Digital Transition in the Energy, Transport and Agriculture Sectors

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Digital transition as the growing interaction and convergence between digital and physical world.

Enabling technologies and tools:

ARTIFICAL INTELLIGENCE &MACHINE LEARNING

AI and MI is creating opportunities for efficient and productive manufacturing processes

INTERNET OF THINGS (IOT)

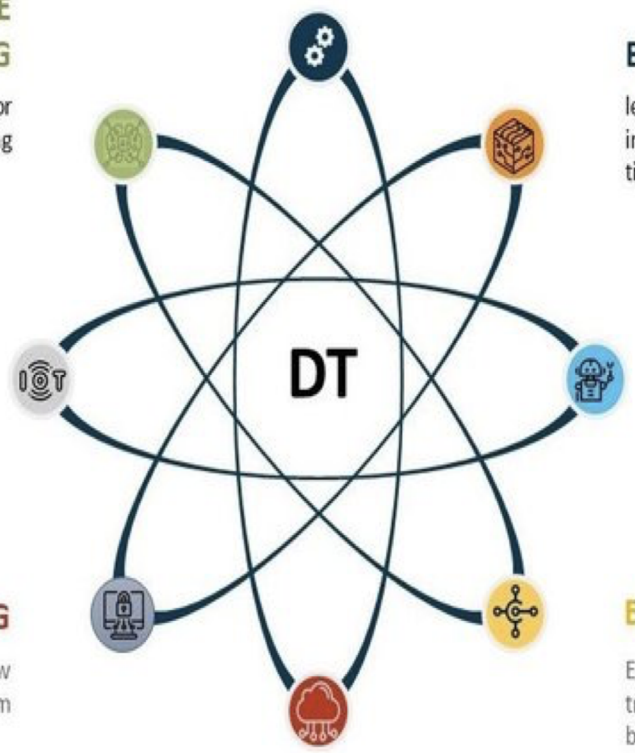
The internet of things is helping to connect the digital and the physical world together.

CYBER SECURITY

sustaining business integrity, data safety and protection of cyber assets is of prime importance

CLOUD COMPUTING

Cloud is the foundation for this new agile business world. It's the platform for enabling agile applications.



BIG DATA ANALYTICS

leading businesses to generate better insights and right decisions in efficient time.

DIGITAL TWIN

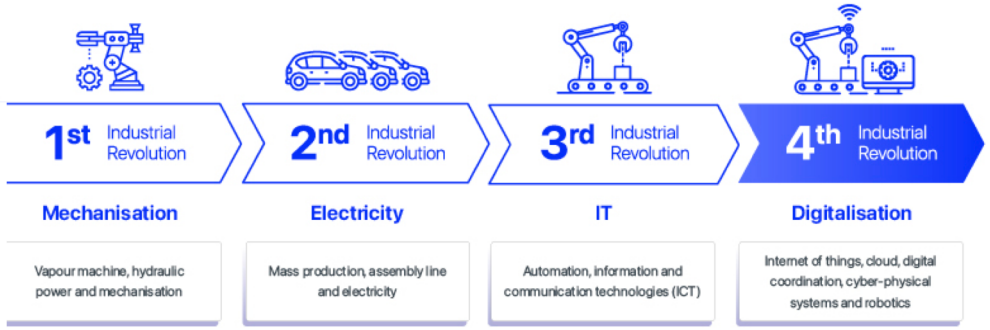
New technology that make a whole different manufacturing ecosystem

ROBOTICS AUTOMATION

Provides flexibility and scalability, Prevents employee burnout.

ENTERPRISE RESOURCE PLANNING

ERP has a major impact on digital transformation. It has the capability of bringing revolutionary changes in various processes of modern business.



