Hoverspill: a new amphibious vehicle for responding in difficult-to-access sites

The Hoverspill consortium[1]

ABSTRACT 300150:

Oil spill experience often shows that response activities are hampered due to the absence of operative autonomous support capable of reaching particular sites or operate in safe and efficient conditions in areas such as saltmarshes, mudflats, river banks, cliff bottoms… This is the purpose of the so-called FP7 Hoverspill project (www.hoverspill.eu), a 3-year European project that recently reached completion: to design and build a small-size amphibious vehicle designed to ensure rapid oil spill response. The result is an air-cushion vehicle (ACV), known as Hoverspill, based on the innovative MACP (Multipurpose Air Cushion Platform) developed by Hovertech and SOA. It is a completely amphibious vehicle capable of working on land and on water, usable as a pontoon in floating conditions. Its compactness makes it easy to transport by road. The project also included the design and building of a highly effective integrated O/W Turbylec separator developed by YLEC. Spill response equipment will be loaded on-board based on a modular concept enabling the vehicle to carry out specific tasks with just the required equipment.

INTRODUCTION:

On the market, there is a lack of amphibious vehicles dedicated to fast oil spill response operations in difficult-to-access areas such as estuarine or riverine shallow waters (salt marshes, mudflats, banks) or remote coves at the bottom of cliffs. The main objective of the HoverSpill project was to fill this gap by designing and building an innovative versatile vehicle able to carry out a series of operations during the different phases of a spill response (from pollution survey to oil containment and recovery). The project was based on the development of an air cushion vehicle (ACV) designed to comply with certain operational and environment requirements: (i) to consist of an autonomous and multipurpose platform capable of providing enough room to operate safely and supplying the required power for implementing oil spill response devices; (ii) to be light and small in size, suitable for road transport and for easy and fast implementation and launch in various ways; (iii) to be easy to use and handle in restricted areas (iv) to be easy to maintain and to repair in the field, and (v) to be environmentally friendly (minimum impact on ground).

THE HOVERSPILL R&D CONSORTIUM:

Hoverspill was a 3-year project, partly funded by the European Commission through its Seventh Framework Programme (EC-FP7), and carried out by a R&D consortium consisting of a combination of 8 partners from 4 countries. The Hoverspill consortium was

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composed of a variety of companies and organizations deeply skilled and experienced in various fields, with heterogeneous core activities and complementary involvement in the project as described below.

HOVERTECH (UK), the technical project leader, experienced in hovercraft technology, was in charge of the global development (design and building) of the platform and its modular propulsion system, as well as of technical coordination. INNOVA (Italy), a private company specialised in innovation consulting and business administration was the administrative project leader. SOA (Italy), a SME specialised in environmental services and studies on advanced technologies by operating with compact hovercrafts, was in charge of building and ergonomics. YLEC (France), a consultant in fluid mechanics mainly in the fields of multiphase flows and in the development of industrial processes dealing with fluids, was in charge of the development of the integrated Turbylec O/W separator. The department of mechanical engineering of the University of Padova – UniPD - (Italy), specialized in mechanical sciences (simulation and experimentation of rotating machinery used in aeronautics, aerodynamics of compressible flows) was in charge of the thrust, lift, venturi and propeller drawing and calculation. CRF-PRT (Italy), the innovation and research centre of the Fiat Group, for innovative technologies to improve engine and vehicle, performed activities related to the integration of an existing engine in the Hoverspill vehicle. TerraMediu (Romania), a SME in environmental services, was involved in field tests. Cedre (France), a non-profit organisation dealing with oil spills on water, defined the possible oil spill response activities for Hoverspill (and subsequent requirements and equipment) and was in charge of testing the 2 Hoverspill prototypes: the Turbylec model and the MACP (in the field).

