

Flavio Tonelli, -prof. ing. Phd.

Università di Genova – Scuola Politecnica Board Member of Intelligent Factory Technological Cluster

The Italian clustering approach to 'intelligent' factories and industrial sustainability

Warwick, September 2017

www.fabbricaintelligente.it info@fabbricaintelligente.it





Flavio Tonelli

Selected publications on the topic:

2013 Industrial sustainability: challenges, perspectives, actions **F Tonelli**, S Evans, P Taticchi International Journal of Business Innovation and Research 7 (2), 143-163

2014 A hybrid System Dynamics – Agent Based model to simulate Complex Adaptive Systems: a new methodological framework for sustainability analysis I Monasterolo, A Jones, **F Tonelli**, D NataliniThe 32nd International Conference of the System Dynamics Society

2015 Investigating Resource Efficiency and Environmental Policy in an Agent - Based Macro - Economic Framework (EURACE) G Fadiran, S Cincotti, M Raberto, F **Tonelli** 27th EAEPE 2015 - A New Role for the Financial System

2015 Where does the capital for eco-innovation and resource resilient growth come from? A balance sheet- based approach to analyse systemic resource risk in the new financial system I Monasterolo, E Lauretta, **F Tonelli** 27th EAEPE 2015 - A New Role for the Financial System

2016 Assessment of mathematical programming and agent-based modelling for off-line scheduling: application to energy aware manufacturing F **Tonelli**, AAG Bruzzone, M Paolucci, E Carpanzano, G Nicolò, A Giret, CIRP Annals-Manufacturing Technology 65 (1), 405-408

2016 Approaching industrial sustainability investments in resource efficiency through agent-based simulation F Tonelli, G Fadiran, M Raberto, S CincottiService Orientation in Holonic and Multi-Agent Manufacturing, 145-155

2017 A Manufacturing Value Modeling Methodology (MVMM): A Value Mapping and Assessment Framework for Sustainable Manufacturing M Demartini, I Orlandi, **F Tonelli**, D Anguitta International Conference on Sustainable Design and Manufacturing, 98-108

Munstere dell Istrucione 11 Università e della Ruerca



Industrial Policy Innovation in Italy A realistic analysis

- Small size of the factories
- Difficult relationships with the banks -> reduced credit
- Need of effective industrial policies
- Poor innovation capacity of SMEs
- Political instability
- Frequent and unattended legislation changes
- Low R&D investments



I Cluster Fabbrica Intelligente (CFI) è parte del sistema italiano dei Cluster Tecnologici Nazionali

Small Medium Entrerprises: Weak points

- Poor coordination between enterprises in the same area/sector (research but also synergy)
- Few relations with the research entities
- Reduced knowledge of the newest horizontal technologies (mostly ICT) and clea technologies
- Application oriented (rapid return)
- Lack of mid-long-term plans to sustainability pathway





The Clusters initiative (2012) https://www.researchitaly.it/cluster-tecnologici-nazionali/



<u>Aerospace</u> <u>Agrifood</u> <u>Green chemistry</u> <u>Smart factory</u> Life Sciences National Technology Clusters are broad and inclusive networks made up of the major public and private entities operating throughout the country and focused on industrial research, training and technology transfer: enterprises, universities, public and private research institutions, start-up incubators and other players active in the field of innovation. Each aggregation focuses on a **specific technology and application area** of strategic interest to Italy, of which it represents **excellence** in terms of skills, knowledge, facilities, networks and potential.

Technologies for living environments Technologies for Smart Communities Transport and mobility systems of land and ocean surface

2017 addition of: <u>Cultural heritage</u> <u>Design and Made in Italy</u> <u>Sea Economy</u> <u>Energy</u>



Il Cluster Fabbrica Intelligente (CFI è porte del sistema italiano dei Cluster Tecnologici Nazionali

The Clusters targets

The National Technology Clusters are **permanent coordination**, consultation and **reference tools** for the development of proposals and strategies to be adopted to accelerate innovation processes and improve the Country's industrial competitiveness. Each National Technology Cluster is aimed at one of the following areas considered of strategic interest to the national industry.

- Lead the process of strategic positioning of our production system in the international technology landscape;
- Welcome, in a coordinated and organic way, the best experiences and skills existing both at local and national level, promoting the inclusion of all the organizations operating in the specific sectors wishing to join in;
- create **synergies** between different industrial sectors on the same types of technology;
- promote stable connection and interaction between fields, policies, measures and tools at national, regional and local level;
- enhance strategic programs of research, technological development and innovation in line with national and international programs, in particular the National Smart Specialization Strategy (NSSS) and the EU Program Horizon 2020;
- create the conditions for **improving the capacity to attract** investment and talent.