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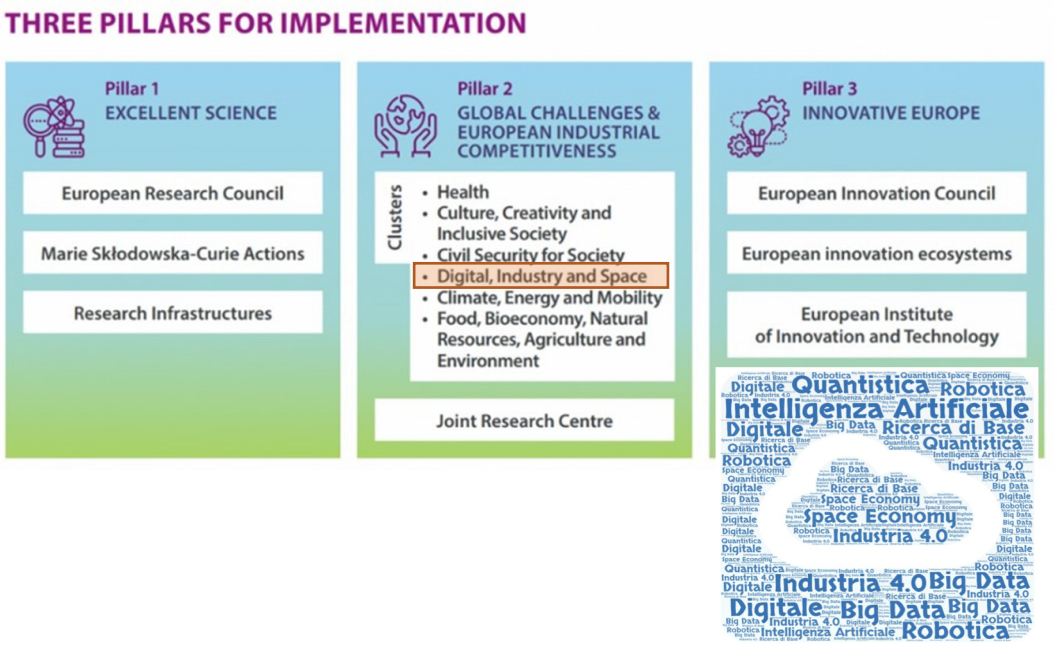

Agriculture

- **Precision Farming**: Precision farming, variable and localized spraying and fertilization treatments. Decision Support Systems for field management.
- **Agricultural robotics**. Highly automated machines, new sensors with AI and ML
- **Integrated Farm System Model (IFSM) models**. Databases to form digitized maps to improve the productivity and sustainability of the fields

Energy

Support tools for the management and optimization of energy systems, mechanics and advanced thermo-chemical processes through:

- **Numerical modeling** of thermo-chemical, mechanical and energy systems processes
- **High performance** computing and big data
- **Data Analytics** of kinetic-chemical, energy or energy production and consumption databases
- **Reduction methods** for the development of digital-twins (PCA, GPR, etc…) and statistical analysis of the dynamic behavior of real systems;
- **Artificial Neural Networks (ANN)** and development of machine learning models (development of real-time models for the predictive control of real systems)

Transport

- **Smart City and Digital Twin** applied to ports, airports or large railway yards, urban mobility. Digital mobility platforms.
- **Automated, connected and safe mobility** (vehicle sharing, living labs, ...)
- **Logistics 4.0** (planning, through digital technologies, of the storage flow of raw materials, semi-finished and finished products in order to meet customer needs).

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Agriculture

- Human out of the loop, treatments programmed and managed independently by IT systems with autonomous control and decision-making strategies (AI-based), based on new sensors and satellite maps
- Biocontrol techniques and digital agriculture tools. 50% reduction in fertilizers and treatments.

Energy

- Sustainability-by-design. Ability to control energy conversion processes using diagnostic tools and advanced predictive simulation techniques.
- Digital Twin and Reduced Order Models (MOR) to support the design, real-time control and development of low-emission technologies operating with renewable energy vectors (kinetic-chemical simulation and CFD of innovative thermo-chemical processes). Use of advanced pervasive sensors for the integration of information between the physical and virtual model. Soft Sensing (development of virtual sensors by combining physical data and AI models) for active and real-time control.
- Digital Energy. Penetration of renewables through the forecast management of resources and energy consumption. Infrastructure-as-a-Service (IaaS) to optimize performance and energy consumption - quantum computing.
- Smart Manufacturing. Automation, exchange of operational information and advanced analysis.

