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Table of Content

After each chapter a contact is provided to ask for additional information.

Effective Operations in Ports EFFORTS

Effectiveness and efficiency are the key words for EFFORTS, a project co-funded by DG Research within the 6th Framework Programme on Research, Technical Development and Demonstration to become concluded in October this year. The three thematic areas are

"Navigation in Ports" led by the Port of Dublin
"Port Environment" led by the Port of Le Havre
"Port Organisation" led by the Port of Gijón.

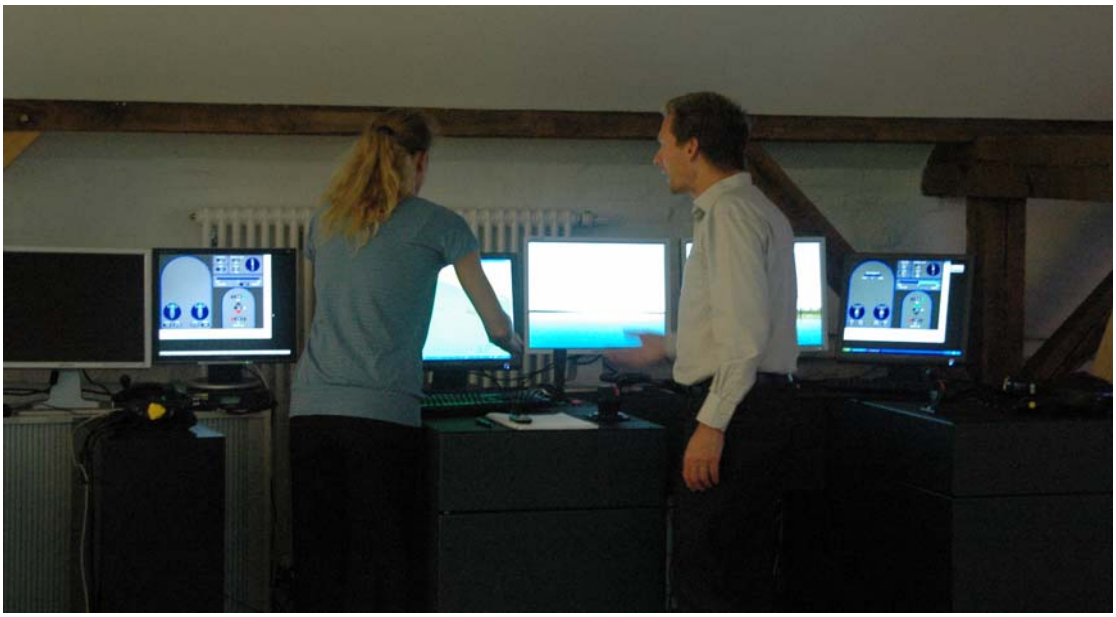
As a cross-project activity "Training, Education and Human Resources Development" elucidates the significance of further development of skills, knowledge and attitudes to realize advanced port operations.

Navigation in Ports

Ships, especially container carriers, get always larger but the ports they must serve remain the same. Navigation and manoeuvring of large vessels in fairways and ports has become a real challenge which cannot be met by navigators' skills alone. As in the other transport modes air, road and rail, ships need intelligent technical support to not only perform required services but also to maintain a very high safety standard to prevent from environmental impact through collisions and groundings.

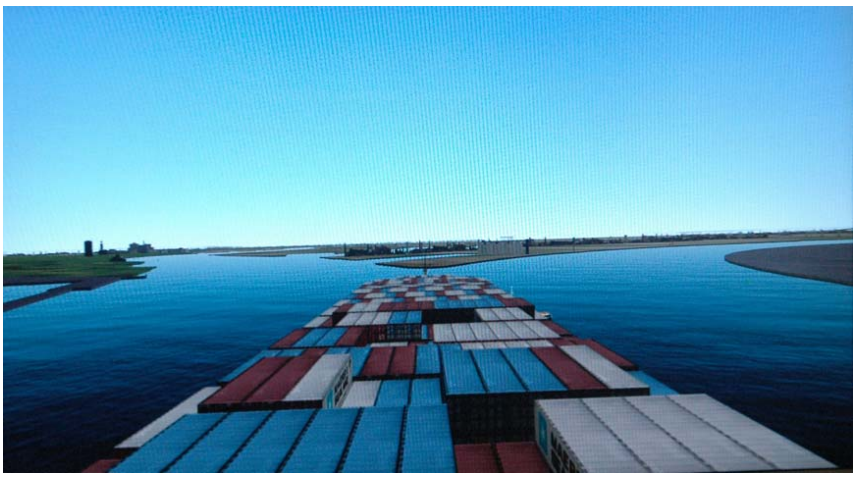
Tug Assistance

The development of the tug simulator modules were demonstrated to the public and the press on two occasions in Hamburg on 15th September 2009 and on 28th October 2009.



Provisional Simulation for Demonstration Purposes

The installation included three interactive ship simulators, modelling an ASD tug, a ROTOR tug and a container vessel as the assisted ship.
Below photographs show some images from the port model seen from the bridge of the assisted ship.



