OUTLINE OF SELECTED RTD PROJECTS

In the past 30 years, as a spin-off from the work done formerly in the Joint Research Centre (JRC) for the international cooperation programmes on Thermonuclear Fusion (NET, ITER and SEAFP), a considerable number of collaborative / competitive projects have been won and carried-out. They concern a wide range of **novel systems / technologies** in the fields of mechanical and systems engineering, mostly for **remote inspection, monitoring and intervention**.

The activities in question range from the realisation of a revolutionary system for inspecting large maritime tankers and cargo vessels to the concept and realisation of an innovative system for locating people trapped in ruins following an earthquake or other similar catastrophic events.

Within these activities, we forged strong links with an important number of partners (academia, national research centres & industry) from all-over Europe. These partners have recognised our scientific and technical expertise, our innovative thinking as well as our capacity to fulfil our role in the project, either as overall technical coordinator or in assessing the requirements and validating the results in a professional and independent way.

From our side, performing RTD in such a highly competitive environment has kept us at the forefront of the technological development and enabled us to perform in “excellence” our Institutional activities, which focus on the scientific support to the Commission and other EU Institutions throughout the policy cycle.

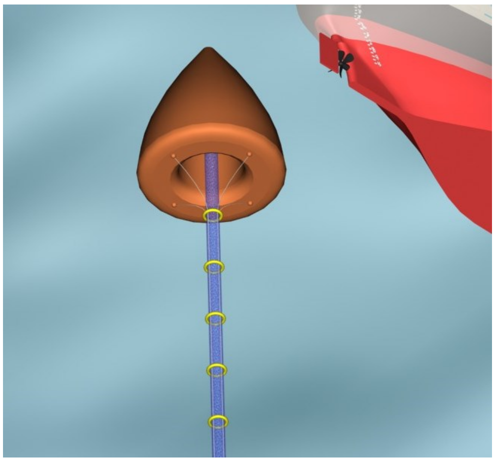
In the pages that follow are summaries of some selected collaborative projects that were either conceived and set-up by us or in which we had an important role.

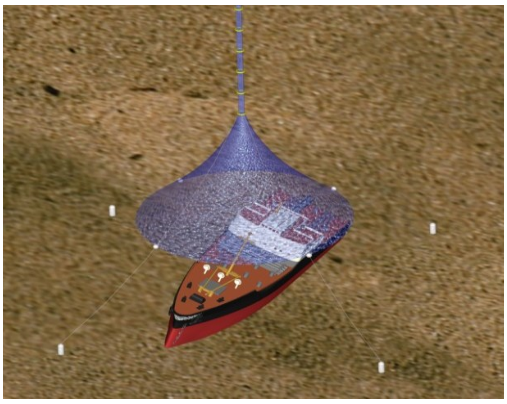
Double Inverted Funnel for Intervention on Ship-wrecks (DIFIS)

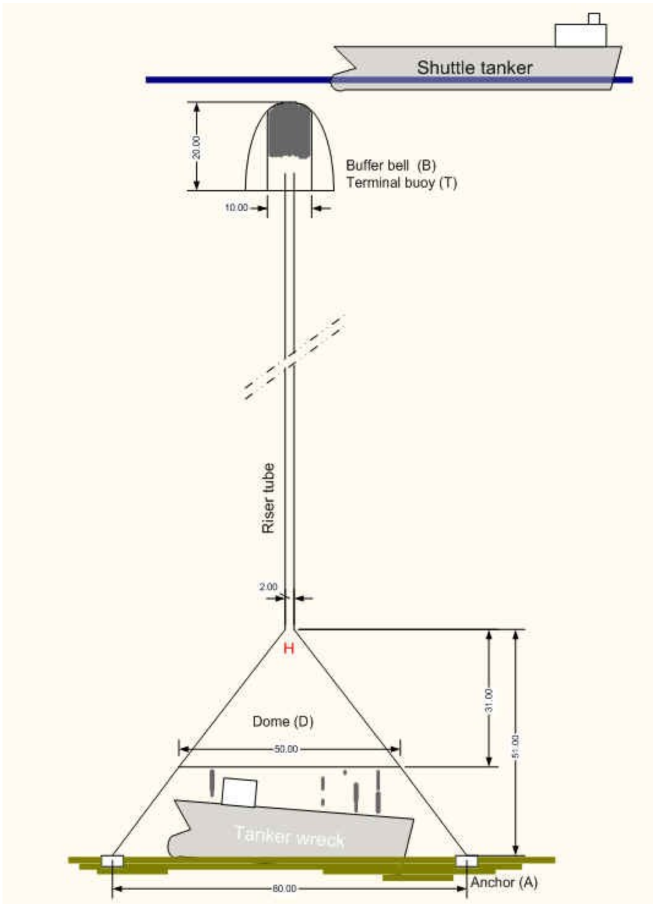
Maritime disasters leading to major environmental pollution happen almost regularly every 2-3 years: AMOCO-GADIZ in 1978, TANIO in 1980, AEGEAN SEA in 1992, ERIKA in 1999 and, on November 2002, the tanker PRESTIGE that sunk off Cape Finisterre with more than 80% of its 77,000 t heavy fuel cargo leaking to the sea, despite a costly and lengthy intervention. These accidents, namely the 2 last ones, triggered several measures, including some European RTD projects, aiming at the prevention of similar maritime catastrophes.