Transport

- **Aerospace** - Automated management of the production processes of aeronautical fuels from renewable sources. Virtual verification of the performance of new generation energy carriers. Automation and unmanned systems, remote sensing, aircraft trajectory prediction algorithms, data fusion to increase the integrity of satellite navigation in take-off and landing
- **Mobility** - Integration of different modes of mobility and development of digital platforms for urban traffic management. Integration of zero-emission propulsion systems with energy production systems and new energy carriers. Human-Machine-Interaction (HMI), intelligent infrastructures such as smart roads and intelligent transport systems (ITS) to support the management of collective services for mobility (MaaS). Development of new sensors and devices, including wearable ones, based on micro / nano, optoelectronic, electromechanical systems and new materials for the development of new components. Biochips and lab-on-chip.
- **Digital Life (e-Health, healthy and active life) -** human-digital-twin. Remote visits, holograms, monitoring to reduce the movement of people and the consumption of medical material.

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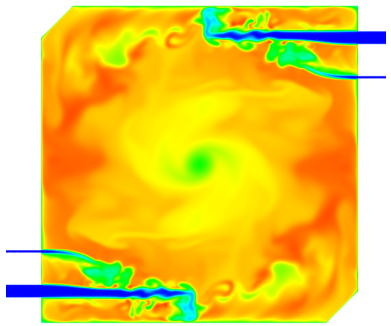
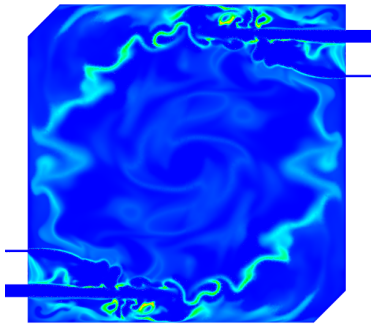
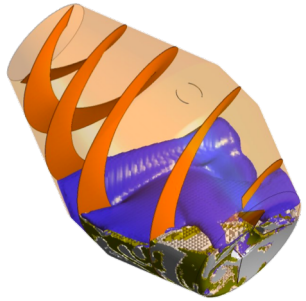
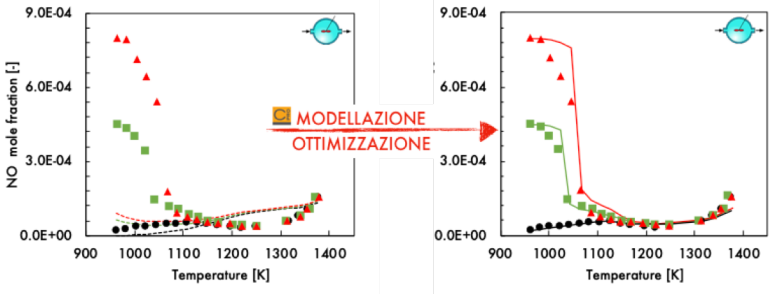
Simulation and data processing

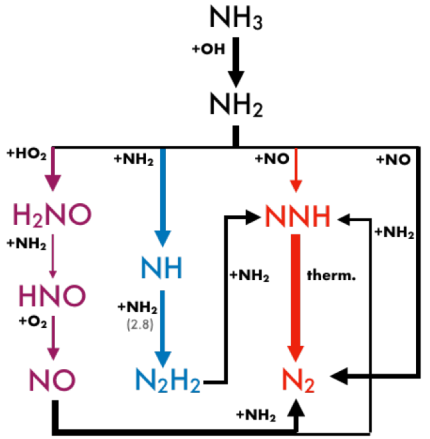
- ✓ ***Prognostics:*** Model Reference Adaptive Controller
- ✓ ***Multi-domain, Multi-physics:*** Thermofluid-Structural, Electrothermal-Structural Fluid, etc ..
- ✓ ***Thermo-fluid dynamics and kinetic-chemistry:*** CFD and kinetic-chemical models for the prediction of the behavior of reactant flows and multiphase thermo-chemical transformations and biomass for energy conversion. Reduction / optimization of kinetic databases.
- ✓ ***Agent-based models and Machine learning:*** Integrated methods of AI, data analysis / processing, data mining for the development of data driven and physics-informed models aimed at creating integrated digital platforms. Data-driven models from DNS.
- ✓ Advanced ***databases for the analysis of thermochemical processes*** of reactive flows
- ✓ ***Concentrated parameter*** modeling of operating machines

