An Open Innovation Model: Six Projects in the Maritime Field

by Emilio Fortunato Campana (DIITET-CNR) and Erina Ferro (ISTI-CNR)

One of the largest shipbuilders in the world, Fincantieri (FC), together with Italy's largest research institution, the National Research Council (CNR), successfully applied an open innovation model (OIM) to six projects in the maritime sector. The external knowledge of the CNR provided fuel to Fincantieri's business model, enabling research and development to be converted into commercial value.

An open innovation model (OIM) is a paradigm under which companies develop competency networks that link suppliers, universities, and research centres to cooperate in solving complex problems. The shipbuilding company Fincantieri (FC) together with researchers from Italy's National Research Council (CNR) have adopted a "coupled innovation process", a variant of the OIM [1], simultaneously applying it to six different projects. Each project addresses a different technological issue within the maritime sector.

The CNR coordinated the six projects outlined below, acting as an innovation "hub". CNR was the interface between the public research system and industry, thus being responsible for selecting the skills, collecting the results and, with the support of FC, collating summaries of results into an overall road-map. The work involved nine institutes of the CNR-DIITET department (Department of Engineering, ICT and Technologies for Energy and Transportation), one institute of the CNR-DSCTM department (Department of Chemical Science and Materials Technologies) and three universities (Genoa, Trieste and Rome-La Sapienza).

E-Cabin (Figure 1) created a set of advanced technological solutions for cruise ship cabins to improve the onboard experience of passengers. The solutions are personalised and include: (i) A cabin monitoring system comprising a set of heterogeneous sensors operating inside the cabin. The sensors evaluate energy consumption, schedule cabin maintenance, measure environmental variables, and automatically actuate solutions appropriate for the specific passenger in that cabin; (ii) A set of applications that learn an individual passenger's habits. These applications predict the individual's needs, maximising each passenger's opportunities to socialise by sharing information through mobile social networking applications. Augmented reality contents relevant to the cruise also help passengers to participate in the "ship world"; (iii) A set of applications based on augmented reality to facilitate passengers' movements within the ship.

A study on the comfort perceived by the passenger, when multiple disturbing factors act simultaneously, is also included. We also developed an energy harvesting solution to power sensors. A dashboard is provided to the ship's technical staff to visualise the status of each cabin and receive information about all the monitored parameters.

PiTER on Board (Technological Platform for High-Efficiency Waste-to-Energy Thermo-Conversion on board) focused on evaluating and developing poly-generation systems for onboard energy production and storage. This system derives its primary energy supply for a bottoming thermodynamic cycle from residual biomass and/or engine waste heat produced during the ship's normal operation. The organic fractions of food waste, waste vegetable oils, and wastewater (sludge) are taken into consideration to produce biogas, syngas, and liquid fuels to use on board. Energy management strategies and CO_2 capture are considered, to achieve optimal integration of each component into the onboard energy grid. Different energy conversion systems and schemes have been evaluated to identify the most suitable for the complete waste-to-energy system. The aim was to optimise the performance of the system in terms of fuel flexibility, global efficiency, low environmental impact, and suitability for waste heat recovery and CO_2 capture.

High-efficiency Vessel is designing and conducting experiments on an advanced energy system to increase the overall energy efficiency of ships by recovering waste heat from the ship's propulsion system. The potential of combining organic rankine cycle (ORC), Stirling engines and latent thermal energy storage systems have been assessed, and a lab-scale prototype of the energy recovery system has been constructed. The propulsion system of the ship was simulated with a small diesel engine. Other core components are a thermal storage tank prototype with embedded phase change materials, a commercial ORC system and a Stirling engine, optimised for the specific application. The exhaust line of the diesel engine was endowed with a proper design gas-to-gas heat exchanger to provide thermal energy to the Stirling engine. Moreover, the cooling system of the diesel engine was modified to send the hot water from the engine alternately to the ORC or to the thermal storage, to maximise heat recovery. An advanced control tool was developed to manage and optimise the

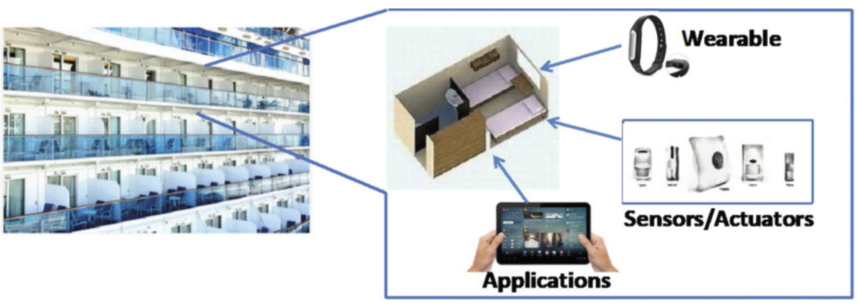

Figure 1: The E-Cabin system.