Our DIFIS system, protected with a European patent, aims in channelling the leaking oil into an appropriate buffer reservoir / separator, close (10-50 m) to the sea surface, from where the oil would be loaded through standard equipment. This is achieved by means of a light, quickly deployable flexible structure that should stay in place until all the tanks of the wreck are emptied and the pollution threat eliminated.

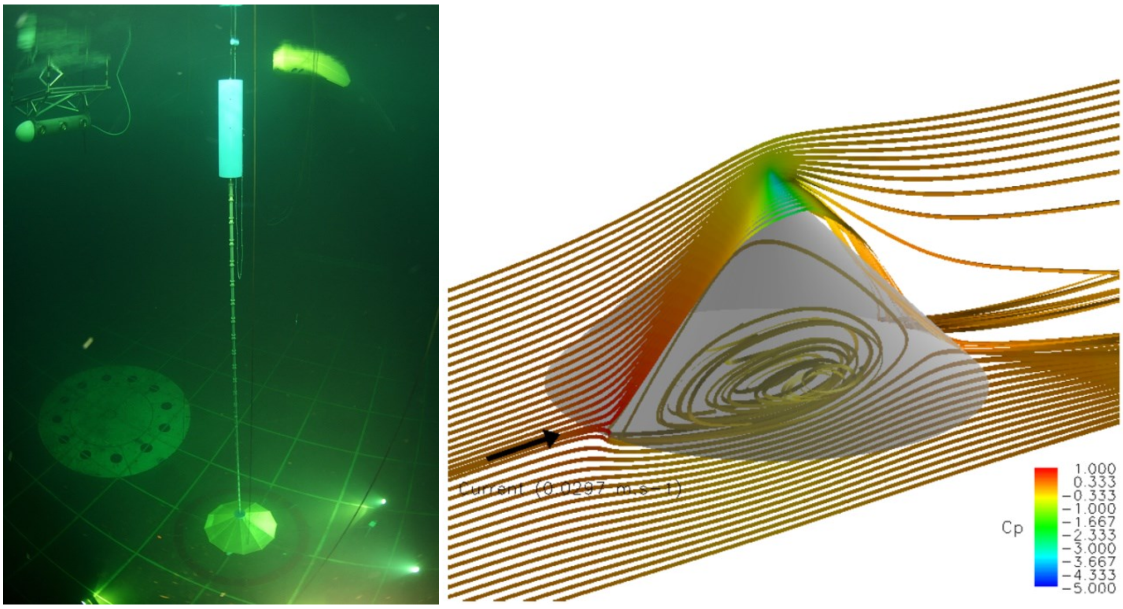
DIFIS can become the reference for a prompt and cost effective intervention in case of similar catastrophes but also for deep sea offshore accidents, like that of Deepwater Horizon in the Gulf of Mexico. It is applicable in very wide range of conditions as long the pollutant does not dissolve quickly and is of lower specific density than seawater.



