Curriculum Vitae of Roberto Sacile

1.1 PERSONAL DATA 2
1.2 LIST OF POSITIONS HELD 2
2.1 FRAMEWORK OF THE RESEARCH ACTIVITY IN RELATION TO SOME PUBLICATIONS 3
2.1.1 Modelling of interaction and cooperation between systems aimed at controlling a TSoS 3
2.1.2 Uncertainty management and robust control of a TSoS 6
2.1.3 Management optimization and economic-performance evaluations of a TSoS 8
2.2 PUBLISHING KPI 8
3.1 COURSES CURRENTLY HELD 9
3.2 COURSES PREVIOUSLY HELD 9
3.3 INTERNATIONAL TEACHING ACTIVITY 10
3.4 DESIGN OF NEW INTERNATIONALIZATION PATHS 10
3.4.1 EMECIS: European Master in Engineering for Complex and Interacting Systems 10
3.4.2 Other dual paths and the design of EMECIS+ 10
3.5 FUNDING OBTAINED ON THE BASIS OF COMPETITIVE CALLS 11
3.5.1 Syse2021: Cross-border Centre of Excellence for Systems Engineering Education 11
3.5.2 Interreg France Italy project (LOSE+) for maritime safety and security in harbour areas 11
3.5.3 Vinci contribution for EMECIS 12
3.6 SUPERVISOR OF MASTER AND BACHELOR THESIS 12
3.7 MENTORING AND FUNDING OF RESEARCH POSITIONS 12
3.7.1 PhD student tutor 12
3.7.2 Agreements for co-supervision of PhDs 12
3.7.3 Agreements for PhD internships 13
3.7.4 Tutor of foreign researchers 13
3.7.5 Research grant tutor 13
3.7.6 Financing of fixed-term positions 13
4.1 SCIENTIFIC RESPONSIBILITY FOR RESEARCH PROJECTS 14
4.1.1 Projects concerning the transport and logistics of dangerous goods 14
4.1.1.1 Scientific liability of research contracts 17
4.1.1.2 Scientific responsibility for research projects eligible for funding on the basis of competitive calls 18
4.1.2 Energy research projects 18
4.1.2.1 Scientific liability of research contracts 19
4.1.2.2 Rscientific responsibility for research projects eligible forfunding on the basis of competitive calls 19
4.1.3 Research projects in the field of environment and sustainable development 19
4.1.3.1 Scientific liability of research contracts 19
4.1.3.2 Rscientific responsibility for research projects eligible forfunding on the basis of competitive calls 20
4.2 EDITORIAL CARE OF SPECIAL ISSUES AND VOLUMES 20
4.3 PARTICIPATION IN EDITORIAL BOARDS OF JOURNALS 20
4.4 SCHOLARSHIP AT FOREIGN AND INTERNATIONAL UNIVERSITIES AND RESEARCH INSTITUTES 20
4.5 PARTICIPATION IN NATIONAL AND INTERNATIONAL CONGRESSES AND CONVENTIONS AS A GUEST SPEAKER 20
4.6 PARTICIPATION IN ACADEMIES, PROFESSIONAL OR SCIENTIFIC SOCIETIES 21
4.7 ACHIEVEMENT OF PRIZES AND AWARDS FOR SCIENTIFIC ACTIVITY 21
4.8 RESULTS OBTAINED IN TECHNOLOGY TRANSFER 21
4.8.1 Patent development 21
4.8.2 Spin-off company 21
4.9 CONSULTANCY ACTIVITIES AT HIGH-CULTURE INSTITUTIONS, UNIVERSITIES, ACADEMIES AND RESEARCH INSTITUTIONS, PUBLIC AND PRIVATE, HIGHLY QUALIFIED AT NATIONAL AND INTERNATIONAL LEVEL; 21
4.10 ORGANIZATION OF NATIONAL AND INTERNATIONAL CONGRESSES AND CONVENTIONS AS PRESIDENT OF THE . LOCAL ORGANIZING COMMITTEE OR MEMBER OF THE SCIENTIFIC COMMITTEE; 22
4.11 ACADEMIC-INSTITUTIONAL ACTIVITIES OF RESPONSIBILITY OR SERVICE 22
4.12 AGREEMENTS WITH RESEARCH INSTITUTIONS 22

1. Personal and professional summary

1.1 Personal data

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1.2 List of positions held

- 1989 – 1990 as a student, contractor for the DIST (Department of Computer Systems and Telematics) of the University of Genoa, for the design and implementation of a software for modeling and simulation in industrial environment (SAM - Simulation And Modelling)
- 1990 After graduating in Electronic Engineering in the same year, Italimpianti scholarship holder for 3 months for the improvement of the language for the modeling of the control of SAM dynamic systems and its application to cold rolling plants of the Terni steelworks
- 1991-1994 PhD (December 1990: winner of the PhD competition in Electronic and Computer Engineering - University of Genoa: January 1991: winner of the PhD in Bioengineering competition - Politecnico di Milano – Genoa consortium - with renunciation of the previous one)
- 1995-1996: Post-doc and specialization abroad for research activities at the ACACIA project (Acquisition des connaissances pour l'assistance à la conception par interaction entre agents) of INRIA (National Institute for Research in Computer Science and Automation) - Sophia Antipolis –France. Permanence of 14 months, with particular study of techniques oriented to the formalization of software agents
- 1997 holder of a research contract at DIST
- 1998 – 2000 Research fellow at the DIST on "Study of object-oriented software models for concurrent and distributed applications in industrial automation"
- since 2000: researcher at DIST/DIBRIS
- since 2014: professor at DIBRIS

2. Scientific production

2.1 Framework of the research activity in relation to some publications

My research activity of the last fifteen years is mainly in the field of "System of Systems Engineering - SoSE". The SoSE theme refers to a set of processes, tools and methodologies for the design and development of engineering solutions related to a "technological system of systems" (TSoS). The development of the means of communication today allows a large-scale interconnection of autonomous technological systems that can cooperate to carry out certain tasks, collectively defined as TSoS. In particular, my research activity is aimed at the studyof methods and technologies for information processing (data and signals) aimed at automating a TSoS. I am therefore interested in modeling, simulation, optimization, and then in the management and control of a TSoS. These methodological aspects are characterized in particular by autonomy, possible competitive or cooperative interactions, and the heterogeneity of the systems that compose them. A peculiar aspect of a TSoS is also to be able to demonstrate an "emergent behavior", therefore a peculiar behavior that can "emerge" only thanks to the complex structure of a TSoS. A frequent demonstration of "emergent behavior" is linked to the resilience of the system itself: for example, in a network of microgrids for the production of electricity from renewable energy, the cooperative behavior between different micro-grids can emerge to allow a better quality of service being able to respond adequately to any peaks or deficits in production or demand. The management and control of TSoS, which is at the center of my research, addresses a potentially very broad scope of application, which also includes relevant socio-economic issues in the fields of transport and mobility, security, energy and the environment.

My scientific production is generally the consequence of a first phase of bottom-up approach to a specific problem. At this stage, I am asked (usually by private companies or public institutions) problems related to the management and control of complex systems. The interaction with experts in the sector, therefore leads me to the formalization of the problem thanks to the simultaneous study of new methodologies in the sector that can be used. Then follows a second phase of generalization of the problem, such as to obtain new original methodological ideas. Finally, through a top-down approach, I try to reapply the experience obtained to new application fields, always with the help and interaction of experts. This approach has allowed me to have several important interactions with the industrial world and to participate in several research calls on a competitive basis, obtaining important funding.

Beyond the engineering aspects, the management and control of a TSoS represents a considerable scientific challenge with important ideas for both methodological and applicative research. My research on TSoS is addressed on three main paths:

- ***modeling of interaction and cooperation between systems aimed at controlling a TSoS*;**
- ***uncertainty management and robust control of a TSoS*;**
- ***optimization of management and economic-performance evaluations of a TSoS***.

These paths have strongly influenced my research and consequently my scientific production, as illustrated in the following subsections. Obviously, the research activity has further influenced my planning, teaching, international collaboration, and mentoring of young researchers. Below is briefly described my scientific production on these three paths, with exclusive reference to the twenty publications presented, of which I am co-author with equal contribution to the other co-authors.

2.1.1 Modelling of interaction and cooperation between systems aimed at controlling a TSoS

In a TSoS, the presence of different systems, sometimes heterogeneous between them, allows the application of various control techniques. Moreover, the presence of an approximate model of the dynamics of TSoS applied to a "rolling horizon" optimization of a cost function can be traced back to a "model predictive control" (MPC) control architecture.

Among the twenty publications presented, the first concerning this subsection is also the only publication that sees me as a single author. In R. Sacile, 2007, [1]I dealt with one of the main engineering problems that underlie a TSoS: the need to communicate between the various components of the system and to give information remotely. In this publication, I illustrated the experimentation of a monitoring system I created

[1] R. Sacile, "Remote real-time monitoring and control of contamination in underground storage tank systems of petrol products," J. Clean. Prod., vol. 15, no. 13–14, 2007.

that allowed via the internet to verify any presence of pollutants in a terrain, in particular in the area of a fuel service station. In the system described in this publication, there was the possibility of blowing air into the ground and always sucking air from it at different points a few meters deep. The novelty of this system (configurable in the category of "soil venting" systems), also considering the period in which it was developed, was to be composed of several simple heterogeneous technological components such as pollution and explosive sensors, solenoid valves for closing and opening air flows, remotely controllable via web communication from a local PLC. It was thus possible to "smell" the soil in different areas (according to an appropriate scanning sequence, or according to its own control policy) and refine the research to establish the presence of pollutant, and by ventilating the soil it was possible to remediate it in case of small leaks. In the meantime, thanks to this experience, I began to deal with a much more complex TSoS such as that of planning and controlling secondary logistics (relating to the transport of petroleum products by road tanker or by train) of Eni, the largest Italian petrochemical company. Still in relation to the engineering aspect of the automation of a complex system, more recently I have also been involved in monitoring and controlling energy-efficient greenhouses, and self-driving cars. These experiences of engineering and technological design of automation components will be discussed in the section on design activities.