THE HOVERSPILLL AIR CUSHION VEHICLE:

Potential oil spill tasks. A hovercraft (or air-cushion vehicle, ACV) is a craft capable of travelling over surfaces while supported by a cushion of slow-moving high-pressure air which is ejected against the surface below and contained within a system of skirts. At the beginning of the project, based on oil spill literature and experience, the different difficult-to-access areas were defined, in which, in the event of an oil spill, an ACV was expected to provide operational support (that any other craft cannot offer – or at least only in part). Then, the possible oil spill response activities for Hoverspill were assessed.

In total, some fifteen tasks were listed within 5 types of missions as follows: pollution survey and impact assessment/monitoring (including establishment of a pre-spill environmental reference state; environmental impact assessment & monitoring; pollution survey), oil containment (including on-water booming; on-shore containment), on-water oil recovery (including static skimming and netting recovery), shoreline clean-up and assistance (including Washing of rocks and man-made structures plus effluent recovery; water supply for flushing; installing free-end nets on mudflats; transportation activities; oiled wildlife response), and spill response product application (including spraying of dispersant and other products; loose sorbent spreading and recovery).

For each of these tasks, their subsequent environment constraints (such as ground unevenness and bearing, slope, etc.), operating requirements (maneuverability, driving, speed, etc.), response equipment and logistics required for their implementation were mentioned, as well as the main expected implications for the platform in terms of structure and ergonomics (gear, mooring/pulling points, etc.) and of room and load requirements.

The MACP concept

The Hoverspill ACP is designed to carry out various tasks at different speeds and in different environments. Thanks to their experience in hovercraft technology and use (gained in environmental services in the Venice lagoon using a Hover4, the first commercial vehicle shorter than 4 m equipped with a low emissions 4-stroke engine), SOA and Hovertech listed the main limitations that prevent the spread of traditional hovercraft use – which are even more critical during an oil spill emergency situation. It was concluded that the Hoverspill ACV had to comply with a certain number of requirements relating to its dimensions (suitable for road transport; low weight payload), power (diesel engine) and propulsion system (high propulsive efficiency; low weight; good balance; allowing the use of innovative cooling surfaces; thrust and lift fans separated and independently regulated). The project focused on possible options capable of complying with these limitations and requirements. The consortium tried to provide answers to a series of questions such as: how can we produce a light, compact, operative and powerful vehicle? How can we obtain a real working platform with maximum room whilst operating safely? How can driving be facilitated and made safer? How can puncturing of the hull or tearing of the skirt be prevented? How can noise be limited? How can spray be limited?

The first designs highlighted the importance of designing an ACV that was (i) versatile, easily adaptable to a specific type of mission, (ii) safe to drive and operate (iii) not expensive to build and (iii) easy to repair, even during operations. As a result, a new type of hovercraft was developed: the Multipurpose Air Cushion Platform (MACP) (Fig.1). The MACP concept consists of a multipurpose flat naked platform on which different elements and oil spill response equipment suitable for a targeted task could rapidly be positioned. All these aspects were thoroughly evaluated or simulated using specialized software, in order to optimize room, weight, energy and air flows. The project focused on maximum usability and flexibility, and on the ability to adjust the parameters within very wide margins, in order to adapt the MACP to different operating configurations with appropriate outfitting. To do so, the platform was designed according to a modular concept that is a key feature of Hoverspill when compared with traditional hovercraft that have a restricted on-board storage capacity for equipment, and on which it is not possible to modify the position of various elements.