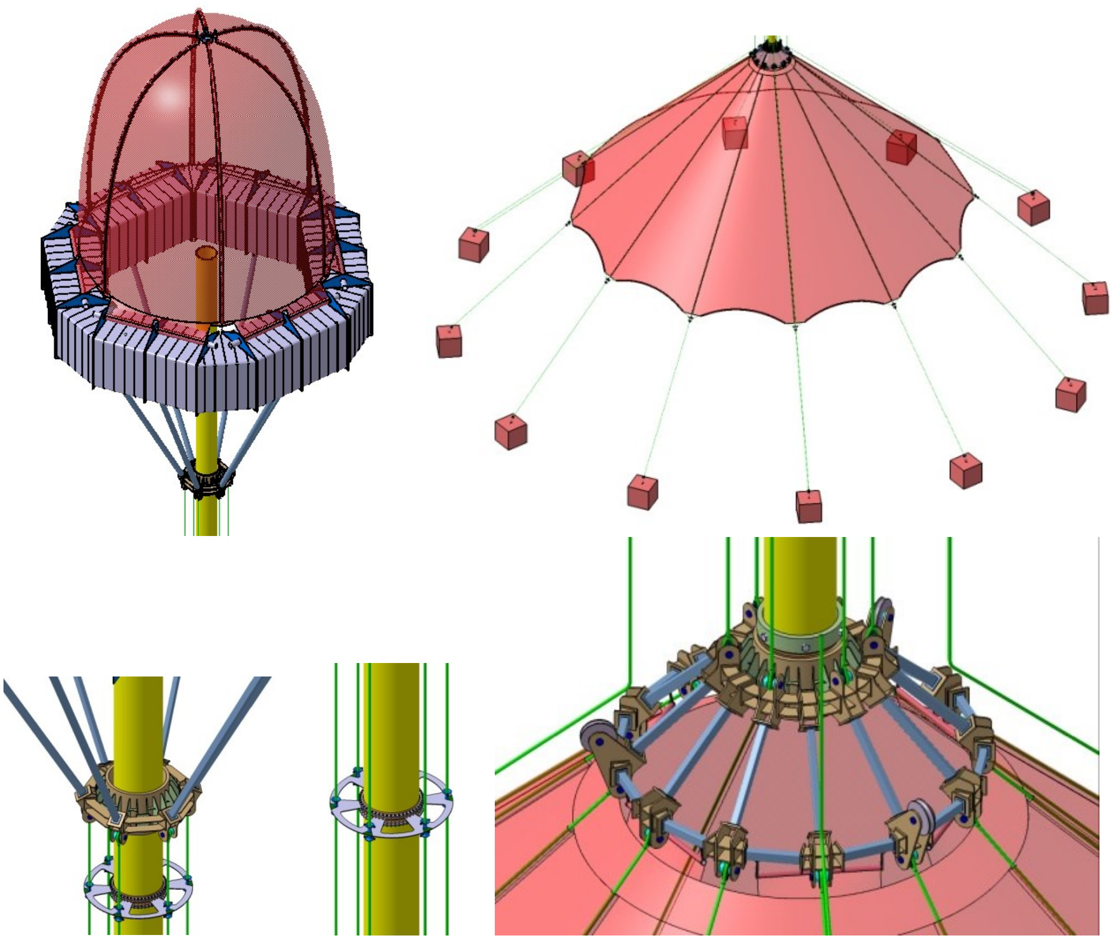




DIFIS was validated and further refined during a 3.5 M€ project with the participation of industry (CYBERNETIX, SENER, CONSULTRANS) and prominent research institutes (IFREMER, CEA, SIREHNA, ISI) from France, Spain and Greece, coordinated by the Dutch institute MARIN. During 3.5 years, the DIFIS consortium performed extended calculations, simulations (internal and external flows at the dome and the riser tube) as well as two 1:60 scale tests that proved the technical feasibility of the concept and defined the operating parameters. The initial concept was refined and its components were optimized and designed in detail. The detailed deployment procedures, both at surface and underwater, were elaborated (including extensive 3D simulation) and the necessary deployment means (vessels, cranes, winches, side derricks etc.) were defined. Finally, the fabrication, deployment and operational costs were evaluated for 3 reference scenarios (shallow, intermediate and deep water).



Experimental set-up for basin hydrodynamic tests and simulations



Engineering design details of DIFIS

The applicability of DIFIS to deep offshore drilling / exploitation accidents had been considered quite early in the development phase of the project. However, it was not until the Deepwater Horizon accident off the cost of Louisiana (US) on April 2010 that the use of DIFIS system for dealing with uncontrolled well blow-outs was studied.

All data suggests that DIFIS could cope with the accident in an effective and economical way, especially if some of its components (riser tube and buffer bell components) are prefabricated so as to be transported and assembled on site. More in particular:

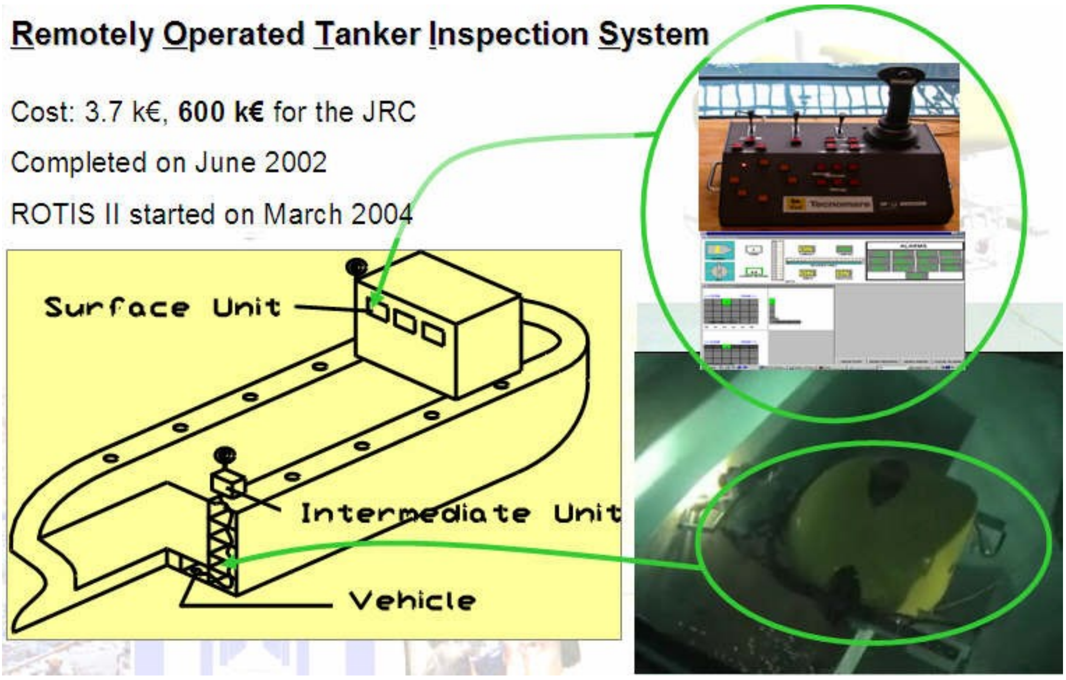
- The solid anchoring and a very wide riser tube of DIFIS, designed to handle *PRESTIGE grade* heavy oil, could handle comfortably much larger flows of the Gulf of Mexico light oil.
- There is a considerable discrepancy (factor 10) as to the oil flow rate in Deepwater Horizon spill. DIFIS could handle even the most pessimistic estimates of 75,000 barrels daily, provided a large enough buffer bell with a high capacity shuttle tanker transfer system is implemented.
- The presence of significant quantities of natural gas would necessitate some additional gas relief valves at the top of the buffer bell, where the gas would accumulate, allowing its separation and eventual collection (or release).
- The methane hydrate issue would not pose any problems in DIFIS because the dome is lowered and deployed together with the riser tube so that water/gas/oil mix can flow upwards right away through the large riser, much less prone to clogging than standard drilling risers. Moreover, the large diameter of the riser tube provides substantial thermal inertia to account for the cooling of the depressurizing gas.

The effect of the gas flowing upwards in the riser tube has been studied in successive simulation 2 and 3 phase flow simulations using commercial and custom made codes. Results indicated that the DIFIS dome, anchored to the sea-bed (suction anchors or big dead-weight blocks) so as to withstand several thousand tons of buoyancy forces, combined with the 77 mm thick riser tube walls, can resist without any problem the dynamic forces generated by the expanding gas. Upon reaching the buffer-bell / separator, the gas accumulates at the top and is collected or evacuated to the atmoshere through a standard gas relief valve.

Remotely Operated Tanker Inspection System (ROTIS and ROTIS II)

The ROTIS and ROTIS II projects have both dealt with the design, development and testing of a **novel remote inspection system**. This system is based on a small ROV (Remotely Operated Vehicle) capable of navigating inside the ballast tanks of tankers and other cargo vessels, through the standard man-holes and openings to perform the close visual inspection and thickness gauging required by the classification societies during the periodic maritime vessel inspections. ROTIS has been running for 4 years (concluded on June 2002) under the BRITE-EURAM / GROWTH scheme (BRPR-CT-97-0500). On the wake of ERIKA and PRESTIGE accident, European Commission, recognising the great potential of the system, has approved, (FP6 Sustainable Surface Transport), the ROTIS II project.

We have had a fundamental role in mounting both projects and aggregating the consortia. JRC has been responsible for the requirements, the system specifications, the preliminary tests and the system calibration in a specifically designed mock-up inside a test-pool, constructed under the RIALTO heavy robotic facility. The overall cost of both projects was 7.2 M€, from which 1.2 M€ was for JRC.



The ROTIS concept

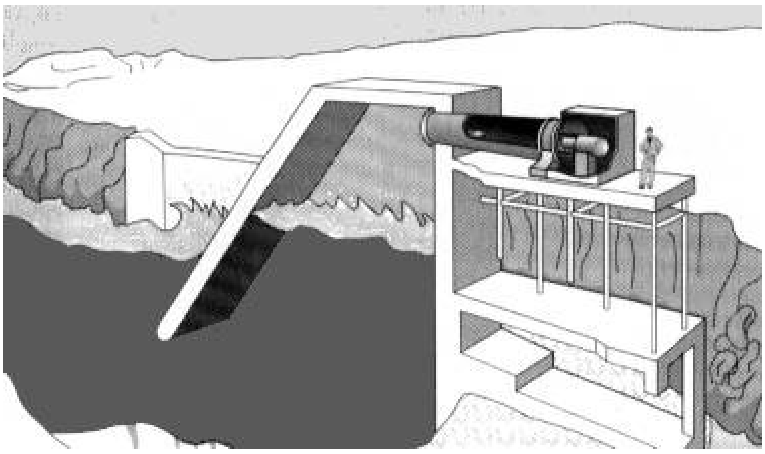
Pictures from the calibration and testing of the ROTIS system at JRC facilities

Performance Improvement of Oscillating Water Column power plants (PIOWC)