In addition to the engineering aspects related to the design and implementation of a TSoS, I was interested in proposing models and possible TSoS control methods. My scientific production has always been contextualized in application approaches, mainly related to the energy sector ("microgrid" in particular) and logistics.

As far as the energy sector is concerned, the interest arises mainly from the collaboration with some colleagues from Moroccan universities and research institutes (prof. Driss Zejli in particular, CNRST Rabat), very active from the point of view of the use of renewable energy (solar and wind in particular), and from the consequent training of PhD students from those countries. My publications applied to the energy sector have therefore often been written in collaboration with two doctoral students of whom I was supervisor, Hanane Dagdougui and Ahmed Ouammi, students of prof. Driss Zejli, now both fellow professors at the Polytechnic School of Montreal, Canada, and the University of Qatar respectively.

The particular characteristics of energy demand and supply present in the Moroccan territory have led me to take an interest in the nascent concept of microgrid, a territorially limited power network within which, locally and autonomously, it is possible to produce, consume, store energy or exchange it with other microgrids. The first work carried out on the subject concerned the definition of hybrid models within a microgrid, as they were designed with energy systems powered by different renewable sources. In particular, in H. Dagdougui et al, [2]2010, we proposed the model of a microgrid containing subsystems such as energy production systems powered by different renewable sources, energy storage systems based on potential energy storage in water tanks, or in the form of hydrogen. In this problem the user was not only electric but the demand also concerned the use of water for domestic use and hydrogen for transport. The case study concerned a specific area of Morocco, and the control variables mainly concerned the methods of use of energy produced from renewable sources (whether e.g. to pump water into the tank, or to produce hydrogen by electrolysis), to meet electricity, hydrogen and water demand.

In Zejli et al., [3]2011, the TSoS was a system that integrated systems of energy production from solar and wind sources, with a desalination plant. The objective was to propose an hourly management plan for energy flows produced from renewable sources, or acquired from the external grid. It was also possible to store/use water in a local storage system, able to meet the demand of some villages in a region of Morocco, making the desalination process economically and environmentally sustainable.

In H. Dagdougui et al., [4]2012, we proposed a modelling approach to the control of on-site hydrogen production using renewable energies. The aim was to make this production sustainable by satisfying the

[2] H. Dagdougui, R. Minciardi, A. Ouammi, M. Robba, and R. Sacile, "A dynamic decision model for the real-time control of hybrid renewable energy production systems," IEEE Syst. J., vol. 4, no. 3, 2010

[3] D. Zejli, A. Ouammi, R. Sacile, H. Dagdougui, and A. Elmidaoui, "An optimization model for a mechanical vapor compression desalination plant driven by a wind/PV hybrid system," Appl. Energy, vol. 88, no. 11, 2011, pp.4042-4054.

[4] H. Dagdougui, A. Ouammi, and R. Sacile, "Modelling and control of hydrogen and energy flows in a network of green hydrogen refuelling stations powered by mixed renewable energy systems," Int. J. Hydrogen Energy, vol. 37, no. 6, 2012, pp.5360-5371,

demand for hydrogen for automotive use. In H. Dagdougui et al. , [5]2012, defined a model predictive control (MPC) approach where the TSoS was represented by a "green" building, whose energy needs in terms of electricity and heat were met by different energy systems based on renewable sources.

These works are particularly important in my scientific production both because they represent the start of an interesting research work with the young colleagues now Dagdougui and Ouammi, and because at the same time a "rolling horizon" and MPC control scheme was introduced. The attention of my scientific production thus shifted from the initially purely environmental context - as shown in publications related to the control of extraction of groundwater from aquifer such as in R. Minciardi et al, [6]2007 - or in others in an environmental energy context (in particular plans for the sustainable exploitation of forest resources for the production of energy from biomass, with high impact on the scientific community in terms of citations).

From these first works in the energy context, it was evident that a microgrid, although itself a TSoS, needed to improve its quality of service to cooperate with other microgrids, thus forming a TSoS of larger territorial dimension. Later, therefore, I became interested in networks of cooperative microgrids represented by a graph whose nodes are the microgrids themselves, and the arcs are transmission lines through which it is possible to exchange energy and information. In two[7][8] papers, among those of the twenty publications presented, we formalized a network of microgrids as a cooperative TSoS, and proposed a centralized control of the TSoS which, through the proof of a suitable theorem, was traced back to a classical Linear Quadratic Regulator (LQR) and Linear Quadratic Gaussian (LQG) discrete-time controller. It is evident that this approach, although interesting from the modeling point of view, requires the verification of hypotheses, not always verifiable a priori, such as those of not constraining the state of the system and of having disturbances, if present, with normal distribution. In addition, the implementation of a centralized control is not always possible. To overcome these problems I have explored new approaches that have given rise to new publications.

In H. Dagdougui *et al.* , [9]2014, extended the previous TSoS model, and, through a continuous-time formalization, proposed an approach that would allow to introduce constraints to the state of a microgrid network, based on the principle of the Pontryagin minimum. The results show the solution of optimal system control. This solution, although methodologically very elegant, has several problems that do not allow an immediate application use, such as the complexity of the resolution on extended graphs and the deterministic formalization of information sources.

For these reasons, we subsequently defined a control architecture for an MPC-based microgrid TSoS[10], which allowed both the definition of a more articulated objective function (in this case multi-objective), and the introduction of constraints. The dynamics of the TSoS, therefore of the different microgrids of the system, is introduced as a further constraint of the problem. The resolution was obtained by formalizing a constrained optimization problem that could be solved with mathematical programming techniques. The resolution is calculated several times in a rolling horizon pattern. In this case, the problems related to the resolution of the problem concern the calculation time, which must necessarily be lower than the duration of the interval for which the displacement of the window on which to calculate the optimization is proposed. Moreover, also in this case, the control is centralized, an approach that is not always feasible and characterized by well-known problems. Also according to a rolling horizon control scheme, in H. Dagdougui et al. , [11]2016, we

[5] H. Dagdougui, R. Minciardi, A. Ouammi, M. Robba, and R. Sacile, "Modeling and optimization of a hybrid system for the energy supply of a 'green' building" Energy Convers. ManAG., Vol. 64, 2012, pp. 351-363.

[6] R. Minciardi, M. Robba, and R. Sacile, "Decision models for sustainable groundwater planning and control," Control Eng. Pract., vol. 15, no. 8, 2007

[7] A. Ouammi, H. Dagdougui, and R. Sacile, "Optimal control of power flows and energy local storages in a network of microgrids modeled as a system of systems," IEEE Trans. Control Syst. Technol., vol. Amendment No 23, no. 1, 2015, pp. 128-138.

[8] R. Minciardi and R. Sacile, "Optimal control in a cooperative network of smart power grids," IEEE Syst. J., vol. 6, no. 1, 2012, pp.126-133.

[9] H. Dagdougui, A. Ouammi, and R. Sacile, "Optimal control of a network of power microgrids using the Pontryagin's minimum principle," IEEE Trans. Control Syst. Technol., vol. 22, no. 5, 2014, pp. 1942-1948

[10] A. Ouammi, H. Dagdougui, L. Dessaint, and R. Sacile, "Coordinated Model Predictive-Based Power Flows Control in a Cooperative Network of Smart Microgrids," IEEE Trans. Smart Grid, vol. 6, no. 5, 2015, pp.2233-2244

[11] H. Dagdougui, A. Ouammi, L. Dessaint, and R. Sacile, "Global energy management system for cooperative networked residential green buildings," IET Renew. Power Gener., vol. 10, no. 8, 2016, pp.1237-1244

analyzed the cooperative management of a TSoS consisting of "green" buildings, which cooperatively provide for the satisfaction of their energy demand, through an integrated production in the building itself.

In H Dagdougui and R. Sacile, [12]2014, we proposed an innovative approach to the decentralized control of a microgrid network. Starting from the basic concepts of dual decomposition introduced by Arrow/Hurwicz/Uzawa, and on more recent work based on team-based control defined by Rantzer et al., we proposed a decentralized control that can be easily realized by a multi-agent architecture. The classic problems of convergence of these methods are partially overcome by methods that allow to accelerate their resolution, even if the time necessary for "bargaining" to reach an optimal shared solution are certainly high in extended graphs or in any case poorly connected.

It is important to note that during my research activity I have always tried to make possible the abstraction and generalization of the experiences made in an application context, in order to reuse the approach to other contexts. For example, we have proposed with appropriate new formulation, the formalization of type LQ at the base of the first works in the energy sector, in the publication C. Roncoli et al. [13], 2013. I am pleased to highlight that the two co-authors, Claudio Roncoli (of whom I was supervisor in the PhD) and Chiara Bersani (whom I also followed during the research activity in the PhD), are now both professors, the first at Aalto University, Finland and the second at the University of Genoa. In this publication, the application context concerns the transport of dangerous goods, and in particular the routing of dangerous goods on a road graph based on the risk to which the population is exposed during such transport. The control variables are the flows on the road network. The control problem is addressed here as both MPC control and LQ control.