The MACP's main components

Hull and platform. The idea was to produce an unsinkable and flexible structure capable of absorbing shocks and wave impacts. The MACP is provided with a new concept of hull (SoftHull™) composed of a flexible structure (SoftSkin) fixed to a rigid frame. The SoftSkin has a sandwich structure, composed of a shock absorber bottom hull made of 5 mm HDPE plates - HDPE is not punctured by sharp objects - in which elastic and lightweight foam constitutes a floating reserve making the vehicle unsinkable (up to 1.9 t gross weight) and as stable as a pontoon in displacement mode. Because the materials used are cheap and easy to work with, the cost of production of the SoftHull is several times lower than the technique with carbon/Kevlar, and repairs are easy even in the field. The main structure is a rigid frame built with a ship-type structure made of anticorodal aluminum 6060 able to absorb waves and peak load stresses. The structural frame supports the total longitudinal and transverse bending moments as well as the total torsional forces arising from asymmetric loads (for example: diagonal waves). The deck floor consists of lightweight composite panels fixed onto the main frame in an air-tight way. The deck shape, slightly tilted from the middle towards the outer edges, prevents any accumulation of liquids and, thus, eliminates the usual hovercraft "bathtub effect" as well as any risk of engine/propeller flooding. Over the deck, a flat working-platform, consisting of an anti-skid grating, helps to make the Hoverspill an innovation in the field of working hovercrafts by: (i) providing a safe walking area, particularly in the presence of oil, and (ii) offering excellent ergonomics for field operations and enabling modular boxes and superstructures to be installed in accordance with operational needs.

Figure 1. The Multipurpose Air Cushion Platform (MACP).

Skirt system. Flexible skirts are fundamental for the hovercraft; they have a dual function on a hovercraft: containing the air blown into the cushion and ensuring air lubrication roughness. The Hoverspill skirt system - made of a particularly flexible and oil- and tear- resistant fabric - covers of the whole of the hull and is subdivided into a series of individual skirts, each one being air-fed via a hole in the hull, and fastened to the hull via zip ties. A perimeter bumper, consisting of a HDPE pipe welded onto the hull, allows the vehicle to operate within trees and brush-type vegetation without damaging the skirt system.

Driving control. Professional activities with the ACV require responsiveness to commands, agility and easy handling with good performance even at low speeds. In order to make the Hoverspill driving and maneuvering safer and easier, an intuitive control system has been developed. This innovative system, far from traditional, complex workstations, consists of: (i) a *Flapton* surface control system (to compensate for the problems created by a center of thrust higher than the center of gravity) consisting of control surfaces characterized by high effectiveness and rapid operation, enabling the use of efficient propulsion systems with large diameters; (ii) a *Unik* single user-friendly command (dumbbell-shaped) both for direction and inversion and for lateral and longitudinal trim. The combination of these two systems enables independent actuation of left and right flow reversion even at full throttle and in less than 1/10 of a second.

Modular Propulsion System (MPS)

The propulsion system is, by far, one of the most important components of the ACV. It has to meet two important goals: horizontal thrust and vertical lift.

Propulsion. The thrust and lift design are defined in order to ensure maximum performances (maximum thrust for the main propeller and maximum efficiency for the lift systems). The chosen design consists of a multi propeller system composed of one main propeller to provide thrust and two smaller propellers to assure separated and automatic lift. The use of a lift system separated from propulsion provides the best results in terms of efficiency and noise. The ability to independently adjust the lift optimizes performance at low and high speeds and prevents unbalanced power absorption. In general such separation is realized by adopting two separate engines. The MACP uses a lift system driven by the main engine but controlled by an innovative mechatronic system that calibrates the lift air-flow in every condition. The distribution of lift flows, made via three main channels crossing the hull, provides a more efficient system of lift with a higher pressure at fore of the ACV. In this way, it is possible to have a cushion already formed at low speed. This enables easy use of the vehicle also for operations at low speed. For cost (cheapest) and practical (widely available and easy maintenance and repair) reasons, the Hoverspill project concept aimed to use elements available in the automotive market and industry rather than in aeronautics. For the lift propeller, two MultiWing 700mm/5Z bladed propellers were actually found to be the best solution. The main propeller was more difficult to design because of the strong coupling with the Venturi duct in which it is inserted; finally a MultiWing 1300mm/5W bladed propeller and a smooth-shaped duct whose geometry is accurately defined were identified.