Energy and decarbonization

- (2012) Cluster SPRING 'Sustainable Processes and Resources for Innovation and National Growth' National Technological Cluster of Green Chemistry <u>http://www.clusterspring.it/chi-siamo-en/cluster-en/</u>
- (2015) Virdis, M.R. et al. Pathways to deep decarbonization in Italy, SDSN IDDRI – ENEA – ENI <u>http://deepdecarbonization.org/wp-</u> content/uploads/2015/09/DDPP_ITA.pdf_explores different aspects as:
 - What are the key challenges and uncertainties?
 - What will the impacts be on the energy system, the economy, and society? What will the related investment costs be?
 - What will the impacts be on income and employment?
 - What policy support will need to be established?
- (2016) Ministero Ambiente/UNEP Report of the Italian National Dialogue on Sustainable Finance <u>http://unepinquiry.org/wp-</u> <u>content/uploads/2017/02/Financing the Future EN.pdf</u> claims that:
 - Frequent legislation modifications and variations led to uncertainty in investors behavior
- (2016) New Government funding for empowering Cluster action by adding the National Cluster on Energy (DD 1610 of 3th August 2016) <u>http://www.miur.gov.it/cluster</u>

Manufacturing and decarbonization

• Why?

- Italy is in the top 3 manufacturers of EU and one of the main manufacturers (PIL/population) in the world
- Italy is in the top 5 industrial machinery builders
- How?
 - Government grants/funds/fiscal incentives (i.e. MISE 'Sustainable Industry plan' 2015, MIUR 'Cluster research programs' 2017, National Plan of Research (PNR) 2014-2020, 'Piano Nazionale Industria 4.0' 2017)
 - Private Funds / EU Funds / ...
- When?
 - On the mid-long term for its industrial system having to operate mainly in the brownfield domain
 - Immediately (already started) in providing more efficient machineries
- Who?
 - Mainly large companies capable to afford such a important investment and cash-flow radical change (i.e. PSS)
 - Some SME providing innovative/disruptive technology to favour that process
- What?
 - Operating on its own industrial system and favouring refitting and new investment in industrial plants and components
 - Developing innovative industrial machineries capable to reduce the consumption of resources (energy, materials, ...)
 - Providing Product-Service-Systems for durable functional goods



Il Cluster Fabbrica Intelligente (CFI è parte del sistema italiano dei Cluster Tecnologici Nazionali

The challenges for Manufacturing

Nuovi mercati emergenti New emerging markets



Sfide specifiche - Specific challenges Crescita dei paesi emergenti (fronte produzione e consumo) - Growth of emerging countries (production and consumption) Condizioni del mercato molto variabili e difficilmente prevedibili - Highly variable and difficult to forecast market conditions Crescita di una nuova classe media a

- livello mondiale Growth of a new middle class at global level
- Necessità di gestire reti di imprese dinamiche e complesse - Need to manage dynamic and complex business networks Nuovi modelli di collaborazione, reshoring offshoring - nearshoring - New models of collaboration reshoring - offshoring - nearshoring Necessità di valorizzazione delle competenze

territoriali - Need to enhance specific competences and skills of each geographical area

Scarsità delle risorse Scarcity of resources

Sfide specifiche - Specific challenges

- Ridurre consumo energetico Reduce energy consumption Uso di fonti alternative nel manifatturiero - Úse of alternative
- energy sources in manufacturing
- Necessità di riciclare componenti e prodotti Need to recycle components and products
- Sfruttare l'energia da scarti e residui Exploitation of energy from waste and scrap
- Ridurre consumo delle risorse attraverso riciclo e riuso Reduce consumption of resources through recycling and reuse

Sfide specifiche - Specific challenges

- Necessità di far lavorare gli over 65 e creare nuove opportunità di lavoro per le nuove generazioni - Need to employ over-65s and create new job opportunities for the new generations
- Aumentare il benessere dei lavoratori in termini di maggiore soddisfazione, sicurezza, inclusività - Increase the worker wellbeing in terms of high satisfaction, safety and inclusivity Necessità di offrire nuovi servizi alla persona - New services tailored
- on the people
- Prodotti per necessità di comfort, salute e benessere di target group specifici - Products to satisfy the demand for comfort, health and wellbeing of specific target groups
- Aumento dell'urbanizzazione integrazione dell'industria nel contesto cittadino (urban manufacturing) - Increase in urbanisation - integration of industry in urban context