As a conclusion of this subsection and always with reference to the process of abstraction of experiences, in the publication C. Bersani et al. , 2019, [14]we propose an evolution of the distributed approach proposed in H Dagdougui and R. Sacile, 2014, improving from the point of view of convergence, and applied to two different application contexts (energy sector and transport of dangerous goods). The formalization of the problem is then proposed in a unifying and abstract way, as a network of inventories subject to stochastic production and demand. The formulation of this problem is original because normally the production regime of a company that feeds the finished products warehouse is the main control variable of the production system. In some energy production systems based on some renewable sources such as the sun or wind, it is evident that energy production is not controllable even if it is possible to predict it with good approximation and therefore is subject to stochastic disturbance. These conditions require modifying the traditional approach of industrial automation based on production control by trying to compensate for the differences between production and demand in a cooperative way between different systems or microgrids. In addition to proposing the distributed control approach, the publication demonstrates how this model can also be characteristic of other applications, such as the control of dangerous goods transport flows in a road graph.

2.1.2 Uncertainty management and robust control of a TSoS

While I was developing in collaboration with other colleagues the methodologies and applications seen in the previous subsection, one of the main limitations of these approaches emerged more and more, caused by the stochastic component due not only to model approximations or to the measurement error of the output of the different systems, but above all to the data relating to the prediction of some future information components. As described above, the approaches to control I use, always require a model that describes the future dynamics necessarily fed also by data deriving from more or less reliable predictions. In addition, the subsystems present in the system may vary in number and interaction with each other. For example, in the energy sector, a microgrid needs future energy production data (e.g. from wind speed in the next few hours) and may decide to isolate itself or cooperate with other systems. The control must therefore always be robust to any sudden variations caused by the stochastic components of the TSoS.

In some of my periods spent as visiting professors spent at the MS2T laboratory of excellence (https://www.labexms2t.fr/, Laboratory of Excellence on Systems-of-Systems) at the Technological

[12] H. Dagdougui and R. Sacile, "Decentralized control of the power flows in a network of smart microgrids modeled as a team of cooperative agents" IEEE Trans. Control Syst. Technol., vol. 22, no. 2, 2014, pp. 510-519

[13] C. Roncoli, C. Bersani, and R. Sacile, "A risk-based system of systems approach to control the transport flows of dangerous goods by road," IEEE Syst. J., vol. 7, no. 4, 2013, pp.561-570.

[14] C. Bersani, H. Dagdougui, C. Roncoli, and R. Sacile, Distributed Product Flow Control in a Network of Inventories with Stochastic Production and Demand, IEEE Access, 7, pp. 22486-22494

University of Compiègne (UTC), School of Engineering of the Sorbonne University, France, I was able to interact with colleagues working on the safety and control aspects of the European Rail Traffic Management System (ERTMS) that characterizes the high lines European rail speeds. At that time, I was also studying with interest some publications of Prof. Rantzer's group from Lund University, which revitalized the concept of team control in a context of robust control. This set of experiences led me to publish in 2015 with my colleague C. Bersani and other colleagues of UTC, a robust and distributed approach to the control of a railway section on which trains run in the same direction. In this approach, the information available to each train was related to the inter-distance with the previous and next train (i.e. the headway). Through the formulation of a theorem, we could show that the optimal control for each train was of linear feedback type with gain values obtainable by solving a system of linear matrix inequalities (better known as LMI, Linear Matrix Inequality).[15]

Subsequently, in the publication C. Bersani et al., [16]2017, we demonstrated in a relative theorem that also in this case an optimal, linear, robust and distributed control could be obtained through the appropriate LMI resolution, in a TSoS composed of microgrids.

If the two previous publications allow to address the problem of optimal control of a TSoS in a decentralized way when partial information, often local, of the overall system, and subject to stochastic disturbances to which one wants to react robustly, is available to each subsystem, the problem of how to better deal with the problem when it is possible to address the problem through a centralized controller remained of further interest.

In the recent publication by C. Bersani et al., [17]2020, we have therefore taken up the problem of a TSoS composed of microgrids, posing the problem of limiting, in a statistical sense, the effects of the disturbance, in a centralized way. We then defined a LQ-type system subject to stochastic disturbance, in which we added quadratic constraints regarding state and/or control. In other words, constraints are introduced that limit to a certain value the expected value of the product of a component of the state (or control) of the TSoS with the same or other components of the state (or control). In the publication we have reported a theorem and a relative corollary that allow to trace the problem to an optimal linear control, whose gain is also obtainable in this case through the resolution of an appropriate LMI system.

Finally, again with regard to uncertainty management, I also addressed problems of risk assessment and reliability of a TSoS (in particular RAMS, Reliability, Availability, Maintainability, and Safety), especially during my stays as a visiting professor at UTC. Collaborating with prof. Sallak, I deepened "valued based system" approaches and more generally based on fuzzy logic. This last topic was also developed by me in collaboration with a PhD student, Haitam Laarabi, of whom I was supervisor, now a project scientist at Lawrence Berkeley National Laboratory, US. Due to the limitation of the number of twenty, no citations to related publications are reported here, however present in the extended list of publications (see Qiu et al, 2015; Boulmakoul et al, 2017). In this type of methodological approach, I report instead the publication of L. Zero et al, 2019. The publication proposes an original extension of the classic solution approach based on dynamic programming in the definition of a minimum path, in particular in relation to the Dijkstra formulation, and another algorithmic formulation always original as an extension of the algorithm A*. The originality of the resolution is due to the fact that it must take into account a deterministic objective (i.e. the distance from node to node) and a fuzzy objective (i.e. the risk). The complication introduced by the fuzzy objective is due to the fact that during the course of the dynamic programming algorithm, operations, for example of sum, between fuzzy numbers, do not always allow to assert in a deterministic way that the value of the optimization achieved in a certain state is better than another.[18]

[15] C. Bersani, S. Qiu, R. Sacile, M. Sallak, and W. Schon, "Rapid, robust, distributed evaluation and control of train scheduling on a single line track," Control Eng. Pract., vol. 35, 2015, pp.12-21,

[16] C. Bersani, H. Dagdougui, A. Ouammi, and R. Sacile, "Distributed Robust Control of the Power Flows in a Team of Cooperating Microgrids," IEEE Trans. Control Syst. Technol., vol. 25, no. 4, pp. 1473–1479, 2017,

[17] Bersani, C., Dagdougui, H., Ouammi, A., Sacile, R. Stochastic constrained linear quadratic control in a network of smart microgrids (2020) IET Renewable Power Generation, 14 (7), pp. 1193-1200

[18] Zero, L., Bersani, C., Paolucci, M., Sacile, R. Two new approaches for the bi-objective shortest path with a fuzzy objective applied to HAZMAT transportation (2019) Journal of Hazardous Materials, 375, pp. 96-106,

2.1.3 Management optimization and economic-performance evaluations of a TSoS

At the management level, a TSoS presents problems related to planning for the best system configurations, taking into account the modeling of different often heterogeneous technological systems, which contribute to creating evaluations, for example economic and performance. Also in this area my publications concern more recently the energy sector, while previously they have dealt more with environmental sustainability issues. In the twenty publications I report only two.

In H. Dagdougui et al., [19]2011, the system we studied is related to the energy sector. In this case the management choice concerns the technological choice to be used in water heating systems based on flat collectors, in order to maximize the water outlet temperature and at the same time maximize the efficiency of the system. More recently, in A. Ouammi et al. , [20]2019, we have defined a decision support system to optimally plan the technological choice of wind farms to be installed in a region. The proposed approach takes into account different economic assessments, but also historical data regarding wind speed and possible restrictions on the installation of the plant resulting for example from environmental considerations.

2.2 Publishing KPI

For convenience, some indicators detectable by Scopus as of 26/8/2024 are reported.

- H-Index: 28
- documents: 188
- Total citations: 3140

[19] H. Dagdougui, A. Ouammi, M. Robba, and R. Sacile, "Thermal analysis and performance optimization of a solar water heater flat plate collector: Application to Tétouan (Morocco)," Renew. Sustain. Energy Rev., vol. 15, no. 1, pp. 630–638, 2011.

[20] Ouammi, A., Dagdougui, H., Sacile, R. Optimal Planning with Technology Selection for Wind Power Plants in Power Distribution Networks, (2019) IEEE Systems Journal, 13 (3), pp. 3059-3069

3. Didactic activity

My teaching activity has obviously been strongly influenced by my research and design activity framed in systems engineering. The repercussions have been partly in the formulation of the program of some courses, and strongly in the definition of new training and orientation paths. The lessons are held by me for teaching requirements in English, even if I have previous experience of teaching in Italian, and interaction with students in English, Italian and French.