View from Bridge of assisted Vessel in Simulation

The special components implemented under the EFFORTS project are the Quadcore PC performing the on-line real-time calculation of the hydrodynamic interaction between the ships participating in the exercise, the Head Mounted Display and the two associated visual computers generating the visual image in the helmet, and the ROTOR tug controls and conning display.

One of the visual results is the application of the HMD 3D see-through helmet shown in the photograph below. Use of the helmet for the visual system on the tug simulator greatly enhances the depth perception and thus enables the tug skipper to judge the distance to the side of the assisted ship much better than in the conventional visual display as shown in the other photograph below.

HMD 3D-Helmet

Aspect of assisted Vessel from Tug Bridge

Existing data was reviewed in order to determine the wave-thrust interaction for different propulsion types (ASD and VSP) and tug sizes. A considerable amount of data was made available by the EFFORTS partner Svitzer for this purpose. The data review resulted in tables and variables to be used in DENMark1 mathematical models for the different propulsion devices. These tables have been implemented in the FORCE SimFlex Navigator tug simulator and will be included as a standard in the next release of the system.

The main and auxiliary hydrodynamic interaction codes were developed and tested. Validation of the code is ongoing, using model test data developed by FORCE in another research project. So far, it seems that the code may generate acceptable interaction forces for midship positions except for very small clearances between the vessels. Surge forces are not well determined by this method and neither are the forces for varying headings. It is not yet clear if the method will provide sufficiently useful results or what can be done to improve the method.

With relation to fender and collision forces the work performed included:
Study and selection of the most suitable collision detection engine concerning the requirements specification.
Interface design and implementation, which includes the definition of all the classes for collision object management, testing and communication with the simulator.

Improvement of the results returned by the collision engine namely the calculation of the contact point, surface normal vectors and velocity vectors.
Development of a platform in a 3D virtual environment for test and validate the interface
Analysis of the interfacing of the collision module to the simulator system for generation of fender forces.

Tug Simulator at FORCE (Danmark)
where EFFORTS Features have been implemented

Conclusion

European tug operators have serious problems to recruit a sufficient number of tug masters to ensure required ship assistance services in ports. There is not sufficient experienced staff available, assisted vessels become larger resulting in decreasing manoeuvring space, tugs are becoming

more sophisticated and powerful and turn around times in ports are continuously being cut down.

Measures to qualify tug masters need to be effective and efficient thus the potential of simulation must become increasingly exploited. Simulation, however, is based on mathematical modelling of reality and a small tug moored to a large vessel manoeuvring very close to it, operates in a hydrodynamic environment which is highly complex and rapidly changing. EFFORTS was able to significantly contribute getting closer to reality in hydrodynamic behaviour of tugs but also in visualization.

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Precise Navigation and Manoeuvring in Ports

The task of a deep sea piloting operation is very different from a berthing operation at an oil or LNG terminal or when performing side by side mooring at sea. There are 5 essential attributes that a PPU (Portable Pilot Unit) should fulfil when being used for piloting tasks:

- Lightweight (The pilots will have to carry the equipment by hand everyday)
- Quick and easy to set up (A pilot must concentrate on piloting, not computing when on board a vessel)
- Small compact size
- Robust and reliable
- Easy to use

These five attributes have been taking into account during the development process to enhance the PPU within EFFORTS. Furthermore, the development of the PPU system, known as E-Sea Fix (CAT I, II and III), a

mix of expertise, experience and user feedback was available when one attribute conflicted with another.

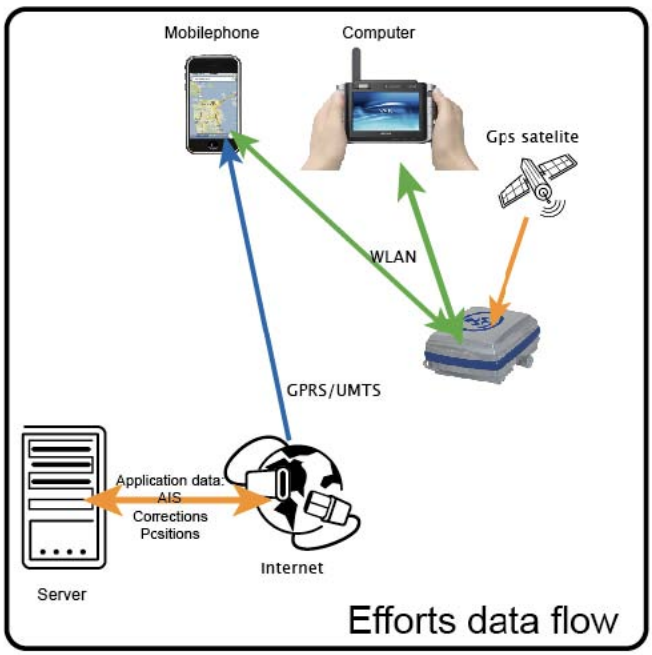
The Efforts framework provides a platform for navigation between different views, called perspectives, and for showing the user a context sensitive menu. To tailor the GUI small graphical components that display data, called Widgets, can be added to the perspectives in various ways. The efforts framework is not concerned with how the widgets get their data, that is the role of frameworks like the Data center and others.