Cooling systems. For a hovercraft, three aspects are critical in terms of the cooling system: environmental constraints (mud and salt that can coat cooling surface; debris that can obstruct the heat exchanger), amphibious feature (water-water type exchanger is not possible), and load minimization. The idea was to use the already existing air flow coming from fans and the propeller without installing additional fans. This consideration led to the necessity of studying a non-conventional cooling system, a laminar flow type using on-board existing elements to ensure heat exchange. The surface-radiator technology, which cannot be obstructed by leaves and bags, is consistent with the heavy-duty logic of the whole MACP concept. The main engine exchange is provided by an air-water cooling system composed of 2 conventional “stream passing” heat exchangers and 4 innovative “laminar flow” panels, realized in Skyve-Fin® and located under the deck where lift air flow passes.

Engine and transmission. The main engine and transmission are critical elements in the implementation of an air-cushion vehicle because of the low power/weight ratio required. The basic Hoverspill engine is an internal combustion power system, including all mechanisms necessary to convert hydrocarbon fuel energy to power delivered to a propeller, an electric generator and to other auxiliaries. After defining the technical specifications for the engine to satisfy the Hoverspill missions, RCF-FPT decided to adopt a 130 kW Multi-Jet 16V diesel engine (so-called HVS 2.0 TD 16V), a derivative of the automotive 2.0 JTD 4-stroke diesel engine with a common rail fuel system controlled by a Bosh ECU. RCF-FPT identified the variants needed for a typical Hoverspill mission with respect to the normal automotive production engine, and tailored the mechanical and fluid interface towards the cooling system, the transmission of the torque to the fans and engine control management to meet performance, safety and emission targets. The engine has an exceptional weight/power ratio (140 kg with 130kW) and is able to operate at ambient temperature ranging from -20°C to +50°C. A single wear-less component was adopted for the transmission, allowing a smooth start and absorbing the typical peaks of diesel engines that can otherwise be destructive for the entire transmission.

The MACP’s main features

A safe and operative platform. The platform offers a total floor area of 7.5 m^2 (empty) – an area similar to a conventional hovercraft twice this size - that is divided, for safety reasons, into two distinct sections, the central safety zone and the outer zone. Loads (example: seats for crew, equipment and sealed box) are preferably distributed within the safety zone. The outer zone has a significant effect on the trim and can be used when the vehicle is in displacement mode (offering easy and safe access to the water), or parked on solid ground. Response equipment is pre-packaged in separated boxes according to the task targeted; different elements of superstructure are proposed (such as lifting gear, seats, protective roof, etc.). All these components – except the drive control column and the driver's seat - are foldable or interchangeable and safely fixed onto the deck grid by quick couplings. In order to provide the crew with a high level of safety, protection and comfort, the Hoverspill structure and its ergonomics were conceived by taking into account all the constraints and requirements generated by its environment in a broader sense, including the physical environment (beaching ground, meteo - oceanographic conditions), the hovercraft's main components (MPS, engine lift and propulsion system), its behaviour on water according to the speed, as well as the operations it is required to implement (oil spill equipment handling, logistics). The platform is very stable on the water and is designed to be able to operate in safe conditions up to Beaufort 3 maximum, provided that some safety precautions are taken.

Figure 2. Artist's view of Hoverspill

The MACP provides the possibility of setting the loads on rails with quick couplings on many parts of the platform, so that the pilot has the possibility, from the drive controls, of changing longitudinal stability even at high speed, compensating in real time for any dangerous trends. In terms of ergonomics, particular care was taken to ensure the safety and comfort of the driver (example: a specific seat for driving in an upright position; easy and safe controls and pilot adjustments) as well as of the crew (example: anti-skid grid on the deck; protections against rotating components at man height and hot spots; life line; reclining bench with safety belts and foldable railings; etc.). The Hoverspill is also equipped with specific gear (Fig. 2) in order to make equipment handling easier (a derrick crane with double arm lifting - 1 m radius /100 kg - for lifting loads or gang-boards) as well as platform handling such as lifting, anchoring and pulling (block or snatch point, pulleys and winches).