3.1 Courses currently held

- Since 2016: Holder of the course "Industrial automation" (9 ECTS) (in English), Master's Degree in Computer Engineering
  In this course, I set the content orienting it to the ANSI/ISA-95 standard, that is, the international standard from the International Society of Automation for the development of an automated interface between business systems and control systems. During the course I describe the three levels, starting from the control level, to the MES / MOM level (Manufacturing Execution Systems and Manufacturing Operations Management), to conclude with the ERP level (Enterprise Resource Planning). In the first part of the course, from a methodological point of view, I focus on basic aspects of PLC ladder programming, and simple feedback control schemes such as PID, LQR, LQG, thus mentioning also the Kalman filter for the optimal estimate of the state in linear systems. In the part relating to MES, in addition to listing the various primary and support features, I focus mainly on scheduling techniques and, with the teaching support of PhD student Dr. Enrico Zero, on production quality control techniques. So at the planning level I mainly describe the functionalities related to the management of stocks, and the distribution of goods. The course is currently mandatory in the Master's Degree in Computer Engineering of the University of Genoa. In other courses provided by the same degree, optional, what is described at the control level and at the ERP level can be further deepened, while the MES / MOM level is peculiar to the course. I consider this last didactic aspect very important also because it is linked and characteristic of what was developed in Genoa by Siemens, which is obviously an industry with interesting employment aspects for our graduates.
- From 2019: Holder of the course "Smart systems control and applications" (6 credits ING-INF / 04) (in English), Master's Degree in Computer Engineering.
  The course aims to provide models and methodological approaches of monitoring and control in order to describe and analyze a system and make decisions based on available data in a distributed, predictive and/or adaptive way. Models and methods adapted to the application in different contexts are introduced, such as smart energy grids, connected autonomous vehicles and platoons, energy-efficient buildings, distributed logistics and environmental monitoring.
- Since 2017: Holder of the course "Dynamics of environmental systems" (5 ECTS) (in English), Master's Degree in Engineering for natural risk management. This course deals with problems of modeling and simulation, and partly decision-making and control in the environmental field. For the formalization of the contents of the course, I took several ideas from a recently published book by prof. S. Marsili Libelli of the University of Florence (who was invited professor in the course). The program contains fundamentals of modeling and simulation in continuous and discrete time, providing basic concepts of identification and application ideas in environmental context such as water quality.

3.2 Courses previously held

- 2014-2017 Holder of the course "Methods and models for optimization and control" (5 ECTS), Master's Degree in Management Engineering
- 2002 – 2014 Holder of the course "Models and methods for the management of environmental systems" (6 ECTS), Master's Degree in Environmental Engineering
- 2014-2015 Holder of the course "Models and methods for logistics" (5 ECTS) at the master's degree in safety engineering: transport and territorial systems
- 2011- 2018 Holder of the course "Logistics of dangerous goods" (5 credits ING-INF / 04) at the master's degree in safety engineering: transport and territorial systems

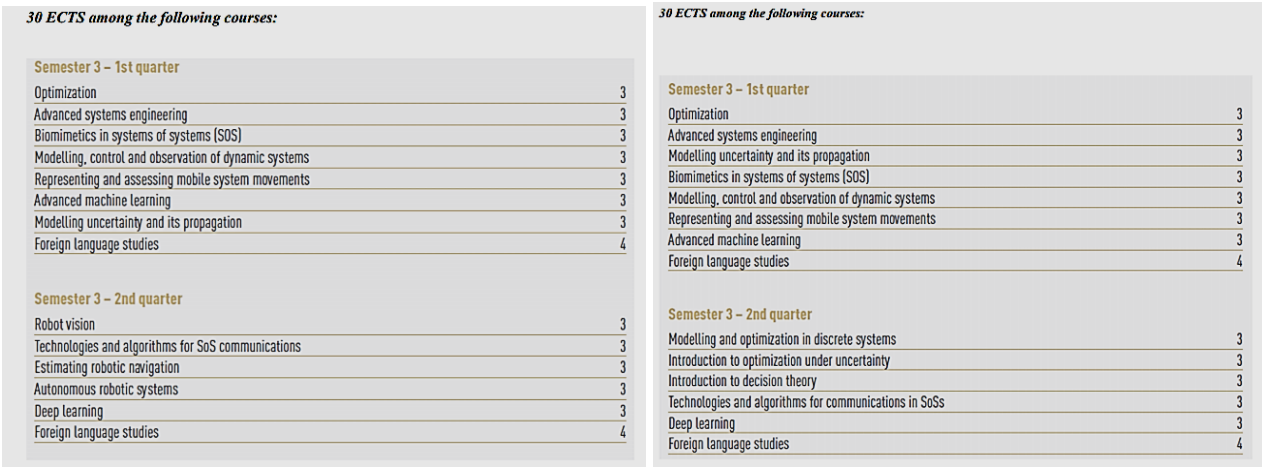
3.3 International teaching activity

- October 2018 invited professor at the "Laboratories of Excellence", MS2T "Control of Technological Systems-of-Systems", University of Compiegne, France, during which he gave 5 hours of lectures on robust control techniques for TSoS
- January 2011, invited professor for the course "Risk based sustainable transport", Mines Paris Tech, France, of the Master in Industrial Risk Management, 8 hours course

3.4 Design of new internationalization paths

3.4.1 EMECIS: European Master in Engineering for Complex and Interacting Systems

- Since 2015, I have been the proponent and manager (as referent of the international teaching activities of the master's degree course in Computer Engineering) of the course of study called European Master in Engineering for Complex Interacting Systems (EMECIS) which provides the titles of "master's degree in computer engineering" at the University of Genoa (UNIGE) and "master in complex systems" at the technological university of Compiègne (UTC), engineering school of the Sorbonne universities. To date, 21 students (http://emecis.eu/en/alumni-en) have been included in the course, of which 16 have already acquired the double degree.
  The educational offer for students enrolled in Computer Engineering at UNIGE, is to support the courses of the first year locally, and to support at UTC the courses in the first semester of the second year with the choice between two curricula: Automation and Robotics in Intelligent Systems (on the left in figure 1) and Machine Learning and Optimization of Complex Systems (on the right). The second semester of the second year is completely dedicated to the thesis project, carried out in a shared way between the two institutions.



30 ECTS among the following courses:

Semester 3 – 1st quarter	
Optimization	3
Advanced systems engineering	3
Biomimetics in systems of systems (SOS)	3
Modelling, control and observation of dynamic systems	3
Representing and assessing mobile system movements	3
Advanced machine learning	3
Modelling uncertainty and its propagation	3
Foreign language studies	4

Semester 3 – 2nd quarter	
Robot vision	3
Technologies and algorithms for SoS communications	3
Estimating robotic navigation	3
Autonomous robotic systems	3
Deep learning	3
Foreign language studies	4

30 ECTS among the following courses:

Semester 3 – 1st quarter	
Optimization	3
Advanced systems engineering	3
Modelling uncertainty and its propagation	3
Biomimetics in systems of systems (SOS)	3
Modelling, control and observation of dynamic systems	3
Representing and assessing mobile system movements	3
Advanced machine learning	3
Foreign language studies	4

Semester 3 – 2nd quarter	
Modelling and optimization in discrete systems	3
Introduction to optimization under uncertainty	3
Introduction to decision theory	3
Technologies and algorithms for communications in SoSs	3
Deep learning	3
Foreign language studies	4

Figure 1. Training offer at UTC in the first semester of the second year of the EMECIS path

3.4.2 Other dual paths and the design of EMECIS+

- Since 2020, a double degree agreement has been active with UPC (the Polytechnic University of Catalunya, Barcelona, Spain). The training course, very similar to what is proposed with UPC, allows the student of the UNIGE Master's Degree in Computer Engineering, to specialize during the first semester of the second year at UPC, on issues of advanced manufacturing systems (fig.2). Since a similar agreement has been implemented between UTC and UPC, a wider European training offer, called EMECIS+, is being defined in the Erasmus Mundus scheme. In this offer I have also included through an appropriate agreement of which I am the referent for UNIGE, the Polytechnic of Tirana (UPT), Albania, to allow their students and with particular requirements, not reported for brevity, to join these training courses.

Advanced Manufacturing Systems

CODE	SUBJECT NAME	TYPE	ECTS	DEPT	COORDINATOR	TEACHING GUIDE
295II231	Advanced manufacturing	ELECTIVE SUBJECT	6	712 / 702	TRAVIESO, ANTONIO JIMENEZ,EMILIO	
295II232	Mechatronics	ELECTIVE SUBJECT	6	710	CONESA, ALFONSO	
295II233	IoT sensors & MEMS	ELECTIVE SUBJECT	6	710	COSP, JORDI	
295II234	Plant monitoring & fault detection	ELECTIVE SUBJECT	6	749 / 713	GRAELLS, MOISES POZO, FRANCESC	
295II235	Robotic systems	ELECTIVE SUBJECT	6	707	TORNIL, SEBASTIAN	

Figure 2. Training offer at UPC in the first semester of the second year of the EMECIS+ course

3.5 Funding obtained on the basis of competitive calls

3.5.1 Syse2021: Cross-border Centre of Excellence for Systems Engineering Education

I recently received the approval of an Interreg-ALCOTRA project of which DIBRIS is the leader and of which I am scientific responsible, concerning the promotion of systems engineering in the years 2020-2021. The project will start with the beginning of the academic year 2020/21. The specific ambitious objective of the project can be summarized in the following points:

- provide integrated training on systems engineering at cross-border level between higher education institutions of the territory (Liguria, Piedmont, Val d'Aosta, Rhone-Alps, Paca), such as POLITO, INRIA, University of Nice and Sophia Antipolis, University of Genoa (UNIGE), and Politecnico della Savoia – Monte Bianco (USMB).
- contribute to bridging the gap between secondary school, university, and demand from companies in the field of systems engineering
- define with local companies a professionalizing educational orientation in the field of systems engineering
- define a new path with a double degree in Computer Engineering at UNIGE and Master M2 in Systems Engineering at USMB
- provide the territory of a summer school located on Imperia, to initiate three-year degree students in engineering to orient themselves to the master's degree in systems engineering
- provide the territory of a summer school located on Annecy, to initiate master's degree students in computer engineering and master's degree students in systems engineering and first year doctoral students to research and/or work
- provide local students or students enrolled in computer engineering courses and masters in systems engineering and first year of doctorate with resources to carry out internships at local companies or missions at research institutes

The project was funded with 503keuro, of which 268keuro is funded by DIBRIS.