The software is written in Java and therefore platform independent. However, the software still uses Ecdis-kernals from different vendors, and not all of these kernals are platform independent.

The basic architecture is bean based. Therefore the user interface will not use the standard office style application, with its menus and small icons. The idea is to make it visually appealing and usable by touch screen without a pen. This does however present a challenge as standard GUI components cannot be used. Furthermore, the focus is on simplicity and familiarity through out the software, providing only the needed functionality, but with the option of adding functionality on the fly if required by the user.

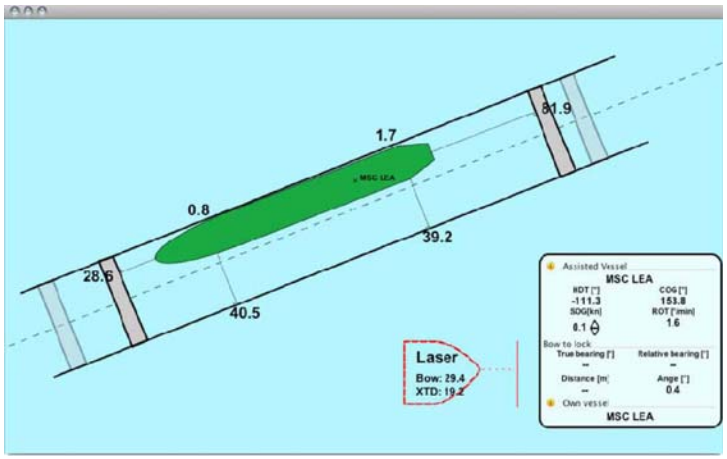
The system configuration has several layers. The basic concept is that any given user should be able to see only the information that he needs at a specific situation.

The software will run on Windows, Linux or Mac. Parts of the software will also be able to run on mobile devices, like PDA's and mobile phones.



Data Flow

Mobile Application



Laptop Application

A software framework has been developed, that will allow the user to get only the essential information that he/she needs at any given situation.
The software can be for example applied in the following scenarios for pilots:

- Berthing
- Narrow turn
- SPM /FPSO
- Tug operation

For tug operation there is no standardized communication procedure for commanding the tug master over the VHF (Very High Frequency) radio that is used for communication between the tug master and the pilot. The pilot cannot be sure if the tug master is following the orders. Failures in radio communication and misunderstandings/misinterpretations can lead to accidents. Thus unambiguous visual information displayed to both, the tug master and the pilot, will dramatically improve the situation awareness and timely perception of required manoeuvres as available space in ports is continuously decreasing.

LNG-Carrier assisted by Tugs

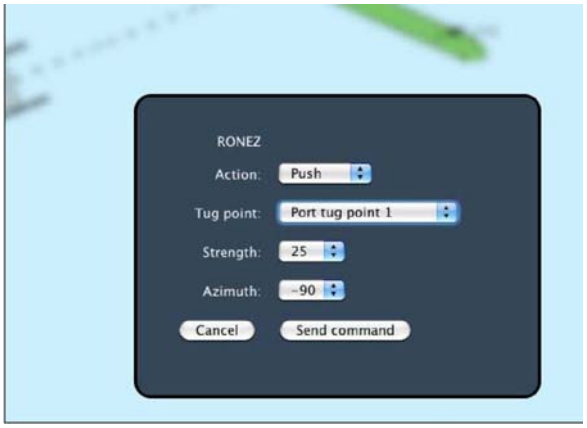
The new PPU (Portable Pilot Unit) system enables a way of silent communication between the tugs, pilot on the vessel and VTS. The software will run on Windows, Linux or Mac. Parts of the software will also be able to run on mobile devices, like PDA's and mobile phones.

There are three different parties in the system namely Data Supplier, Data Consumer and Date Center. They are connected through any communication media.

The new PPU (Portable Pilot Unit) system by Marimatech enables a way of silent communication between the tugs, pilot on the vessel and VTS. The software will run on Windows, Linux or Mac. Parts of the software will also be able to run on mobile devices, like PDA's and mobile phones.
The Tug operation scenario is meant as an aid to navigation and communication to both tug masters and pilots.

The intention here is to allow the pilot to select a tug and send a command to the tug master to tell him what to do. When a tug is clicked on

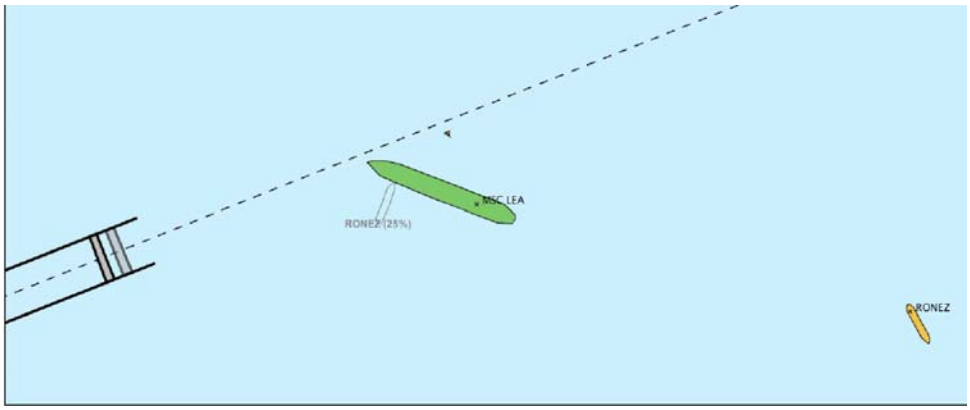
the screen, a dialog is shown asking the pilot what command to send to the tug.