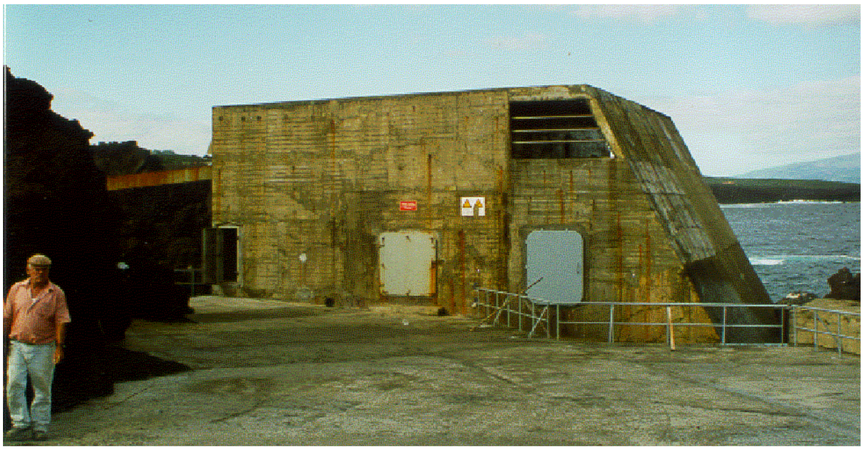
An Oscillating Water Column (OWC) power plant produces electricity from the wave energy. It consists of a chamber, constructed in coastlines where the sea is quite rough. The incoming waves result in an oscillating free surface of the water inside the chamber causing, via a piston effect, an oscillating pressure of the air on the upper part of the chamber. A Wells turbine (i.e. with symmetric blades assuring a rotational direction independent from the air flow direction), on the top part of the chamber, coupled to a generator, converts the resulting air flux into electric energy.

A pilot OWC plant has been designed and constructed, in the frame of two EC supported JOULE projects, in the Pico island of Azores, equipped with such a Wells turbine. The PIOWC project proposes the substitution of the 'conventional' Wells turbine by an innovative variable angle, actively controlled blade turbine. Measurements, done on the existing plant, as well as computer simulations have indicated a significant potential for improvement in the plant efficiency through a sophisticated real-time blade-angle control.

The project has been financed by the EC under the JOULE scheme.



Schematic design of a OWC power plant



The OWC power plant at the Pico island, Azores, Portugal as in October 1999.

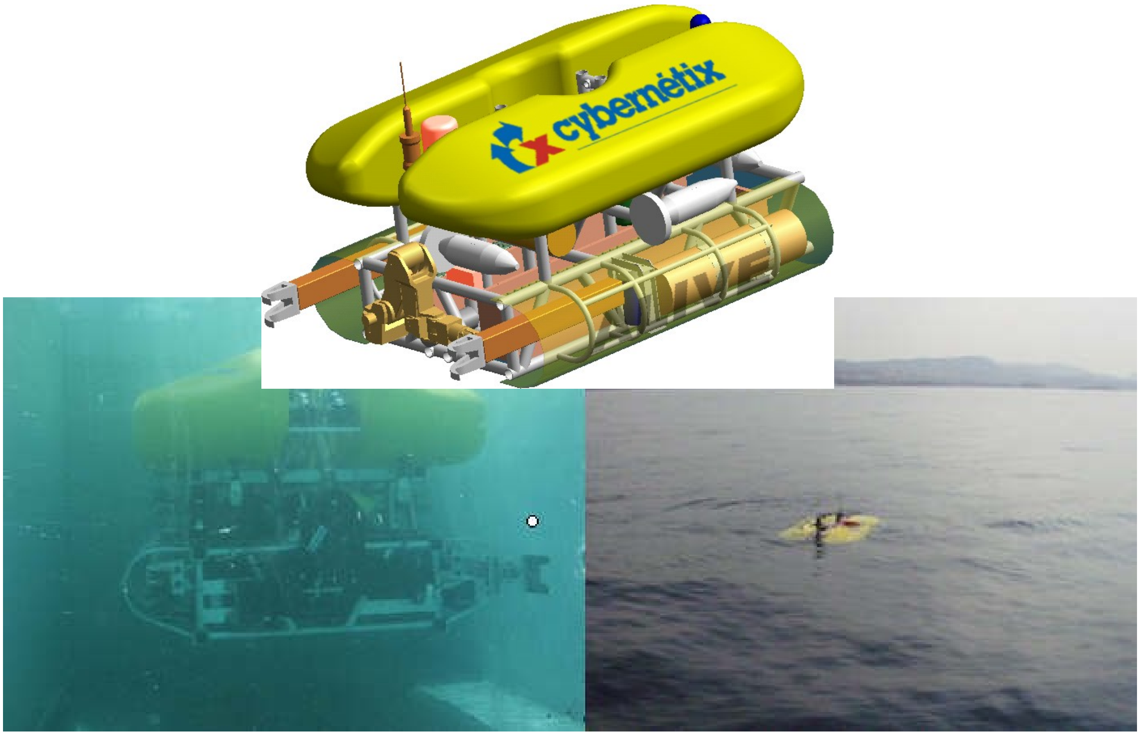
Autonomous Light Intervention Vehicle (ALIVe) & FREESUB TMR