3.5.2 Interreg France Italy project (LOSE+) for maritime safety and security in harbour areas

This project has been funded about 2M€ and developed on 2020-2022. Roberto Sacile was the scientific leader of the project.

3.5.3 Vinci contribution for EMECIS

- The EMECIS course has been recognized by MIUR, through funding from the Vinci program (Italian-French university) of which I am scientific director in the period 2016-2019, funding DIBRIS 30keuro.

3.6 Supervisor of master and bachelor thesis

Since 2002, I have been supervisor of 56 degree theses (of which 43 of master's / specialist level) in various degree courses of the Polytechnic School of the University of Genoa.

3.7 Mentoring and funding of research positions

3.7.1 PhD student tutor

- Chiara Bersani (2004, researcher at the University of Genoa), PhD in Transport Systems on inventory-routing problem and sustainable transport of dangerous goods (cotutor). He is now professor of the courses ING-INF/04: Dynamics of Environmental Systems (in co-teaching); Methods and Models for Logistics.
- Angela Maria Tomasoni (2008, cotutoring with Ecole des Mines de Paris; researcher at Liguria ricerche, now research fellow at the University of Genoa), PhD in Systems Monitoring. The PhD was co-financed in mobility by the Galileo call, on a request I submitted to the Italo-French University program, with 5 keuro
- Ahmed Ouammi (co-tutoring with Tetouan University, Morocco, 2010; now associate professor at Qatar University), responsible for the management and control of renewable energy-based energy systems
- Hanane Dagdougui (PhD exam in 2011, cotutoring with Ecole des Mines de Paris), research fellow at the University of Genoa in 2012-2013, since 2014 assistant professor at Polytechnique Montréal, Department of Mathematical and Industrial Engineering, Montréal, Canada. Holder of the following courses: Algébre linéaire pour ingénieurs; Optimisation des microréseux électriques intelligents; Modélisation techno-économique des systèmes énergétiques.
- Giuseppe Masetti (PhD exam in 2013), now assistant professor at the University of New Hampshire, Durham, USA. Course holder: Appl Tools for Ocean Mapping; Seafloor Characterization.
- Claudio Roncoli (PhD exam in 2013, one-year internship at Imperial College, London), since 2013 researcher at Technical University of Crete in the group of prof. Markos Papageorgiou; since 2016 assistant professor at Aalto University. Holder of Traffic Flow Theory courses; Traffic Management.
- Mohamed Haitam Laarabi (PhD exam in 2015, cotutoring with Ecole des Mines de Paris), now project scientist at Berkeley Lab (laboratory of the United States Department of Energy managed by the University of California, located in Berkeley). He is currently leading the development of BEAM, the framework for modeling Behavior, Energy, Autonomy, and Mobility developed at the Sustainable Energy Systems Group of the Energy Technologies Area (ETA) of the Berkeley Lab.
- Riccardo Zaccone (PhD exam in 2016), PhD in collaboration with BDC srl, funded by Polo Energia Sostenibile, now consultant for companies operating in the energy field
- Stefano Terribile (PhD exam in 2017), PhD in collaboration with Ansaldo STS, now engineer with technical responsibilities at Trenitalia. The PhD was 100% funded by Ansaldo STS, between 2014 and 2016, for an amount of 47keuro.
- Abdellatif Soussi in co-supervision with the University of Tetouan, Morocco, with PhD exam in 2020, now research fellow at the University of Genoa.

I am currently responsible for the following PhD students: Maria del Cacho, Enrico Zero, Simone Graffione, Alessandro Bozzi, Said Zahmoun

3.7.2 Agreements for co-supervision of PhDs

- 2008 -2011 (thesis co-supervisor Ahmed Ouammi), University of Tetouan, Morocco. Collaboration on wind energy generation systems: control, simulation, evaluation of the possibility of exploiting energy in the area.
- 2016-19 (cosupervisor of Abdellatif Soussi) University of Tetouan, Morocco. Collaboration on systems for monitoring and controlling risk in the transport of dangerous goods.

- Since 2002 I have been collaborating with Ecole des Mines in Paris, Risk Research Center, Sophia Antipolis, France also through projects and the co-supervision of two doctoral theses (Angela Maria Tomasoni, Hanane Dagdougui and Haitam Laarabi).

3.7.3 Agreements for PhD internships

- 2011-2012 Imperial College, London, responsible for an internship agreement during Claudio Roncoli's PhD lasting a total of one year.

3.7.4 Tutor of foreign researchers

- 18/5/2016-10/8/2016: I hosted the Russian researcher Evgeniy Zheldak of Far-Eastern Federal University, Vladivostok, Russia, for an internship of study and research on monitoring techniques. The internship was funded at DIBRIS with 3keuro to cover mentoring expenses.

3.7.5 Research grant tutor

The following research grant contracts are currently active on funds of which I am scientific responsible: Enrico Zero band 4 grants; Anita Trotta, band 2 check; Angela Mesina, band 1 check. Previously they were financed on grants of which I was scientific director: Mauro Benza, Chiara Bersani, Massimo D'Incà, Silvia De Nadai, Fabio Merlo, Francesco Parodi, Susanna Pivetti, Luca Zero.

3.7.6 Financing of fixed-term positions

- 1/12/2018 – 30/11/2021: Funding on research funds of which I am scientific director of an RTDA position, won by Chiara Bersani
- From 1/2/2020 position as a laboratory technician of band D, renewable for three years, won by Massimo D'Incà

4. Scientific research activities

From the design point of view, research in systems engineering (SoSE) has a strong applicative character and therefore allows to find interest in different research programs, as well as to interact very easily with industries and public institutions. Below are briefly mentioned the research projects of which I have been or still am scientific director during my scientific research activity. After a brief description, the funding obtained from contracts or participation in tenders for which a selective tender procedure was foreseen.

4.1 Scientific responsibility for research projects

4.1.1 Projects concerning the transport and logistics of dangerous goods

The research is based on an integrated approach to improve safety in the transport of dangerous goods, mainly by road, focusing on different aspects (risk assessment, real-time monitoring, driver training, traceability systems such as vehicle maintenance, transport optimization). As part of this research activity we have designed an original hardware prototype for monitoring the transportof dangerous goods (fig.3). This prototype consists of an On-Board Unit and various sensors related to the physical characteristics of the transported goods (eg. quantity, temperature), as well as various hardware and software interfaces with other systems such as CAN bus, and electronic warhead. The system installed on each vehicle then sends the information at "frequency" (every 3 minutes) or "event" (therefore whenever a particular event occurs such as the opening of the tailgate as detected by appropriate RFID) to a server via TCP / IP on a physical GPRS channel. This prototype defined in all its parts, both hardware and software including the syntax present in the transmission protocol has not been patented, but in addition to Eni which commissioned its design, always at the behest of Eni it was released free of charge to MIT (Ministry of Infrastructure and Transport) in order to facilitate its dissemination, therefore so that such a system could be produced by different companies as well as adopted on the territory as a reference model. Currently the system is developed by six companies on the national territory and is adopted in some regions as well as used in the national logistics platform UIRNET.