Silent Order to Tug from Pilot of assisted Vessel

After the command is sent, an outline of the tug is shown, with an indication of the push force. Different command like push or pull, and the azimuth can be requested by the pilot. The same display will be shown on the tug boat within 1 second after the information is sent.

The wanted tug placement is shown on both the tug master and the pilots screen as an outline, indicating azimuth and strength (push or pull) in percent.



Tug operation scenario (Pilot and Tug operator screen)

Several tugs can be commanded and will be shown up on both screens.

Conclusion

The PPU is not a new device but its application by pilots was impaired by mainly weight and insufficient user-friendly system interface. The results achieved within EFFORTS do not only remove these hindrances but opened a door to applications beyond mere pilotage such as tug operation, described above, or lock and port operation from ashore or for a wide scope of applications in the offshore industry. The efficient digital communication between the PPU and other parties allows also to integrating the system into a vessel traffic service system (VTS).

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Port ECDIS

The focus has been to create a new ENC standard and ECDIS viewer that is designed to meet the needs of the Port community. This effort focused on the ports' needs in the areas of ENC production, International standards (ENC, IENC, and Harmonization of IHO Standards), the accuracy of the information that is contained within the Port ENC, the creation of new chart objects, features, and extensions, file size limitations, and skin of the earth difficulties. In addition to these areas, the Project Team worked to compile a demonstration of the Port ENC dataset. This dataset includes the PENC chart data, gridded bathymetry, bathymetric ENCs, and channel reference models.

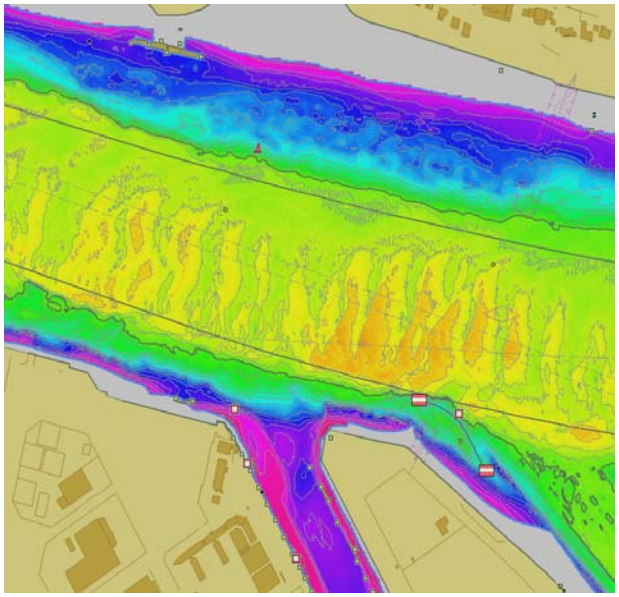
This usability of this standard has been a major focus, given that it must be compatible with Inland ENC and maritime ENC. This is very important with respect to the IMO information, because of the decision made at the 85th session of IMO's Maritime Safety Committee (MSC), mandating the carriage of an ECDIS on SOLAS vessels by 2012.

Normally the ports and harbours are responsible for their own business including all tasks that are necessary to operate and control the port activities. The ports are normally also responsible for survey tasks and representing the results, for example as fair sheets or hydrographic charts, in a large scale environment as base information for the harbour master, the pilots and other maintenance or safety groups, depending on their requirements.

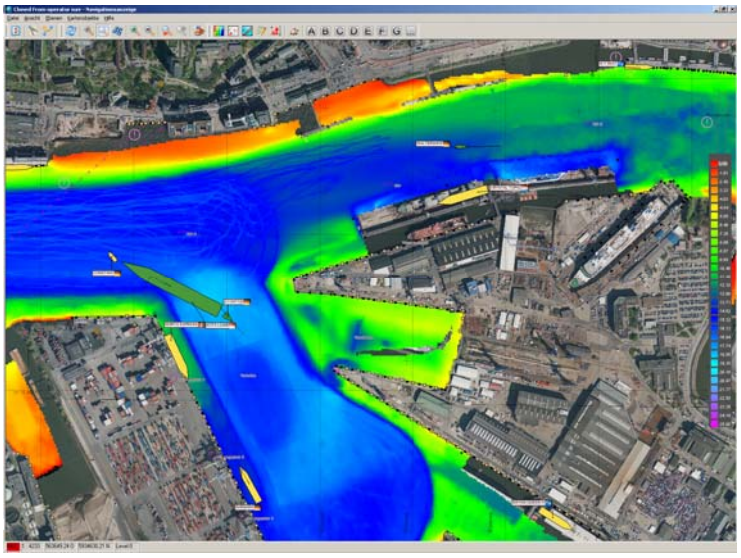
The work package succeeded in extending the current standards with new and additional features and objects to fulfil port requirements. These objects cater directly to the unique needs and requirements of the port community, and provide this community with the tools that are required to produce and approve Port ENCs. It is the opinion of this work package team that in the future, Port ENCs that have been certified by Port Authorities should have the same status as an official ENC with respect to ECDIS type approval.