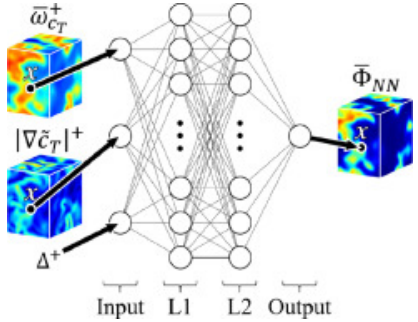


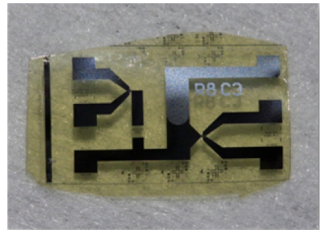












Advanced sensors and diagnostics

- ✓ ***Wearable sensors,*** design and application of MEMS sensors on flexible supports
- ✓ ***Nanostructured sensors*** for gas sensing and environmental monitoring and for plant condition monitoring.
- ✓ Development of ***integrated sensors (optical, chemical, mechanical)*** and use of advanced diagnostics for the analysis of reactive flows (PIV, LIF, scattering, Chemiluminescence, IR spectroscopy, etc ...).

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Methodologies and instruments

- ❖ High performance computing systems **(HPC**), parallel computing on conventional architectures (multicore), **GPUs** and processors for AI, shared data storage
- ❖ **Edge and Cloud Computing - cloud PaaS** (Siemens, Apache Stratos, ...)
- ❖ AI-based algorithms for the development of multiscale data-driven models of complex systems.
- ❖ Proprietary **software platforms** (ANSYS, FIRE, ELMER, Matlab, AMESim, GaBi, LabVIEW, ChemKin, GT-Power, AspenTech), open (OpenFOAM, MFIX, Cantera, FDS, ...) or developed in-house.
- ❖ Tools and methodologies for **data storage, management, analysis and processing** (Cassandra, DataStax, Python, Anaconda, Glue, OpenStack, etc ..)
- ❖ Methodologies for **machine learning, statistical analysis, UQ and forecasting models** (Python / Java libraries: PyTorch, Tensorflow, Keras, Scikit-learn)
- ❖ **Real-Time data acquisition systems** and dedicated programming
- ❖ **Rapid Prototyping Printers**
- ❖ Development and application of **integrated 1D / 3D design methodologies** for the optimization of components or machines
- ❖ **4D manufacturing**
- ❖ Lightweight design (additive manufacturing)
- ❖ Methods of LCC (Life Cycle Costing) and **LCA** (Life Cycle Analysis) analysis
- ❖ **Fast cameras** and UV / VIS laser
- ❖ **Optical sensors**: solid state and photomultipliers
- ❖ **Chemical sensors** for analyzing the concentration of gaseous species and emissions (NOx, O2, CO, ..);
- ❖ **Mechanical sensors and transducers**: accelerometers, microphones, thermocouples, etc ...