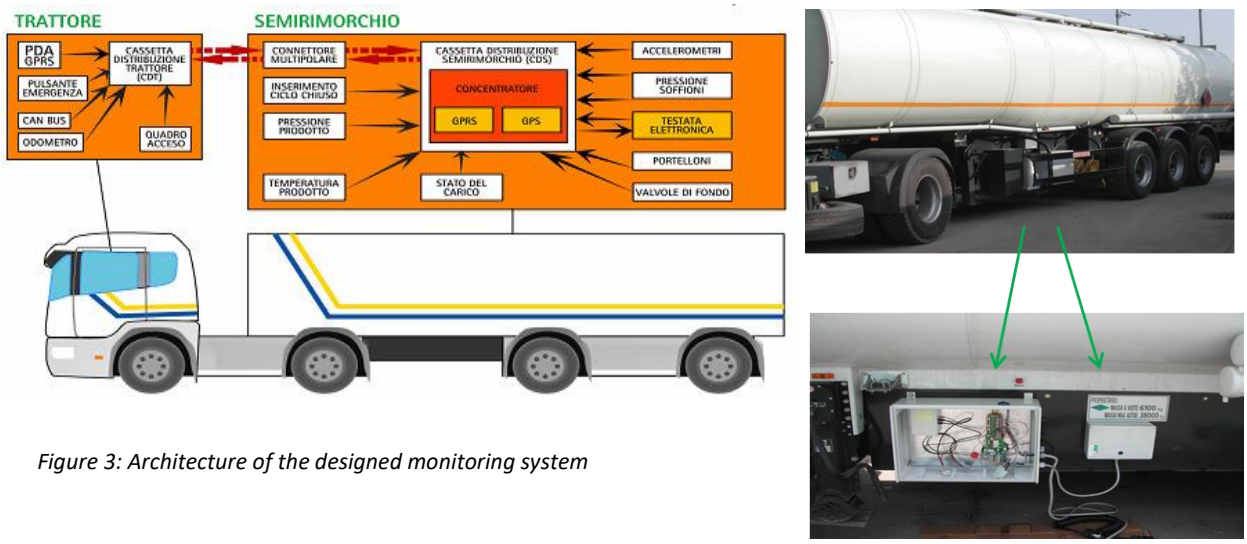


Figure 3: Architecture of the designed monitoring system

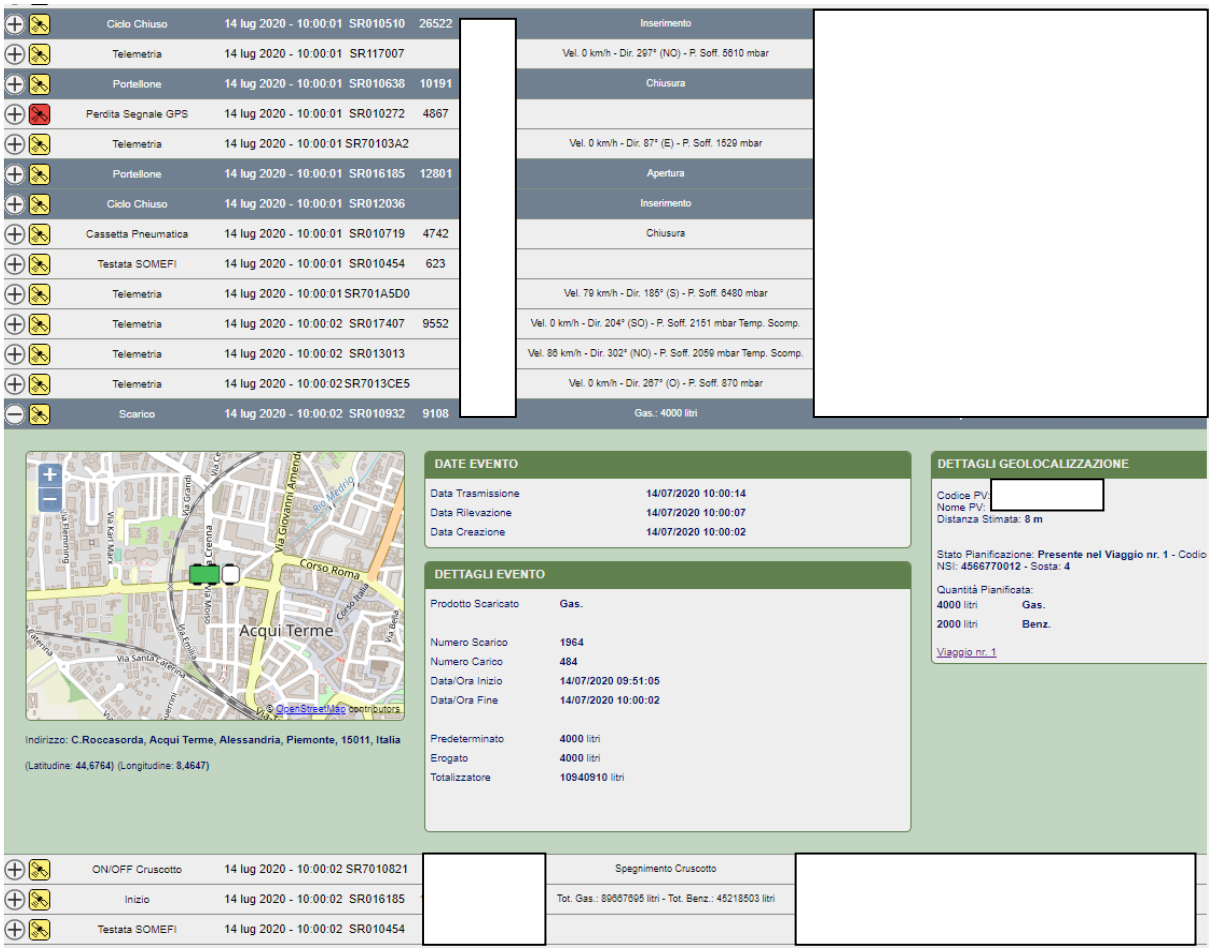


Figure 4: Web interface for data visualization. White boxes mask sensitive business data.

A centralized system (fig.4) managed by DIBRIS under my scientific responsibility then monitors the fleet in real time with relative reporting on the status of each vehicle.
The further research activities that are underway through the involvement of research fellows, scholarships, or master's degree theses are currently three.
The first concerns trip planning during the distribution of fuel at petrol stations. This activity has also been carried out for some time, and has led to collaborations with Prof. MGH Bell of Imperial College, UK (now at the University of Sydney) regarding the use of the concept of risk aversion during transport. Furthermore, with our colleagues M. Bersani, D. Giglio and M. Benza, we are inventors of an Italian and European patent owned by the University of Genoa. Several publications in international journals and invited to the congress, [21]various realization projects, the PhD thesis of prof. Bersani on inventory-routing issues, and some master's degree theses refer to this activity. More recently, we have reached a final level of technological maturity on this topic, therefore TRL9, i.e. a "real system tested in an operating environment" for the exclusive use of Eni, which creates a pull system (therefore framed in the category of vehicle routing problems, VRP) for trip planning, created through an innovative approach that allows to find suboptimal solutions and in any case shared by the operator dedicated to planning in a short time (1-2 minutes) on a set of nodes to be served varying between about 20 and 200 service stations.

[21] E.g. in addition to those cited in the twenty publications presented, C. Bersani, F. Papa, R. Sacile, M. Sallak, and S. Terribile, "Towards dynamic exposure-based schedule for hazardous material trains," *J. Rail Transp. Plan. Manag.*, vol. 6, no. 2, 2016, pp.116-127; S. Qiu, R. Sacile, M. Sallak, and W. Schon, "On the application of Valuation-Based Systems in the assessment of the probability bounds of Hazardous Material transportation accidents occurrence," *Saf. Ski.*, vol. 72, 2015, pp. 83-96. M. H. Laarabi, A. Boulmakoul, R. Sacile, and E. Garbolino, "A scalable communication middleware for real-time data collection of dangerous goods vehicle activities," *Transp. Res. Part C Emerg. Technol.*, vol. 48, 2014, pp.404-417

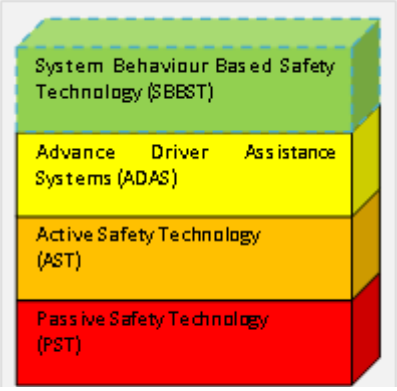


Figure 5. The proposed SBBST level of safety support

The second research activity concerns the use of innovative and non-invasive sensors to monitor the driver's driving behavior always with a view to improving safety while driving. This activity is carried out mainly in collaboration with a PhD student, Enrico Zero, as evidenced by some publications, for example[22]. Current driver support technology systems are passive (e.g. seat belts, braking) assisted), active (e.g. ABS braking), or ADAS ("Advanced driver assistance systems", such as ad ES. automatic braking in case of vehicle or obstacle in the vicinity, lane keeping). My activity is aimed at a further level that concerns the monitoring of driving behavior, called in figure 5 as System Behaviour Based Safety Technology (SBBST). SBBST uses the human component as a sensor. Some technologies associated with human component monitoring are already on the market and are generally included in the ADAS classification (e.g. detecting changes in blinking, as a fatigue detector). If in these technologies the purpose is to monitor the efficiency of the driver, in SBBST we want to analyze signals related to movement or signals such as heart or brain, of the driver (but with a view to future automatic driving also of any passenger), to associate them with danger signals. In a recent congress publication[23] we tested smart shirts and helmets (fig.6) on OKTAL driving simulator (fig.7), showing how it is possible with these devices to detect dangerous conditions and near misses. Also in this context, with other French, German and Portuguese colleagues, we are currently in the selection phase of contributions for the journal "Cognition, Technology & Work", Springer, a special Issue on the subject "Special Issue on Human and Industry 4.0".

Figure 6. The helmet equipped with 8 channels tested in the laboratory and in the field during riding sessions.

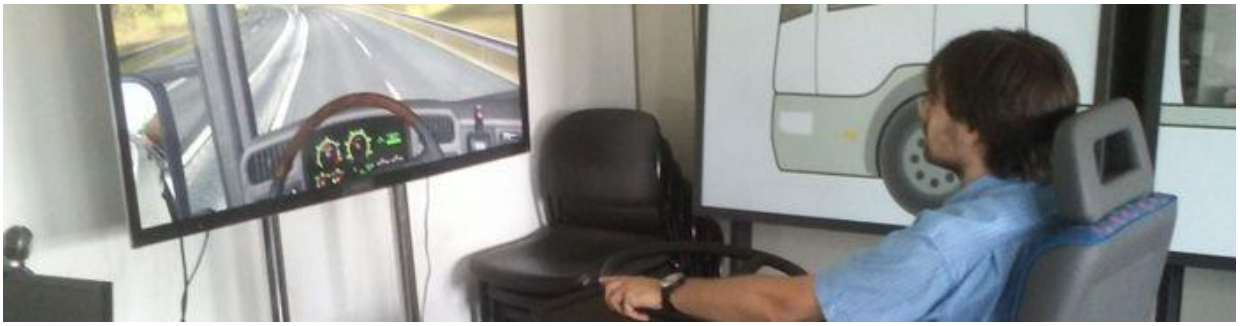


Figure 7. The OKTAL driving simulator present at the DIBRIS industrial automation laboratory and in the background on the right the interface with the monitoring prototype, which includes CAN bus simulator.