Essential feature achieved are

- Higher accuracy meeting requirements of restricted manoeuvring situations in ports and during approach and to minimize dredging efforts by precisely allocating operations
- Port-related chart features not included in the sea or inland navigation ECDIS
- Gridded bathymetry allowing a 3D-model of the port and fairway. By intersecting a 3D-reference model with a 3D-model from survey, dredging requirements can be precisely determined.



Gridded Bathymetry



A new Quality for Navigation and Dredging

Conclusion

The current ECDIS standards are developed for sea navigation, however, when navigation and manoeuvring became really challenging, i.e. in fairways and ports, ECDIS did not meet requirements with respect to accuracy, resolution and chart features. The later invented inland navigation ECDIS was developed to meet river navigation but was not adequate for sea ships in a very restricted environment. This gap is bridged by developing the Port ECDIS. However, usability goes far beyond mere navigation. For those ports affected by sedimentation, dredging is a cumbersome and expensive activity. Through the Port ECDIS features “gridded bathymetry” (3D) and the high resolution/accuracy dredging can now become precisely focused avoiding any redundant work.

Port ECDIS now goes through the international standardization process which is expected to be concluded soon because of the high interests ports show in this development.

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Port Environment

The attribute „sea view“ is not just raising the price of accommodation at a seafront hotel but also the price of a house or flat. Obviously the view out to water is attractive. So it is no surprise that owners of land in and around ports convert old warehouses into new flats to sell them at high prices. The surprise comes for buyers who, having dreamed of blue water covered with sailing boats, seagulls displaying their air acrobatics and the sky's white clouds passing by, are instead confronted with a view onto gantry cranes, the noise of vancarriers and the smell of a tanker berth. One could argue they should have known better but when reality does not comply with dreams, it is always others who are guilty. So the conflict between residents and the port is pre-programmed.

There is no escape, ports must work hard to establish a good relationship with residential areas in the vicinity. This theatre has various plays, ranging from Sunday children's parties in the port in order to improve the social relationship, to communicating the key economic role a port plays and the need for close co-operation to minimize annoyances.

Some of these annoyances have an environmental aspect and need to be considered under various green port initiatives that most European ports meanwhile have on their agenda.

The European Commission co-funded some model approaches amongst which EcoPorts is one of the most popular. Within the research project "Effective Operations in Ports EFFORTS" protection of port environment became one of three thematic columns.

The overall topic for the environmental tasks in EFFORTS is "better prevention than cure" which means to pro-actively investigate all possible environmental threats before others find out, forcing re-active measures, which are always more expensive than prevention. The port industry is well advised to become an environmental protagonist instead of fighting the image of an industry trying to hide environmental problems. Certainly this must be communicated to the public to build mutual trust and confi-

dence between society groups, especially nearby residents, and the port industry.

Whilst research in port water and air quality and in annoyance due to port noises without doubt will contribute to making ports a better neighbour to nearby residents, the port energy issue may become ambivalent because wind parks for producing clean energy are not always welcome and are often considered visual pollution. However, wind parks are not the only source of clean energy. It is expected that intelligent management of energy will have a larger effect on the carbon-dioxide footprint of a port than that from new sources of energy. The question, however, is not what method to select but to exploit all possibilities to achieve the maximum effect.

Europe does not have many opportunities to meet increasing transport challenges by establishing greenfield ports, the majority of future transhipment demand must be met by extending existing ports commonly close to cities and hence in direct vicinity of residential areas causing conflicts between those planned to enjoy the sea view undisturbed from industrial impacts and those dependent on effective port operations. This conflict can only be solved by early involvement of residents affected by port operations and by comprehensive and transparent information about all issues of relevance including those which are not welcome. Neighbours support and trust each other and they need to accept also those peculiarities which do not contribute towards comfort but cannot be avoided when operating and living close to each other.

A port environmental office needs to act more stringently than any other party. The port must be the first to recognize environmental impacts and immediately initiate measures to investigate and to improve. Those waiting until they are blamed by others are in a defensive position which requires more effort to overcome than taking an early initiative and not impairing the public image.

As a conclusion it can be stated that environmental issues must be placed at the top of a port CEO's list of tasks and be timely and comprehensively communicated to residents living in the vicinity of the port. The benefits of

clever terminal contracts can rapidly become irrelevant once residents succeed in e.g. restricting night operations and a port can seriously become constrained by communities when planning an extension. Talking to each other does not solve the problems but it prepares the ground for coming closer to shaking hands.