Behaviour versus speed. The Hoverspill's draught and behaviour vary according to its speed. At "on air cushion" speed (i.e. at medium and high speed, from 15 to 60/80 km/h) the rigid hull is lifted up to 30 cm from the surface. At high speed, the hull has to be parallel to the overflown surface but, on the contrary, becomes very sensitive to unbalanced lateral loads leading to for the air cushion inconsistency. At “displacement” speed (i.e. at low speed <5-7 km/h), the rigid hull rises to 15/25 cm (depending on the total load): this position allows equipment to be easily handled at the sea surface. The Hoverspill acts as a very stable platform which is insensitive to lateral loads thanks to the shape and width of the hull and to the presence of the foam flotation inside the bottom hull which allows strong stability. In a stationary position, the draught is at its maximum but the engine continuously idles to keep its own power, electric (at low voltage, 12 or 24 volts) and hydraulic generator functions.

Performances. The MACP has a good dimensions/payload ratio, usually offered by vehicles twice its size (weight: 650÷800 kg / payload: 1 pilot + max 550 kg +100 L diesel fuel for max performances). Depending on speed (about 45 knots maximum) and activities, the autonomy of the Hoverspill varies between 5 and 8 hours.

The MACP tests

At the end of the project, the brand new Hoverspill prototype, was tested in field situations first on the Pô river in Italy then the following week in France on the Loire estuary (Fig.3) and in Cedre’s facilities (Fig.4).

Figure 3.Tests (Loire estuary)y: platform stability on water at high speed, and at the water edge.

Observations recorded during these trials highlighted the remarkable stability and maneuverability of the platform, confirmed the amphibious capacities of the craft as well as its response speed, and the benefits of the principle of the Hoverspill’s modular concept, and validated the feasibility of most of the OSR tasks initially listed (boom deployment, moving on a pebble bank or in a narrow pass through high vegetation; pumping operations, etc.), even if all the scenarios could not be tested.

Figure 4.Tests at Cedre: towing boom in trawling configuration and U-turn on beach

THE HOVERSPILL TWO-STAGE OIL RECOVERY SEPARATION SYSTEM:

An inherent part of the Hoverspill project was the integration of a multistage separation system (MSSS) consisting of an oil recovery system (i.e. skimmer plus pump) plus an O/W separator (the recovered oil storage capacity being either a drum/box on-board or a small floating storage capacity alongside the craft). To this end, the Hoverspill project included the development of a biphasic oil-water separator to be installed on-board and mounted in line with the recovery system. Only the separator was to be developed as part of the project.

The recovery system (skimmer + pump) was not to be built as part of the project; rather it was to be (i) selected from existing equipment on the spill response market and (ii) tested to assess its real performance (in terms of flow rate and selectivity) on different types of pollutants and to determine the compatibility/complementarity with the Turbylec separator. The Hoverspill platform has a relatively limited payload and must provide the necessary power required to run not only itself but also all the equipment onboard. Its characteristics therefore impose dimensional and power constraints on the recovery system which is to be used onboard. Furthermore, this recovery system is to work together with the TurbYlec separator: the separator's treatment capacity should therefore also be taken into consideration when selecting recovery means. These pre-defined requirements were as follows: (i) a compact format and maximum weight of 25 kg per skimmer and 50 kg per pump; (ii) hydraulic power requirement (skimmer + pump) less than or equal to 25 kW, and (iii) a flow rate range similar to that of the Turbylec separator (less than 10 m^3/h).