Finally, with particular reference to some master's degree theses and consequent internships and scholarships, in collaboration with UTC / Sorbonne I have recently dealt with autonomous driving of vehicles. In particular, at the joint UTC/Sorbonne – Renault laboratory called SIVALAB

[22] S. De Nadai, M. D'Incà ; F. Parodi ; M. Benza ; A. Trotta ; E. Zero ; L. Zero, and R. Sacile, "Enhancing safety of transport by road by on-line monitoring of driver emotions," in 2016 11th Systems of Systems Engineering Conference, SoSE 2016, 2016.

[23] 5. E Zero, C Bersani, L Zero, R Sacile, "Towards real-time monitoring of fear in driving sessions", IFAC-PapersOnLine 52 (19), 299-304, 2019.

(https://www.hds.utc.fr/en/partnerships/laboratoire-commun-sivalab.html), in collaboration with French colleagues and master's degree students who have chosen to proceed on the EMECIS double degree path. The research activities are of different types, among other enhancements of ADAS systems, use of obstacle detection sensors such as LIDAR, autonomous driving control of the single vehicle and vehicle platoons. The approaches to the control are then verified by master's and doctoral students either on OKTAL simulator, but in this case with a real vehicle connected (fig.8) or on Zoe car on a special circuit within the Campus at UTC/Sorbonne (fig.9). Ongoing research is also carried out under my supervision both by Stefano Masi, UTC / Sorbonne PhD student, and by some recent scholarship holders of which I am scientific director, Simone Graffione and Alessandro Bozzi in particular.

Figure 8. The OKTAL driving simulator interfaced to a Zoe vehicle placed on special pedestals and rotors that simulate its grip on the ground.

Figure 9. A Zoe vehicle autonomous driving session on the circuit within the UTC/Sorbonne Campus.

4.1.1.1 Scientific liability of research contracts

Since 2002: I have been scientific manager of several contracts between Eni and the University of Genoa, on the subject of monitoring, risk control, and optimization in transport, with specific reference to the transport of dangerous goods transport (DGT). In 2009, an agreement was signed for a joint laboratory (DELAB) between Eni and DIST of the University of Genoa, in which I am scientific director for the University of Genoa. As far as Eni is concerned, the monitoring system (tracking & tracing) seen above is installed on the entire fleet of tankers (about 700) that transport fuel to the network of Italian Eni service stations (about 4000 arranged on 20 national loading bases), and part of the Eni stations in France, Switzerland and Germany. It is also installed on "aviation" tankers that transport fuel to airports. As an indicator of the success of research activities, VET road accidents for Eni have fallen from over 120 in 2002 to less than 5 since 2011 (accidents are defined here as any road accident for which there has been damage of any kind, as described by police reports or insurance companies). The contracts resulted in DIST/DIBRIS a share of funding exceeding €4M. On this project, in addition to various research grants, 50% of an RTDA position assigned to Chiara Bersani was funded.

Other research contracts in this area are:

- 2014-2015 "Research support to LOSE project", funded by the Municipality of Genoa, DIBRIS quota 12keuro.
- 2013 "Assessment of critical infrastructures during the rail transport of dangerous goods", financed by Ansaldo STS, DIBRIS shares 10 keuro.
- 2009-2011: SCUTUM (SeCUring the EU GNSS adopTion in the dangeroUs Material transport), EU VII FP, DIBRIS subcontractor of Eni, DIBRIS share 27keuro

- 2000-2001, "Definition of a system for remote monitoring of underground tanks", funded by Water&Soil S.p.A for 30keuro

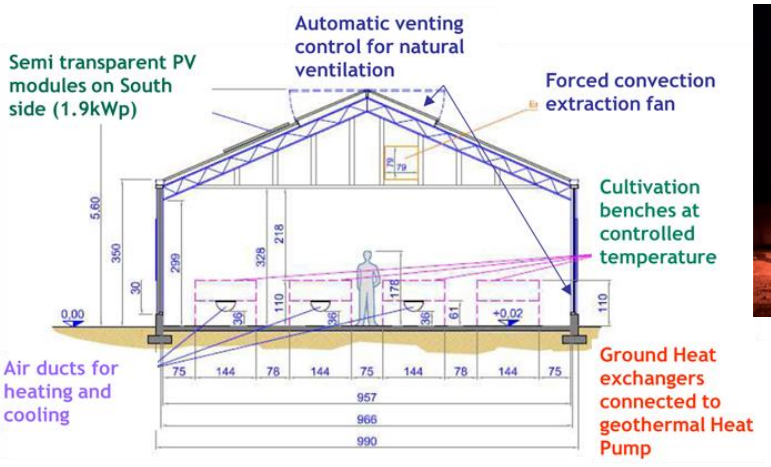
4.1.1.2 Scientific responsibility for research projects eligible for funding on the basis of competitive calls

- 2019-2021: LOSE+ project, Interreg Italy France maritime project, on monitoring the transport of dangerous goods in port and hinterland areas, DIBRIS leader, project manager. Total funding 1.8M€, of which €450k DIBRIS share. On this project was 100% funded a position as a fixed-term laboratory technician type D, won by Massimo D'Incà.
- 2019-2021: OMD project, Interreg Italy France maritime project, observatory for monitoring the transport of dangerous goods in maritime areas. Total funding 2M€, of which about 200keuro share DIBRIS. On this project 50% of an RTDA position was financed, won by Chiara Bersani
- 2013-2014 "Definition of a system for decision support for the assessment of risk from transport of dangerous goods on the Puglia region" Innovapuglia contract deriving from a competitive tender response, financing to DIBRIS 75keuro
- 2010-2012 SECTRAM, Safety in the transport of dangerous goods between Italy and France, ALCOTRA Interreg, DIBRIS quota 250keuro.
- 2008: Innovative approaches based on GIS and DSS for risk assessment in the transport of dangerous goods in pipeline, funded by ISPESL, National Institute for Safety at Work, with 25 keuro
- 2006-2008, DAGOT Dangerous goods transport, EU VIFP, financing to DIST 30keuro
- 2005-2007, TMD-NIS (ICT for the transport of dangerous goods between Italy and France), ALCOTRA Interreg, financing to DIST 150 keuro

4.1.2 Energy research projects

As evidenced by the publications, I have been interested in various problems of management and control of energy production deriving in particular from renewable energies. One of the first stimuli in this sense came from the development at that time of my main teaching and research activity at the Savona Campus, which is itself a microgrid, and from the collaboration with Moroccan colleagues. Stimulated also by some small economic realities of Savona, as well as by a beginning of collaboration with colleagues in mechanical engineering (in particular prof. M. Fossa of DIME, University of Genoa, professor of technical physics) and with CERSAA (Center for Experimentation and Agricultural Assistance, Albenga), in 2014-15 we designed and built through regional funding a high-tech greenhouse / laboratory (fig.10) on which it is possible to develop several technological and methodological approaches, including the application of automatic controls aimed at thermo-hygrometric well-being for crops. Access to this greenhouse/laboratory is regulated by an appropriate agreement between DIBRIS, DIME (Department of Mechanics) of the University of Genoa and CERSAA. I am the scientific referent of this convention for DIBRIS.

Figure 10. On the left simplified diagram of the technologies adopted; above realization of the greenhouse / laboratory at CERSAA Albenga.



4.1.2.1 Scientific liability of research contracts

To date, I have never been responsible for contracts with direct assignment by public or private institutions on these topics.

4.1.2.2 Rscientific responsibility for research projects eligible forfunding on the basis of competitive calls

- 2014-15: SMART AGRO-MANUFACTURING LABORATORY (SAM-LAB) Research laboratory for the experimentation of innovative methodologies and technologies for monitoring, control and increase of energy efficiency in agro-manufacturing processes in protected crops, funded by the Liguria Region in the PAR-FAS program with 650keuros, DIBRIS share with 100keuro. DIBRIS was the lead partner and I was in charge of the project.

4.1.3 Research projects in the field of environment and sustainable development

In the first years of activity as a researcher I worked on several environmental and sustainable development projects, also in collaboration with CIMA (International Center for Environmental Monitoring of the University of Genoa) now CIMA Foundation. This activity has given rise to several publications as well as several research activities in the field of environmental risk management and the exploitation of forest biomass for energy purposes.