The ALIVE (Autonomous Light Intervention Vehicle) project dealt with the design, development and testing of a new generation of AUV (Autonomous Under-water Vehicle), called «intervention AUV», with dynamic positioning, auto-heading (sonar and video based), auto-docking and tele-manipulation capabilities. It would have no physical link with the surface and could be supported only by a light and fast support ship. Such an AUV would be capable of performing quickly and efficiently tasks like routine inspection, light maintenance, sampling or object collection. The ALIVe project has been financed by the GROWTH programme of the European Commission.

As opposed to ROVs or divers, ALIVe could be mobilised extremely rapidly, by helicopter if needed, to carry out emergency inspection on a catastrophe site (sunk tanker, chemical weapons disposal, radio-active elements loss, accidental pollution, etc.). On an accident like the sunken tanker ERIKA, on December 99, a vehicle like ALIVe could have been on site in few hours and ready to operate immediately, being insensitive to the sea surface meteorological conditions. Instead, it took several weeks to start getting some valuable information about the wreck configuration and eventual residual spilling.

The overall budget of ALIVE was about 3.2 M€ from which 350 k€ were allocated to JRC, which focused on the design of the tele-manipulation and the docking system.

The FREESUB and FREESUB.NET TMR projects were associated with the ALIVe project, providing funding for 3 young researchers to work in JRC, in the frame of their PhD, in the design and trials of the ALIVe tele-manipulators.



Automation & Integration of Processes in Shipbuilding (AIPS)

EU shipbuilding and other related industries, in order to stay competitive, faced an urgent need for profound changes with ultimate goals:

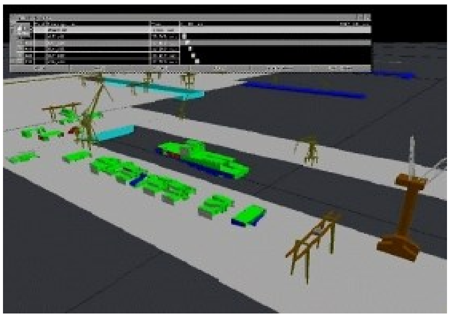
- The drastic reduction of the costs and lead times, imposed by the over-capacity in production and the consequent fierce international competition.
- The achievement of a sustainable shipbuilding process, integral part of sustainable shipping, ensuring the highest possible quality standards necessary for a safe and environmentally friendly navigation.

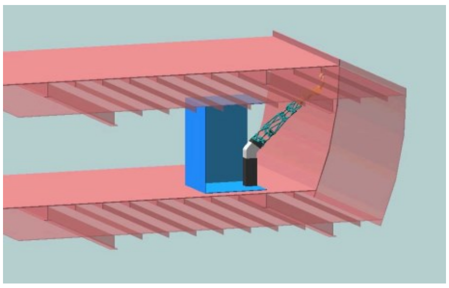
The enlargement of the Union with new member states, some of which have a considerable shipbuilding industry, was an additional factor to be considered.

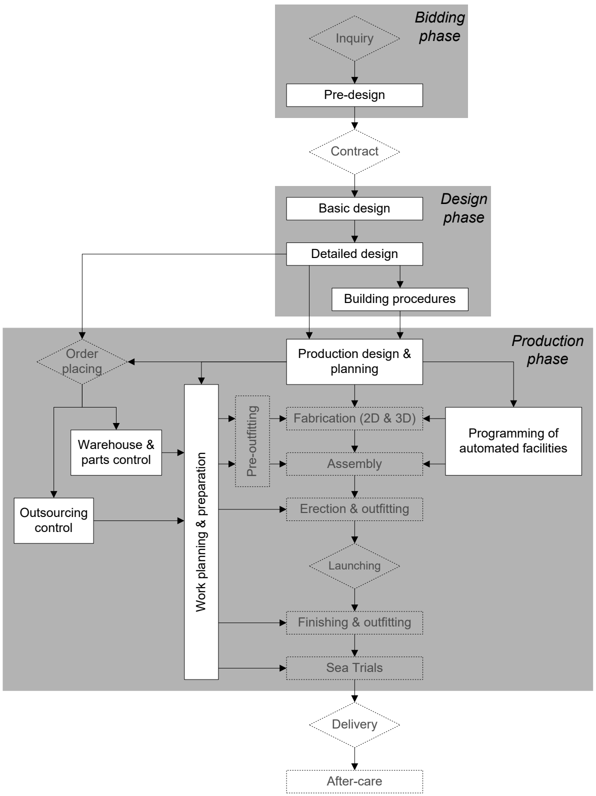
We have undertaken a study on “the Automation and Integration of Production Processes in Shipbuilding” (AIPS), with a budget of 150 k€, financed at 100% by DG Enterprise. It lasted from January 1999 till June 2000 and tackled the production technology, organisation and planning issues for the achievement of the aforementioned goals.