Oil recovery system

The study was conducted in 2 phases: pre-selection of existing equipment (pumps and skimmers) liable to meet the necessary requirements, followed by comparative trials of these devices. In reality, few models within this range are available on the spill response market; the flow rates are generally far higher than those required here. In all, 10 small-scale recovery and pumping devices were preselected, based on their light weight and compact format, for testing at Cedre's technical facilities, on 2 to 3 oils of different viscosities: 8 skimmers (5 mechanical skimmers of 3 different types - 3 self-adjusting weir, 1 fixed weir and 1 direct suction - and 3 oleophilic skimmers of 3 different types: 1 disc, 1 grooved drum and 1 brush) and 2 hydraulic displacement pumps: 1 lobe pump and 1 vane pump.

The efficiency assessment tests were conducted on oils of various viscosities based on the French AFNOR standardised procedures (AFNOR standard NF T-71-500 for skimmers and AFNOR standard NF T-71-401 for pumps), in a 10 m^3 tank with seawater plus 200l of oil. The pumps were tested in a designed well with various configurations of use (suction height and discharge pressure), on three oils of different viscosities. The oils used during these trials are representative of the standardised viscosity categories defined in the above-mentioned AFNOR procedures: one very fluid oil (approx. 1cSt), one moderately viscous oil (density: 0.96 / around 5,700 cSt @11°C, for skimmers and around 1,200 cSt @13°C, for pumps) and one highly viscous oil (for the pumps only: around 40,000 cSt @ 14°C). For each of the skimmer tests, 200 l of oil were released into the tank (forming an oil slick with an initial thickness of 2 cm), while 1m^3 of oil was used for each of the pump tests.

Through a series of comparative trials, two skimmers (FOILEX Micro and DESMI Terrapin) showed good flow rates, both with fluid and moderately viscous oils. Both can be combined with the Turbylec separator. The oleophilic skimmers were finally not considered with the Turbylec separator, for various reasons: very high selectivity (low intake of water), lower – nonetheless good – flow rates, and additional power requirement (for rotating process).

As for the pumps, the BÖRGER AL 25 showed better results than the VIKOMA IMP 65 pump in terms of flow rate as well as suction height and discharge pressure, and was the only one capable of pumping (although at a low flow rate) highly viscous oil in operational conditions. These performances counterbalanced its slight disadvantage due to its weight (50 kg compared to only 17 kg for the other pump). In the end, the efficiency results coupled with the ease of handling and panel of possible oil spill response actions led to the selection of the DESMI Terrapin - BÖRGER AL 25 duo.

The Turbylec separator

In order to be compatible with geometry/size/power characteristics of the Hoverspill, the separator had to comply with quite strict requirements and constraints including being: (i) compact and light-weight (< 100 kg with liquid), (ii) able to cope with different types of pollutants (in terms of density, W/O ratio, viscosity), (iii) able to handle average inlet flow rates of 7.2 m^3/h, (iv) able to tolerate intermittent or continuous air ingestion, (V) able to ensure a cut diameter (i.e. diameter of the smallest oil droplets that are all separated) < 100 µm, (vi) easily adjustable, and (vii) easily dismountable on board for rapid cleaning in case of clogging with debris.

Different separation principles and existing types of separators (gravity, static cyclonic, centrifuge, rotating cyclone separators) were analyzed with a view to selecting the appropriate system for the Hoverspill configuration. None of them was fully compatible with the specific Hoverspill requirement: too large compared with room and load requirements, unable to cover a wide range of oil viscosities or of oil/water inlet ratios, separation control system too sophisticated for enabling easy use, concept too sophisticated to be easily repaired or cleaned on-site, etc.