MEGATREND vs SFIDE **MEGATRENDS vs CHALLENGES**

Cambiamento demografico

Demographic change

Accelerazione tecnologica Technological acceleration



- Sfide specifiche Specific challenges Maggiore flessibilità e riconfigurabilità produttiva - Higher production flexibility and reconfigurability
- Aumento della produttività Increase in productivity
- Integrazione di tecnologie avanzate- Integration of advanced technoligies in existing systems Pervasività dell'utilizzo di internet
- Pervasiveness of internet

Fig. 13: I megatrend e le sfide specifiche per il manifatturiero - The megatrends and the specific challenges for manufacturing

- Nuove forme di employment New forms of employment
- Interazione con il singolo individuo (cliente, lavoratore, cittadino) - Change in the interaction with the individual (customer, worker, citizen)

Cambiamento climatico Climate change



Sfide specifiche - Specific challenges Ridurre l'inquinamento dell'aria, del suolo, dell'acqua attraverso una maggiore sostenibilità ambientale Reduce pollution in air, ground and water through improved environmental sustainability

Aumentare la resilienza dell'industria agli effetti del riscaldamento globale e del cambiamento climatico (su produzione, approvvigionamenti e mercati) - Increase the resilience of industry to global warming and climate change (on production, procurement and markets) Gestire i cambiamenti del territorio legati allo sfruttamento dei terreni agricoli, alla costruzione delle infrastrutture e all'urbanizzazione Manage environmental changes due to exploitation of farmland, the construction of infrastructure and urbanisation

Climate Change

- Reduce pollution in air, ground and water through improved environmental sustainability
- Increase the resilience of industry to global warming and climate change (on production, procurement and markets)
- Manage environmental changes due to exploitation of farmland, the construction of infrastructure and urbanization

Scarcity of resources

- Reduce energy consumption
- Use of alternative
- energy sources in manufacturing
- Need to recycle •
- components and products
- Exploitation of energy
- from waste and scrap
- Reduce consumption of resources through recycling and reuse





The Italian challenge

The INTELLIGENT FACTORY CLUSTER represents a national platform for advanced manufacturing

intelligente

- The INTELLIGENT FACTORY CLUSTER is an official association created in September 2012 sponsored by the Ministry of University and Research
- The target of the CFI is to promote research and innovation in the area of production systems, and to support the Italian factories



- Large and Small-Medium enterprises
- Universities and research centers
- Associations and public









Cluster involvement in Innovation and Industrial Policy at Italian level

- Synergy between complementary skills
- Sharing of research infrastructures
- Access to international knowledge
- Internationalization of the Italian manufacturing companies
- Technological partnership
- Support for the access to research grants
- Possibility of proposing new ideas
- A direct communication link with national/regional institutions





1. Four large research project 2014-2017 (<u>10 M€ each</u>)



Project 1: SUSTAINABLE MANUFACTURING

Low impact technologies during the Life Cycle of the product

Project 2: ADAPTIVE MANUFACTURING

Innovative mechatronic solutions for rapid adaptation of the factory

Project 3: SMART MANUFACTURING 2020

Digital technologies for virtualization and preventive maintenance

Project 4: **HIGH PERFORMANCE MANUFACTURING** *HP machinery and processes for efficient production*





2. National Research and Innovation Roadmap (2015) update (2018)



- Priorities for research and innovation in the Italian manufacturing
- ✓ State-of-the-art R&D
- Sharing the targets with the Ministry of Industry and other international entities





3. National Reasearch Plan 2015-2020



"...the national Technological Clusters are the main instrument to achieve a good coordination between public-public (nationalregional-local administrations) and public-private. The Clusters have the task of defining the research strategies and the national roadmaps for technological advancement."