Two important issues were identified as bottlenecks for the shipbuilding processes in passing from the labour intensive shipyards of today to the technology intensive ship-making virtual enterprises of tomorrow:

- The integration of the production processes, including design and logistics, through CAD tools and
- The introduction of sensor integrated robotic tools performing large classes of similar, low level tasks autonomously.





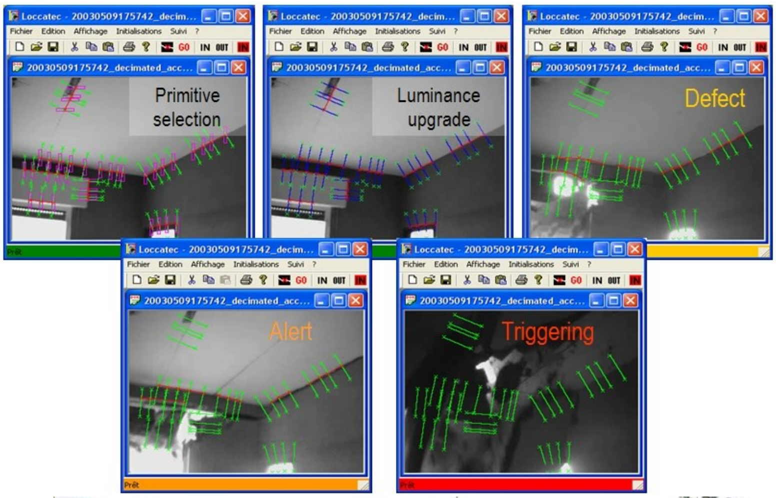


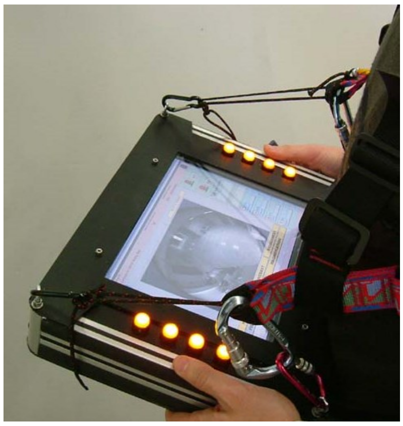
Low Cost Catastrophic Event Capturing (LOCCATEC)

The prime objective of the LOCCATEC project was the design and realisation of a system, which would **enhance significantly the effectiveness of the rescue management and operations by providing a tool to perform a quick survey of the disaster site to detect and locate trapped people and plan the subsequent rescue operations in the quickest and most effective way**.

The system was based on small, autonomous devices that can detect when a room is about to collapse so as to record the situation starting some minutes before till just after their triggering. Each device records the presence (or not) of persons in each room immediately before the collapse and remains buried in the ruins. The rescue team, equipped with a central unit, upon arriving at the vicinity of the collapsed building, transmits a signal, triggering the wireless download of the information stored in each capturing device (including information like identification keys, floor plans, location etc.).

We have had a key role both in conceiving the LOCATEC system, in writing the proposal and setting-up the consortium. We have been the **technical coordinator** of the project.





Autonomous Surveillance in Public Transport Infrastructure Systems (ASPIS)

ASPIS aimed at the development of a prototype surveillance system based on autonomous, smart monitoring devices that capture data only upon the occurrence of an incident, potentially dangerous for the passengers (like an explosion blast or the triggering of the fire detector). When triggered, these devices propagate the triggering to their neighbouring devices and send an alarm. Successively, they upload the captured data to the central station providing a wide (space and time-wise) coverage of the potentially hazardous incident.

This innovative system was meant for the **unattended surveillance of public transport means** and infrastructure as well as other public spaces. It would serve primarily for the prompt and reliable situation awareness during the early, most critical emergency phase, thus greatly facilitating the overall crisis response. A blast / fire triggered system was selected as pilot implementation and proved the validity of the concept in two very different surface transport applications: a **metro network** and a large **maritime vessel**.

ASPIS promised to overcome the drawbacks of classical, centralized surveillance by offering a prompt and wide coverage, space and time-wise, on events potentially hazardous to public safety in a cost-effective way without being excessively intrusive to the individual activities. In fact, it constitutes a **very good compromise between the need for surveillance and the respect of privacy and civil liberties of the citizens**.

ASPIS was a spinoff from our LOCCATEC project, conceived following the London bombing events. We formed the consortium and wrote the proposal, which has been accepted for financing under the FP7-SST- 2007- RTD-1 call on Improving Safety & Security of surface transport. The consortium was led by THALES Security Systems and included important end-users like RATP and ANEK shipping lines. We were the technical manager of the project, with 965 k€ allocated to JRC out of the 4 M€ of total ASPIS budget. The project started on June 2008 and concluded successfully on March 2012 with two demonstrations: one at the line 14 of the Paris metro and another onboard of an ANEK ferry vessel.