4.1.3.1 Scientific liability of research contracts

- 2019: assignment from the Regional Park of the 5 Terre to DIBRIS for the monitoring of tourist flows (40keuro)
- 2018-2019: various assignments from Ligurian municipalities (Laigueglia, Alassio, Levanto, Riomaggiore) for consultancy on technological tools for monitoring and controlling tourist flows (total funding of about 8keuro)
- 2006-2008: GIS and DSS in support of Italian vulnerable areas, funded by the National Department of Civil Protection, with 130 keuro to the University of Genoa

- 2005-2007: Definition and design of a multi-agent architecture for decision support in risk management, with 150 keuro at the University of Genoa

4.1.3.2 Rscientific responsibility for research projects eligible forfunding on the basis of competitive calls

- 2017-2019 Interreg Alcotra Antea project, with expertise on technologies for tracking edible flower production (DIBRIS funding about 80keuro)
- 2002-2005: Integrated Water Management Pilot Study, funded by NATO-CCMS Committee with about 200keuro, project directed together with prof. Meire, Antwerp University Belgium
- 2002-04: EESD V F.P. project, sitar, Seafloor Imaging and Toxicity: Assessment of Risks caused by buried waste. Responsible for Decision Support System and GIS development

4.2 Editorial care of special issues and volumes

- 2020: Guest editor of the Special issue on *Human and Industry 4.0*, "Cognition, Technology & Work", Springer Journal.
- 2020: Guest editor of the Special issue on *Optimal Control of Smart Distributed Power and Energy Systems*, "Energies"
- 2013: Guest editor of the Special issue on *System of Systems Engineering in cooperative and competitive distributed decision making for complex dynamic systems*, IEEE Systems Journal
- 2011: Guest editor of the International Journal of Hydrogen Energy for the Special Issue on *Optimization Approaches to Hydrogen Logistics*
- 2010: Guest Editor of Environmental Quality Management for the Special Issue: *Mathematical Models for the Management of Sustainable Development*
- 2010: Guest Editor of IEEE Systems for the Special Issue on *Identification and Control of Sustainable Energy Systems*
- Co-Editor of 3 books, co-author of 3 books (see attachment 1).

4.3 Participation in editorial boards of journals

- since 2017, Associated Editor of Energies
- since 2016, IEEE Access Associated Editor
- 2010 to 2016, Associated Editor IEEE Systems Journal
- since 2012, Associated Editor of Journal of Control Science and Engineering
- since 2000, reviewer for several journals including: IEEE Systems Journal, IEEE Transaction Automatic Control, IEEE Transaction Control Systems Technology, IEEE in Automation Science Engineering, Risk Management, Energy, Environmental Modelling & Software, Applied Energy, International Journal of Sustainable Energy, International Journal of Hydrogen Energy.

4.4 scholarship at foreign and international universities and research institutes

- 1995-1996: Post-doc and specialization abroad for research activities at the ACACIA project (Acquisition des connaissances pour l'assistance à la conception par interaction entre agents) of INRIA (National Institute for Research in Computer Science and Automation) - Sophia Antipolis - France. Permanence of 14 months, with particular study of techniques oriented to the formalization of multi-agent systems
- May-July 2014 and June 2013: visiting professor at the "Laboratories of Excellence", MS2T "Control of Technological Systems-of-Systems", University of Compiegne, UTC-Sorbonne, France.
-

4.5 participation in national and international congresses and conventions as a guest speaker

- from 24 to 28 August 2015: invited speaker at the first summer school of Labex M2ST, UTC-Sorbonne, at St Valery sur Somme
- June 10, 2013: invited speaker at "Université de Paris I PANTHEON-SORBONNE" at the round table "L'aléa dans les transports aériens, maritimes et terrestres" for the end-of-year talks of the professional master "international transport", with presentation on "transport of dangerous goods by road"
- April 2012: invited speaker at "Models and methods for a safe transport of dangerous goods" CNRST Morocco.

- June 2011: invited speaker at "Microgrids and sustainable development" at the 20th anniversary of LERMA (Laboratoire d'études et de recherches en mathématiques appliqués), Rabat, Morocco
- April 2011: invited speaker at "Risk evaluation in pipeline transport", CTSC, Le Havre, France, International Meeting on the Risk of CO2 logistics;

4.6 participation in academies, professional or scientific societies

- since 2011 member of the IEEE
- since 1990 non-practicing member of the Order of Engineers of Genoa.

4.7 Achievement of prizes and awards for scientific activity

- 2011: Best Paper at IEEE International Systems Conference (co-author)
- 2003: The GIS product created in 2003 within the project "GIS (Geographic Information System) and DSS (Decision Support System) for the AVI (Italian Vulnerate Areas) project", received the "VI Italian ESRI Conference-Research and Applications for the Environment" award.

4.8 Results obtained in technology transfer

4.8.1 Patent development

1. Inventors: R. Sacile, D. Giglio, M. Benza, C. Bersani "System for the automatic generation of multi-product orders based on demand prediction, stock levels and optimization of delivery routes in a logistics system" 15/04/2009 Italian patent, GE2009A000021, owner of the University of Genoa.
2. Inventors: M. Benza, C. Bersani, D. Giglio, R. Sacile European patent n.2242011, 2010, applicant: Università degli Studi di Genova, "Method for managing the distribution of products or goods".

4.8.2 Spin-off company

1. Founding member of Logness srl, based in Savona, founded in 2010, with funding of € 30k deriving from the competitive assignment of the UNITI project (Filse project in collaboration with UNIGE for regional entrepreneurial development), and currently in agreement with DIBRIS and UNIGE as a university spin-off. Since 2016 it has sold its shares to young researchers, leaving the company completely.

4.9 consultancy activities at high-culture institutions, universities, academies and research institutions, public and private, highly qualified at national and international level;

- 2018: reviewer of Horizon 2020 projects in Bio-based Industries Joint Undertaking
- 2016-2019: MIUR evaluator of the European project COACHES European Project Cooperative Autonomous Robots in Complex and Humans Environments, (University of Caen Basse-Normandie (UNICAEN) France, Sapienza University of Rome - Lab RoCoCo, Italy; Vrije Universiteit Brussel, Belgium, Sabanci Universitesi
- 2012-2013: reviewer of the project VIIFP ICT-2011.3.3 New paradigms for embedded systems, monitoring and control towards complex systems engineering, IP, DANSE "Designing for Adaptability and evolutioN in System of systems Engineering"
- 2011: Reviewer for European Union, VIIFP, 6.2 ICT for energy efficiency
- Since 2010: Reviewer for several national programs: France, Sweden, Cyprus, Russia, Piedmont region.
- 2009: member of the list of scientific experts on "risk assessment" (2009/146/EC)
- 2006-2011, member of the international scientific panel "NATO Science for Peace: environmental security panel"
- 2004-2006 member of the scientific panel INTAS (The International Association for the Promotion of Co-operation with Scientists from the New Independent States of the Former Soviet Union) for the evaluation of research projects.
- 2004 and 2008: Member of the Selection Board for the evaluation of exams "Habilitation a diriger des recherches" (HDR) at the University of Nice (France).
- 2001: member of the evaluation jury as external evaluator of five PhD theses at the Ecole des Mines de Paris.

- 2018: Contract of employment with tenure with effect from 1/9/2018 as "professor in systems engineering" at Systems Engineering Department at King Fahd University of Petroleum and Minerals (QS Global World Ranking 189, public university), with immediate resignation.

4.10 organization of national and international congresses and conventions as president of the . local organizing committee or member of the scientific committee;

- 2018: member of the IEEE SOSE2018 Conference (System of Systems Engineering) technical committee
- 2014: Member of the IEEE SoSE2014 organizing committee
- 2013: Member of the IEEE Systems Conference Technical Committee
- 2013: member of the IEEE SOSE2013 Conference Technical Committee
- **2012: Chairman (organizer) of the international congress IEEE SOSE2012 (www.sose2012.eu), Genoa, July 2012**.
- 2010: Organizer of the workshop "Renewable Energy and Sustainable Development: new opportunities for cooperation between Italy and Africa", Genoa, Italy
- 2007: Organizer of the NATO workshop "Advanced technologies and methodologies for risk management in the global transport of dangerous goods" funded by NATO, Science for Peace Advanced Workshop Programme, with 30keuro.
- 2004: Organizer of the workshop "Sustainable development and risk management in integrated logistics and transport" in Brussels, in collaboration with the Office of the Scientific Attaché at the Italian Embassy in Brussels, and Eni HSE Dept.
- 2004: organizer of the 2nd Workshop of the Integrated Water Management Pilot Study, NATO-CCMS Committee on the Challenges of Modern Society, Genoa, 28-30 January 2004. I was co-director of this project together with prof. P. Meire of the University of Antwerp (Belgium).
- October 2010: "Energy systems and sustainable development", CNRST Morocco;
- July 2010: "Models and methods for the transport of dangerous goods", NATO ATI, Paris.

4.11 academic-institutional activities of responsibility or service

- from 2006 to 2016, coordinator of the PhD course Monitoring of **Systems and Management of Environmental Risks**, at the University of Genoa, with about 7 PhD positions per academic year, of which two funded by the University, two funded by the Interuniversity Center for Environmental Monitoring, now CIMA Foundation, and 3 without scholarship or otherwise funded.
- Since 2018 member of the steering committee of the degree course in computer engineering
- Since 2015 **responsible for the internationalization** of the degree course in computer engineering
- Since 2015, member of the DIBRIS board
- 2007-2009, Member of the DIST Department Board
- 20052010: Member of the Steering Committee for Degree Courses in Environmental Engineering
- 2000-2004: representative of international activities (in particular Erasmus) for the degree course in environmental engineering
- 2003-2006: member of the board of the Interuniversity Centre for Environmental Monitoring (CIMA)
- 2001, 2002, 2003, 2013 Member of the Commission for the qualification to the profession of engineer

4.12 Agreements with research institutions

I formalized and I was the referent of the following agreements for research and training:
- UTC/Sorbonne, Compiègne, France (contact prof. P. Bonnifait)
- Mines ParisTech, Sophia Antipolis (contact: prof. Franck Guarnieri),
- CNRST, Morocco (contact: prof. Driss Zeijli),
- San Antonio Texas University, US (contact: prof. Mo Jamshidi)