Energy Management

Advanced terminal operations, especially those of container operations including large numbers of reefer containers, consume high quantities of energy, which is not only a cost factor but also a question of CO_2 and emissions in general. Under the EFFORTS umbrella, a team worked to model the port energy consumption and to map the consumption level and costs per type of operation and of site. In order to locate energy production as close as possible to consumption, renewable energy sources compatible to ports will be investigated and by means of sophisticated simulation, correlated to the port energy consumption related to time and operation. Unexpected consumption peaks is one of the main problems in energy management and this will become even more difficult once cool ironing, which means to plug ships into the port power net, comes into practice.

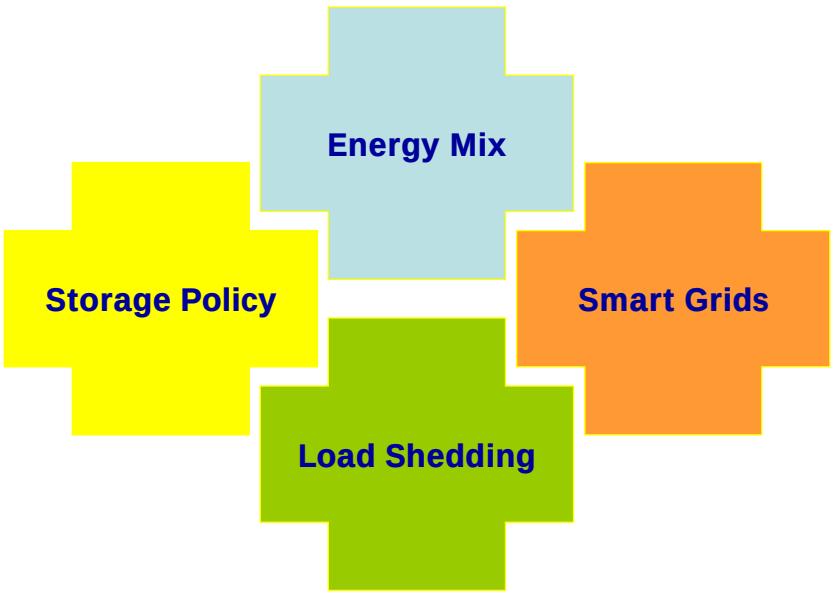
The Port of Bremerhaven
(Photo Sabine Nollmann)

Project work included

- Census of current annual energy consumption in the Port of Le Havre for all port activities and an estimation of future consumption
- Census of available primary and secondary energies available in association to their conversion and storage modes (maturity, market penetration, performance, cost and CO2 emissions)
- Elaboration of scenarios of port activities for validation of the overall energy blend to control energy costs and enviromental impacts
- Platform to integrate data and scenarios
- to model port area
- simulate environmental and financial impacts to provide local CO2 emissions and electrical energy consumption.

The scenarios chosen and applied to the case of the Port of Le Havre have been extrapolated to the Port of Dublin and the decision support tool programmed with the Irish national grid and gas prices showing national differences. From an economical point of view e.g. a gas turbine generator provided unfavourable results whereas a similar gas turbine generator in Dublin improved the economical and ecological conditions. The reason is the higher carbon content of electricity from the Irish grid.

Based on these results a tool for analysis, prognosis and management of port power consumption and production has been developed to provide the most effective energy management strategy which needs to cover an intelligent management of sources of energy, shedding of loads whenever possible even for very short periods and procedures to store energy in combination with smart grids to initiate power storage remotely once grid loads are low. The latter being an excellent way to consume power excess from e.g. wind energy. Most ports are close to the coast and wind energy is one of the most promising regenerative energies for ports.



Combination of Sources of Energy, Storage, Load Shedding and Smart Grits

Conclusion

Intelligent management of energy consumed by ports and terminals is a must to allow sustainable economical operation. Terminal clients increasingly request carbon dioxide footprint calculations from their transport service providers. Project results show that optimum solutions must be based on a comprehensive approach considering energy sources and consumption in relation to storage and load shedding. The potential of smart grits for ports and terminals needs further investigation. However, the project also showed that it is extremely difficult to access all required data in great detail to optimize software tools for intelligent energy management. Future research either needs to provide easy and quick access to required data in real-time or to find solutions less dependent on direct data access.

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Ballast Water

The background of this research task is the International Convention for the Control and Management of Ships Ballast Water and Sediments (International Maritime Organisation) focusing on

- Identifying harmful aquatic (micro)organisms in ballast water
- Solutions to eliminate these or at least reduce negative consequences on the port environment.

Invasive species booking trips around the world in ballast water tanks (Chinese mitten crab on rise in English rivers)

European ports need to ensure that discharge of ballast water from ships treated with chemicals does not affect the port, river and coastal bio-sphere. Therefore, they must be aware of the current status and impact of different harmful aquatic organisms in ballast water and eliminate or at least reduce negative consequences. In case of economic, public health or ecological disasters, the ports liability (and not only ship owners) could be at stake. Treating ship's ballast waters or enforcing the regulations by re-alistic and effective measures must be done as soon as possible. It is of tremendous importance to further develop effective ballast water treat-ment systems, without impending ship's trade competitiveness.