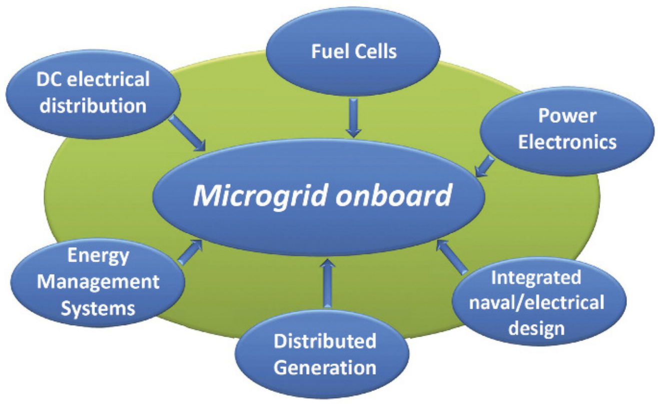

Figure 2: The main outcomes of the GEI project.

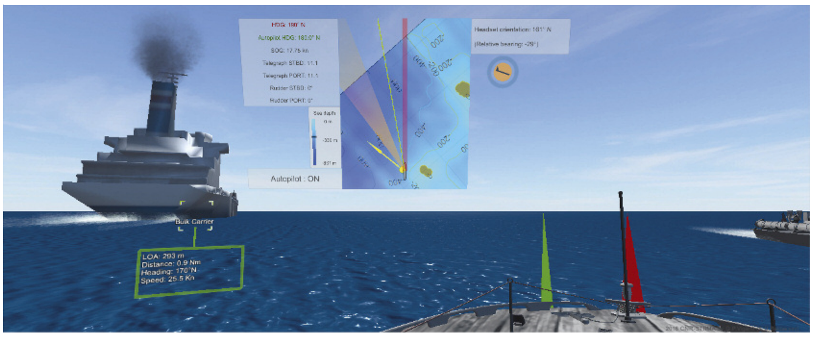

Figure 3: The E-Navigation project.

energy flows as a function of user demand.

GEI (Innovative Electric Generation) (Figure 2) aimed to develop new technologies to improve the efficiency and sustainability of the ship's electrical power plant, considering different aspects including: electrical generation, power distribution and energy management. How to maximise the payload and increase the system safety and reliability were also investigated. Five main outcomes were: (i) The design of new direct current (DC) and hybrid medium voltage alternating current (MVAC)/medium voltage DC (MVDC) electrical architectures; (ii) The design of a new electrical generation system based on fuel cells; (iii) The definition of a new paradigm of distributed generation on board; (iv) The development of new energy management techniques to optimise the use of electrical power on board; and (v) The development of new, reliable, efficient, and compact power electronic converters.

E-Navigation (Figure 3) developed a virtual dashboard for using digital information to support navigation, as well as some features of the propulsion control and navigation. These features increase the number of operations that the ship can perform without the direct intervention of a ship operator. The augmented reality system allowed the digital overlapping of information over the perceived reality. The displayed information comprised routes, speed, possible obstacles on the route and their characteristics, captions of naval vehicles near the target ship, and information on control commands of the propulsion. The augmented information is used via smartphones, tablets, smart glasses or binoculars.

Secure Platform had two main objectives: (i) To develop an advanced security system to protect passengers and personnel in both routine situations and emergencies. This was achieved with computer vision techniques based on cameras (visible and thermal) for people and goods tracking. We also used multisensory biometric recognition techniques (fingerprint, vocal imprint, face recognition) to restrict access to certain areas on the ship. In addition, radar technologies were used to detect, localise and track people within a closed environment; (ii) To realise a completely novel system for search and assistance of a passenger overboard. This system was based on: a) air drones to raise the alarm and to initialise the search if a passenger falls overboard. If the individual is uncooperative, one or more drones can be automatically launched to locate the person and activate the recovery operation; b) autonomous marine unmanned robotic vehicles, integrated with the man overboard recognition and tracking subsystem, for the rescue of the person.

All these projects started in January 2017 and ended in January 2019. During the collaboration between FC and CNR, new services were developed in each of the six projects, confirming the importance of interdisciplinary collaboration for the successful development of new innovative services. Innovation in services increases the quality, contributes the skills of new services, answers to the requests, creates new services, and can increase the competitive advantage because it contains the knowledge of customers and employees. It also implements new markets for services and it promotes competitive differentiation between competitors. The model used is a perfect example of harmonious balance between the inbound and outbound open innovation process. The ideas from outside (CNR and universities) were conveyed inside Fincantieri and combined with their internal ideas to generate innovative outcomes, for the benefit of both Fincantieri and the research units. Moreover, all resources necessary to successfully complete the program of the six projects were available, as, in total, there were over sixty researchers involved, thus guaranteeing the alignment between the necessary resources and the program to carry on. The model applied was so successful that Fincantieri is replicating it in another innovation project devoted to develop technologies that can prove to be disruptive for the maritime industry.

Reference:

[1] E. F. Campana, et al.: "CNR–Fincantieri Joint Projects: A Successful Example of Collaboration between Research and Industry Based on the Open Innovation Approach", Journal of Open Innovation: Technology, Market, and Complexit, vol. 6, issue 1, 2020.

Please contact:

Erina Ferro
ISTI-CNR, Italy
erina.ferro@isti.cnr.it