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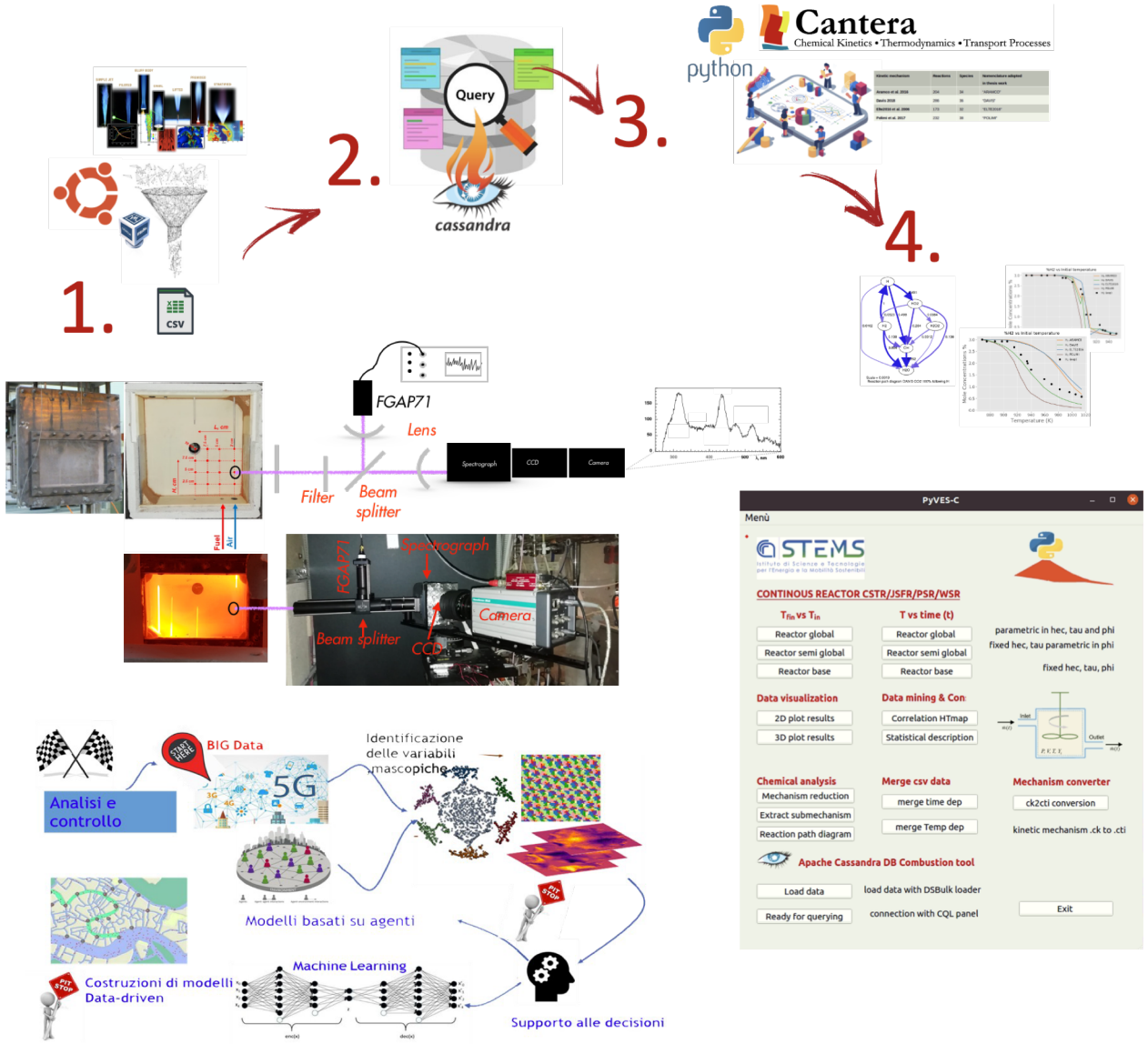
- Techniques for set up of a **database for biomass classification**
- **Multimodal analysis** for the production of non-fossil fuels from biomasses
- **Advanced statistical techniques** (PCA, ...) for evaluating the performance of biomasses thermochemical processes
- Implementation of **machine learning techniques for the optimization** of biomasses thermochemical processes
- **Data-driven modeling based on agents** for the simulation, analysis and distributed, decentralized and multiscale control of urban mobility.
- Data-driven modeling of erosion processes
- Big Data Analysis and Modeling for reactive processes
- **CFD models** (RANS, LES, URANS) for the analysis of combustors, emissions, explosions and fires, multiphase and non-Newtonian flows
- Characterization and development of **low-cost integrated sensors** (optical, chemical and mechanical) for innovative burners
- **Data analysis, soft-sensing and diagnostic strategies** for innovative combustion processes of alternative energy carriers
- **Kinetic-chemical simulation techniques and strategies** for MILD, fuel-flexible and low-emission combustion processes.
- **Integrated methods of AI, processing and data mining** for the creation of integrated digital platforms for urban mobility.
- Methodologies for the development of **autonomous navigation and cooperative agricultural robots**
- **Precision spraying** integrated on a robotic platform
- Design of **open and integrated systems** for automated management in agriculture



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BIOFEEDSTOCK
Sviluppo di Piattaforme Tecnologiche Integrate per la Valorizzazione di Biomasse Residuali

CORYL ROBOT
Realizzazione di un robot innovativo per la raccolta in campo automatica e autonoma delle nocciole

EFC-Mobility

Burner 4.0

COVER
Being safe around collaborative and versatile robots in shared spaces

MAIN SOURCES OF FINANCING / COLLABORATIONS