A sampling campaign for laboratory tests in the ports of

- Le Havre
- La Rochelle
- Rochefort

has been performed to identify (micro) organisms identification and num-beration of

- Bacteria
- Phytoplanktonic species
- Zooplanktonic species.

In a ballast tank under simulated vessel conditons dedicated biocides

- PeraClean Ocean
- Mexel
- Seakleen

have been applied and evaluated.

Additionally MEXEL© was assessed by regular samples from a double bottom tank of a large container carrier treated at 50 mg/l during a trip Le Havre – Hamburg – Rotterdam for

- Efficiency
- Degradation kinetics.

Mexel® 432/336, the active substance selected after the laboratory tests, was efficient at large and full scales on complex communities of bacteria and phytoplankton in the first 24h of treatment. It was also rapidly degraded when added in seawater suggesting that its environmental impact is limited and that seawater can be deballasted after one day of treatment.

Nevertheless, the ecotoxicological tests on oyster larvae performed at large scale tests (ballastodrome) do not confirm this hypothesis and showed a high percentage of abnormality. Thus, further experiments have to be undertaken to ensure the environmental acceptability of the product.

In addition “growth” of surviving bacteria observed in the treated tank during the two onboard tests was unexpected. The following reasons could explain that behaviour:

- The degradation products released in the tank could be assimilated by bacteria and facilitate their growth and/or
- The action of the product on biofilms may accelerate the release of bacteria in the ballast seawater.

These onboard tests also highlighted the limits of the injection and mixing procedures for the biocide via manhole. The procedure was time consuming and not possible in all ballast tanks. The further development of a dosing system needs to be considered, an installation of an automatic injector may be the solution.

Finally, additional assays on board should be undertaken to ensure significance of the results, in (further) approval process.

Conclusion

A convincing technical solution to fully comply with the objectives of the "International Convention for the Control and Management of Ships Ballast Water and Sediments" is not yet available, therefore the convention emphasizes research in this field. The EFFORTS results contribute to minimize the environmental impact from ballast water treated with chemicals to avoid migration of aquatic organisms to be released into the sea when again loading the ship. From the scientific point of view the project results provide a clearer picture, however, further research is required in order to formulate unambiguous guidelines for practical ship operations.

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Aluminium from Cathodic Protection of Port Steel Constructions

In ports, aluminium sacrificial anodes are frequently used to prevent excessive corrosion of steel constructions. The objective of the investigation was to assess the aluminium concentration in the port water and in the sediment and to determine its toxicity against marine organisms.

Sacrificial Anodes to protect Port Steel Constructions

Aluminium (as well as other metals Cd, Co, Cu, Cr, Fe, Mn, Ni, Pb, Ti, Si, and Zn) in surface and pore waters were analysed by Inductively Coupled Plasma Atomic Emission Spectrometry (ICP-AES, Varian, Vista MPX).

Nitrate, phosphate and silicate were also determined by continuous flow analyser (Bran Luebbe).
To determine total concentration of aluminium and other elements in sediments, alkaline fusion was performed (procedure NF ISO 14869-2). The recovered solutions were analysed by ICP-AES.

The mean concentrations of dissolved aluminium in the water column range from 20 to 47 $\mu g.L^{-1}$. These concentrations are quite similar to the concentrations measured in some water river or in estuaries. No significant influence of Al sacrificial anodes dissolution in water was detected, as

the Al level in water remains within the concentrations range observed in natural environment. The aluminium concentrations measured for the waters sampled at the vicinity of the sacrificial anodes present no significant differences with the concentrations observed at locations far from anodes (port entrance, Tancarville Lock). As no significant increase of Al concentration has been detected in the harbour, compared to the upstream flow or to other similar environment, it might be concluded that the use of aluminium sacrificial anodes has no significant influence on the total Al water content.

The total concentration of aluminium in the sediments ranges from 12.9 to 32.4 $g.kg^{-1}$ and are quite stable throughout the 3 sampling campaigns. These values are similar to the values previously observed in sediments dredged within the port of Le Havre (Port Authorities Data, unpublished) but are slightly higher than what is reported for the Seine estuary sediments. Considering the spatial distribution of aluminium in the port, it can be noted that the highest concentrations are situated in the open basin (from 28.1 to 32.4 $g.kg^{-1}$).

An Al enrichment is then observed in the harbour sediments and is more particularly obvious in the non-dredged sites near anodes. Such an enrichment is characteristic of recent anthropogenic input. Lower Al enrichment was observed near Al anodes where regular dredging is performed. No significant difference between the sediment sampled under anodes and at 20m from anodes was observed for the sites near anodes suggesting that this Al enrichment is not only a local enrichment.

The determination of aluminium speciation, by single (HCl, EDTA) and sequential extractions were performed on all the sediment samples. The presence of Al sacrificial anodes might be correlated to an increase of Al mobility in the surface sediments. This unusual value of Al lability in harbour sediments, suggests a modification of the Al speciation in sediments and/or an input of mobile Al.