European Commission
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THALES

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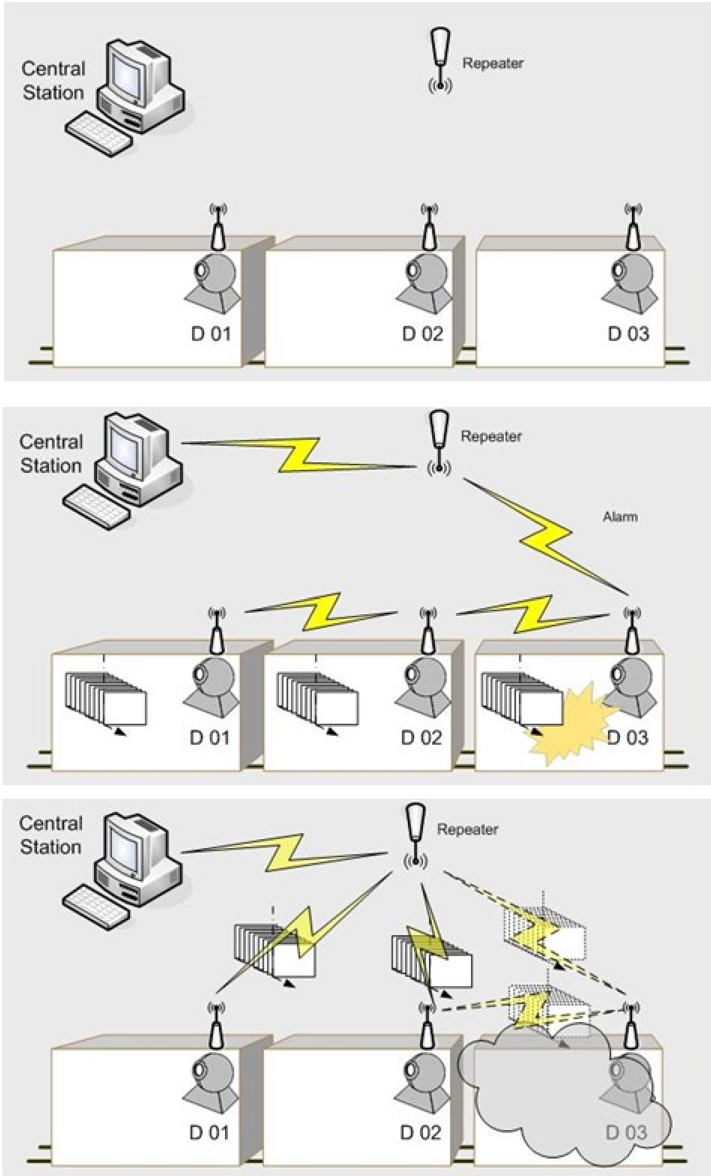
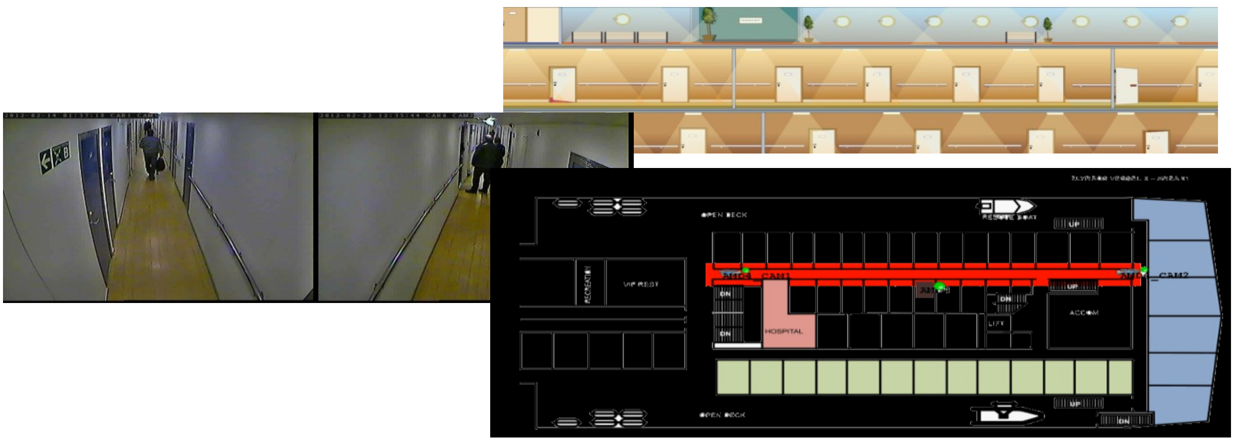


ASPIS underground metro application



ASPIS maritime: cabin attendance monitoring under evacuation condition