technologies and future needs focusing on advanced machining, robotics and automation, joining, additive manufacturing, surface treatments, inspection and metrology. With its activities on design, manufacturing, repair and software technologies, GE MTC contributes to every stage of an aircraft engine part life from birth to retirement.

SIEMENS

Siemens AG (Berlin and Munich) is a global technology powerhouse that has stood for engineering excellence, innovation, quality, reliability and internationality for 170 years. The company is active around the globe, focusing on the areas of electrification, automation and digitalization. One of the world's largest producers of energy-efficient, resource-saving technologies, Siemens is a leading supplier of efficient power generation and power transmission solutions and a pioneer in infrastructure solutions as well as automation, drive and software solutions for industry. With its publicly listed subsidiary Siemens Healthineers AG, the company is also a leading provider of medical imaging equipment – such as computed tomography and magnetic resonance imaging systems – and a leader in laboratory diagnostics as well as clinical IT. In fiscal 2017, which ended on September 30, 2017, Siemens generated revenue of €83.0 billion and net income of €6.2 billion. At the end of September 2017, the company had around 377,000 employees worldwide.

Corporate Technology

Shaping the future – with passion for research, technology and innovation – this is the mission of Corporate Technology (CT). Under the leadership of the Chief Technology Officer and in cooperation with the operative units, CT develops the company's technology and innovation strategy, generates basic technologies, promotes business excellence through consulting and development services, and protects Siemens' intellectual property. As a strategic partner to the company's businesses, our central research and development unit plays a key role in maintaining Siemens' leading competitive positions in the fields of electrification and automation while at the same time helping the company fully tap into the growth field of digitalization. CT supports the company along the entire value chain, – from research and development to production and quality assurance, as well as the optimization of company processes.

CT has more than 7,800 employees. They contribute not only a deep understanding of fundamental technologies but also models and trend analyses as well as extensive knowledge of software and processes. Approximately 1,600 researchers and 5,300 software developers work at sites in Asia, Europe, and the United States. Around 400 additional experts assist the company with registering, establishing, and marketing industrial property rights. CT is also networked with universities and research institutes around the world. Key research and development facilities are mainly located in Germany, the United States, China, Russia, India, and Hungary. CT thus maintains a balancing act – serving as a creative driver of disruptive innovations as well as a reliable partner for Siemens businesses by providing highly qualified research, development, and consulting services.



COMAU is a worldwide leader in manufacturing flexible, automatic systems and integrating products with an international network that spans 17 countries in Europe (Italy, France, Poland, Romania ...), North & South America (USA, Brazil, Mexico ...) and Asia (China and India).

COMAU has globally around 9000 employees in 35 operative centres, 15 manufacturing plants and 5 innovation centres worldwide . COMAU comprises the following organizational units: Body Welding, Powertrain Systems, Robotics & Service, and Adaptive Solutions.

COMAU specializes in producing advanced industrial automation solutions that integrate products, technologies and services to help companies of all sizes increase plant efficiency while lowering operating costs and optimizing returns. Comau's competence stems from over 40 years of field-proven experience and a strong presence within every major industrial country.

The comprehensive offering of modular, flexible and highly configurable products is based on open automation principles, and can be tailored to meet the needs of each individual customer.

COMAU has a long experience in funded R&D programs, which have been developed as European Projects (6th, 7th Framework Programme, H2020) and also national programs like Italian applied RTD innovation projects. COMAU will contribute to the project with its skilled research personnel, as well as with its laboratories and research facilities, where advanced solutions are developed and extensively tested. COMAU facilities include specific areas for advanced powertrain and body welding testing, as well as a robotics laboratory with a wide range of innovative robot types, six and multi-axes articulated robots, covering all payload categories and applications.

Some relevant recent research programs funded by EU are: EMC2-Factory "Eco Manufactured transportation means from Clean and Competitive Factory", PLANTCockpit "Production Logistics and Sustainability Cockpit", ebbits "Enabling business-based Internet of Things and Services - An Interoperability platform for a real-world populated Internet of Things domain", X-act "Expert cooperative robots for highly skilled operations for the factory of the future", ROBOPartner "Seamless Human-Robot Cooperation for Intelligent, Flexible and Safe Operations in the Assembly Factories of the Future", SMERobotics "The European Robotics Initiative for Strengthening the Competitiveness of SMEs in Manufacturing by integrating aspects of cognitive systems", TWIN-CONTROL "Twin-model based virtual manufacturing for machine tool-process simulation and control".



3D New technologies born from the experience of their founders in the field of laser processes for material processing and Additive manufacturing for metal parts. The experience collected in the aerospace market, particularly for additive manufacturing, allows the company in investing in optimized additive manufacturing technologies. The company mission is studying, producing and commercializing additive manufacturing technologies. 3D NT is producing their additive manufacturing machines based on the modular mechatronics principles. The most relevant project is the development of the optimized powder bed machine for additive manufacturing by laser melting/sintering. The focus of this project is a low cost laser device based on high brilliance diode laser. Monitoring and control of additive manufacturing laser melting process is a part of the strategy of the 3D NT products. This approach will improve the reliability of the AM process, by getting it more flexible, efficient and easy to use. 3D New Technologies srl has its own head quarter based in Turin, with three joint labs. Machine and mechanics with a laser machine builder, electronics and laser with Prima Electro and research with Polytechnic of Turin. 3DnT develops an innovative multilaser device in a second plant closeby to Milan.

University of Birmingham submitted this abstract to Materials Science and Technology 2018, Columbus, Ohio, USA. <http://www.matscitech.org/>

Abstract Title: Microstructural and Mechanical Properties Control using Direct Laser Deposition in IN718 Ni-superalloy

Authors: Abdullah Alhuzaim, Luke Carter, R. Mark Ward, Moataz Attallah

Abstract: Investigations were performed for IN718 Ni-superalloy built using DLD to assess the role of DLD parameters on controlling the microstructural development, notably the grain size/morphology, precipitates types/distribution, and texture. To achieve this, thin walled structures were built by varying DLD process parameters; laser power, powder feed rate, scanning speed, and laser mode (continuous versus pulsed), and characterised to rationalise the influence of DLD parameters, also employing statistical design of experiments to assess the sensitivity of the parameters. A heat flow model was used to elucidate the microstructural and hardness development. The results showed a significant potential for microstructural control via DLD, while generating builds with porosity <0.01%. The laser power and mode can be used to control the degree of mechanical and microstructural anisotropy in the builds, as well as the amount of micro-segregation and Nb-rich intermetallics, due to the variation in the heat distribution within the melt pool.

Politecnico di Torino submitted two publications:

Mostafa Toushekhah, Abdollah Saboori, Mattia Busatto, Simona Tusacciu, Manuel Lai, Mariangela Lombardi, Paolo Fino, Sara Biamino, "Correlation between the laser focus and regularity of deposition" in DED of AISI 316L, Junior EuroMat 2018, 8-12 July, Budapest (Hungary).

Abdollah Saboori, Sara Biamino, Anna Valente, Diego Gitardi, Gloria Basile, Mariangela Lombardi, Paolo Fino, "The Capacity of Cold Spray Additive Manufacturing Technology for Metallic Part Repairing", EuroPM2018, 14-18 October, Bilbao (Spain).

Project Coordinator



Project Partners



Technical Coordinator

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Keen Bull



SIEMENS



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