YLec Consultants initially proposed to adapt an innovative cyclone technology that they developed in collaboration with TOTAL: the OPTISEP. The main difficulties encountered by the Optisep were its weight and its inability to handle emulsified oil which is quite a usual occurrence in oil spill situations. So, the Optisep option was abandoned. It was consequently decided to develop a totally new separator able to operate with no level control system in a wide range of densities and of inlet water-cut: the so-called Turbylec separator. The working principle is based on a motorised rotating oil-water separator, able to handle large variations of inlet flow rate, and air ingestion. The flow within the separator is centrifugal (solid rotation) and the residence time is long enough (about 15 s) to establish a free interface between oil and water without control. It is operated at a limited speed (1500 RPM) to prevent too much emulsification at the inlet. Motorisation is provided by a small size and lightweight hydraulic motor, powered by a high pressure hydraulic pump entrained by the diesel engine of the hovercraft. This high pressure hydraulic entrainment solution minimizes the weight of components. A prototype was realized to validate the theoretical concepts of the Turbylec separator: the rotor produced as one single piece by Selective Laser Sintering in Nyglass material (a combination of fiberglass and nylon, light and strong), the stator made of marine aluminium, a 5 kW electrical motor with variable speed drive (more flexible than a hydraulic motor for carrying out the tests required for its mechanical qualification and set-up, then for assessing its separation efficiency in the configuration of

Hoverspill multistage skimming and separation system (Fig.5): the Turbylec associated with a self-adjusting weir skimmer (DESMI Terrapin) and a volumetric hydraulic driven lobe pump (BÖRGER AL25). The separator shows very good oil/water separation performances (similar separation performances to an 8 m^3 gravity separator: in comparison, the weight of the TURBYLEC is only approximately 100 kg, full of liquids), efficient in a wide range of density contrasts, and is easy to handle and dismantle.

Figure 5. Turbylec: tests at Cedre (Demi Terrapin skimmer in a tank with oil, Börger A25 pump and Turbylec separator)

The detailed concepts of the Turbylec separator as well as the main results of the assessment efficiency tests carried out at Cedre are presented in *MAJ et al.* (2014).

CONCLUSION:

It is quite unusual to see this type of short, partly funded, R&D project lead to 2 innovative prototypes with 4 patents filed: 3 for MACP and 1 for Turbylec. Central to the Hoverspill project has been the development of a new air-cushion hovercraft vehicle; the so-called Multipurpose Air Cushion Platform (MACP) represents the basis of the Hoverspill system. Hoverspill MACP is a prompt intervention system based on a compact, amphibious and fast system. The vehicle is designed for carrying out rapid oil spill response operations both on land and in shallow waters, more specifically in difficult-to-access sites such as in estuarine and river environments. It can be fitted with specialized equipment, including the innovative Turbylec oil-water separator also developed within the Hoverspill project. The mechanics of the system required a very complicated design phase in order to ensure the ease of handling the consortium wanted. The members of the consortium worked together closely, with a constant transfer of techniques, know-how and experience, and some partners are now continuing to collaborate even after the official project end, to improve the technical design and to develop a business plan in order to commercially exploit the project outcomes (MACP and Turbylec).

Currently, no vehicle exists which is able to implement the different listed oil spill response operations in difficult-to-access areas: some craft (airboat for example) are sometimes used locally in oil spill response for some of these operations, but none is fit for multipurpose missions in coastal areas, both on water and on land, like the Hoverspill will be thanks to its versatility, modularity and speediness. New field tests are planned in France in the near future, on mudflats this time, to confirm the feasibility of those oil spill response tasks that could not previously be tested, and compliance with environmental constraints such as slope and mud spray.

Hoverspill can also be used in situations other than oil spill response because the MACP is essentially a stable and secure mobile chassis, not expensive to produce and operate, on which different gear and structures can easily be installed. Properly equipped, it could, for example, be used in flooding scenarios, for firefighting or police operations, or as an amphibious ambulance. It could also serve in geophysical surveying, or in environmental management, especially in wetlands, which are among the most vulnerable ecosystems but also the most difficult to access. Today there is no compact system comparable in size to the Hoverspill on the market that is as quick and versatile for carrying out such varied operational scenarios. The Hoverspill project came to completion in mid-2013 but the two prototypes have been improved since then, and the project partners with particular commercial interest continue to promote the development and use of the two prototypes and not only in the oil spill response field.

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