Long term innovation programs (15 yrs)



RESEARCH/INNOVATION/INFRASTRUCTURE/NETWORK



Il Cluster Fabbrica Intelligente (CFI) è parte del sistema italiano dei Cluster Tecnologici Nazionali



GTTS = Scientific Technical Thematic Group GTTS are permanent structures that have the goal of defining the

GTTS are permanent structures that have the goal of defining the activities for each Line of Intervention:

- LI1: Customized production systems
- LI2: Strategies, methods and instruments for industrial sustainability
- LI3: Systems for improving the working environment in the factories
- LI4: High efficiency production lines
- LI5: Innovative productions systems
- LI6: Adaptive production systems
- LI7: Strategies and management of next generation production systems



GTTS Targets

- Creation of a community of experts in a specific area
- Definition of the research areas to propose to the Ministries (Industry and University & Research)
- Strategies for founding specific research projects
- Coordinate the Italian activities with similar European activities
- Collect and coordinate activity proposals from the members
- Every member of the Cluster can participate the GTTS on a voluntary base
- Every GTTS has a Steering Committee for the coordination of the activities



Research and Innovation Roadmap



luster Fabbrica Intelligente (CFI) arte del sistema italiano dei ster Tecnologici Nazionali

Enabling technologies mapping



Ministere dell'Istracione, dell'Università e della Ravrea il Cluster Fabbrica Intelligente (CFI) è parte del sistema italiano dei Cluster Tecnologici Nazionali

R-0431-D0516-CI-I

The Lines of Intervention (LI)

- LI1: Customized production systems
- LI2: Strategies, methods and instruments for industrial sustainability
- LI3: Systems for improving the working environment in the factories
- LI4: High efficiency production lines
- LI5: Innovative productions systems
- LI6: Adaptive production systems
- LI7: Strategies and management of next generation production systems





Il Cluster Fabbrica Intelligente (CFI) è parte del sistema italiano dei Cluster Tecnologici Nazionali

R-0431-D0516-CI-2

GTTS2: Strategies, methods and instruments for industrial sustainability

2.1. Integration of design and development processes in integration lifecycle management
2.2. Product energy footprint monitoring
2.3. Product-process-system integrated modelling for energy and resources eco-efficiency
2.4. Technologies and processes for re-use, re-manufacturing, and recycling of products, components, and materials end-of-life and maintenance interventions





2.5. Technologies and tools for intelligent demanufacturing systems
2.6. Modelling and Simulation for economical and environmental sustainability analysis of production processes based on LCA/LCC
2.7. Business Models for "Circular Economy"





National Industry 4.0 Plan

http://www.sviluppoeconomico.gov.it/index.php/en/

 The Plan is an opportunity for a smart and innovative industry for an even more competitive Made in Italy to be future ready

Key Points

- a public investment of about 20 billion euros
- a super and hyper amortization of 140% and 250%
- a 50% tax credit on R&D investments
- incentives on investments in start-ups and innovative small businesses
- https://youtu.be/y-2GfHhMLSU





Some interesting Industrial Projects in the area of Industrial Sustainability

- EU SYMBIOPTIMA <u>http://www.symbioptima.eu/</u> H2020 - programma SPIRE-call 6 2015
 - Human-mimetic approach to the integrated monitoring, management and optimization of a symbiotic cluster of smart production units.
 SIEMENS – ITIA (application to Italy)
- Regional project FIDEAS <u>http://www.fideas.industries/</u>
 - De-manufacturing plant for high tech electronics products
 - ITIA Regione Lombardia





Some interesting Industrial Projects in the area of Industrial Sustainability

Active Projects:

- Zero-Waste PCBs: Integrated Technological Solutions for Zero Waste Recycling of Printed Circuit Boards (PCBs). •
 - PCB-ID Prototype Project: In-line automated device for the identification of components and the characterization of materials and value in waste PCBs
 - ShredIT Prototype Project: Self-optimizing shredding station for demanufacturing plants
- FIDEAS: Fabbrica Intelligente per la Deproduzione Avanzata e Sostenibile. •
- WEEE ReFlex: Highly Evolvable E-waste Recycling Technologies and Systems. •
 - WEEE Reflex CPS Prototype Project: Cyber-Physical System (CPS) for reconfigurable e-waste recycling processes
- National Cluster: Intelligent Factory Project 1.3 Demanufacturing. •
- **RobustPlanet EU Project:** Use case remanufacturing of mechatronic components at Knorr Bremse. •
- **Cyber-Sort:** Identificazione in linea e sorting automatizzato per soluzioni di circular economy ad alta efficienza. •
- FiberEUse: Large scale demonstration of new circular economy value-chains based on the reuse of end-of-life • fiber reinforced composites.













To sum up...



- The Cluster Fabbrica Intelligente is the natural and official mediator between Italian stakeholders and the International Entities driving the evolution of the Digital Factory.
 - Normative activities are of primary importance
 for the industrial members of the Cluster.
- Italian companies are more interested in the application of the new technologies than in their definition.



I Cluster Fabbrica Intelligente (CFI è parte del sistema italiano dei Cluster Tecnologici Nazionali