The total concentration of Al in the solid phase of the sediment core was also measured. The Al concentration in the sediments remains relatively

constant with depth (32.6 to 34.5 $g.kg^{-1}$), and these values confirmed the strong Al enrichment near anodes previously underlined.

Regarding the large scale experiment, a six months observation time served to estimate the minimum time required to reproduce and model natural conditions and processes. Regular sampling of water and sediment were performed and analyzed for Al-content and speciation. Neither in water nor in sediments significant influence of Al sacrificial anodes dissolution was detected.

In in-situ mussels, a decrease of the Al concentrations was recorded in organisms collecting during summer, suggesting different physiological states of organisms in according to seasonal variation. All aluminium concentrations in Le Havre port range between a minimum of 53.7 mg/kg to a maximum of 602.9 mg/kg, the values recorded during this work remain comparable or inferior to concentrations given by different works such as the mussel watch. Then, we can consider no Al contamination of mussels from port of Le Havre.

The Al bioaccumulation assay performed in laboratory with mussels in controlled conditions demonstrated that digestive gland was a short and medium term storage site for this metallic element. Results showed natural physiological process settled by mussels to release Al accumulated in tissues. Then, these results allow understanding the few Al levels recorded in in-situ mussels which seem to be able to eliminate Al with natural biological tools.

Ecotoxicological works performed have confirmed the lower toxicity of seawater contaminated by Al released from sacrificial anode in comparison to contamination results given by another Al chemical form ($Al_2(SO_4)_3$).

Conclusion

There is currently no economic alternative to cathodic protection of port steel constructions and there was concern that aluminium from sacrificial

anodes diluted in seawater could affect marine life. Results, however, are encouraging but not providing a comprehensive all-clear message. If aluminium sampled out from port water is allowed to accumulate over longer time periods sediment contamination can become rather high. Currently not sufficient tests have been performed to determine all possible impacts on marine life, however, the fact of sediments contaminated by aluminium need to be kept under surveillance until more comprehensive research results are available.

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Port Air Quality

This task tackled the problem of volatile organic compounds (VOCs) and sulphur compounds which are emitted as gases through loading or discharging operations of petroleum products and being considered as carcinogenic. It is the objective to reduce the global impact of port operations on air pollution.

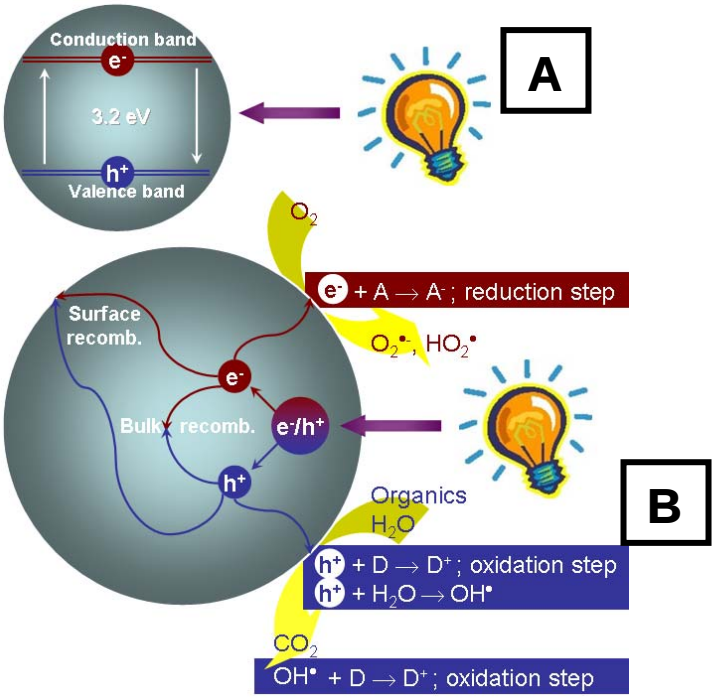
A prototype air treatment unit for on-site application under restrictive operational conditions (explosive atmosphere, saline mist, high humidity), based on photocatalysis technology was developed and tested.

The photocatalysis technology is an emerging and promising technology, which now profits by an unprecedented development resulting from joint efforts conducted by academics and industrials since many years in the search for innovative solutions within the sustainable development trend.

In chemistry, briefly and basically, catalysis is the acceleration of a reaction in the presence of a catalyst. Photocatalysis by polycrystalline

semiconductor oxides is a relatively recent catalytic field, in which activation of the catalytic solid occurs through photon absorption, for irradiation wavelengths greater than the semiconductor band-gap (mainly in the near UV, i.e. UV-A). Transfer of photo-generated electrons and holes from the light-activated bulk to the photocatalyst surface allows redox reactions to occur with adsorbed reactants. Photooxidation is the most popular class of photocatalytic reactions, leading to mineralization of organics, via the oxidative photogenerated holes or the creation of highly reactive surface radicals such as OH°.

Briefly, photocatalysis has many advantages:
It is a destructive technique, by contrast to recuperative sorption ways such as filters, and acts as a mineralizing process.
Furthermore, photocatalysis can be a low cost technology, by contrast to energy consuming thermal heating.
Finally, this technique can be used on a large panel of chemical targets (global impact).

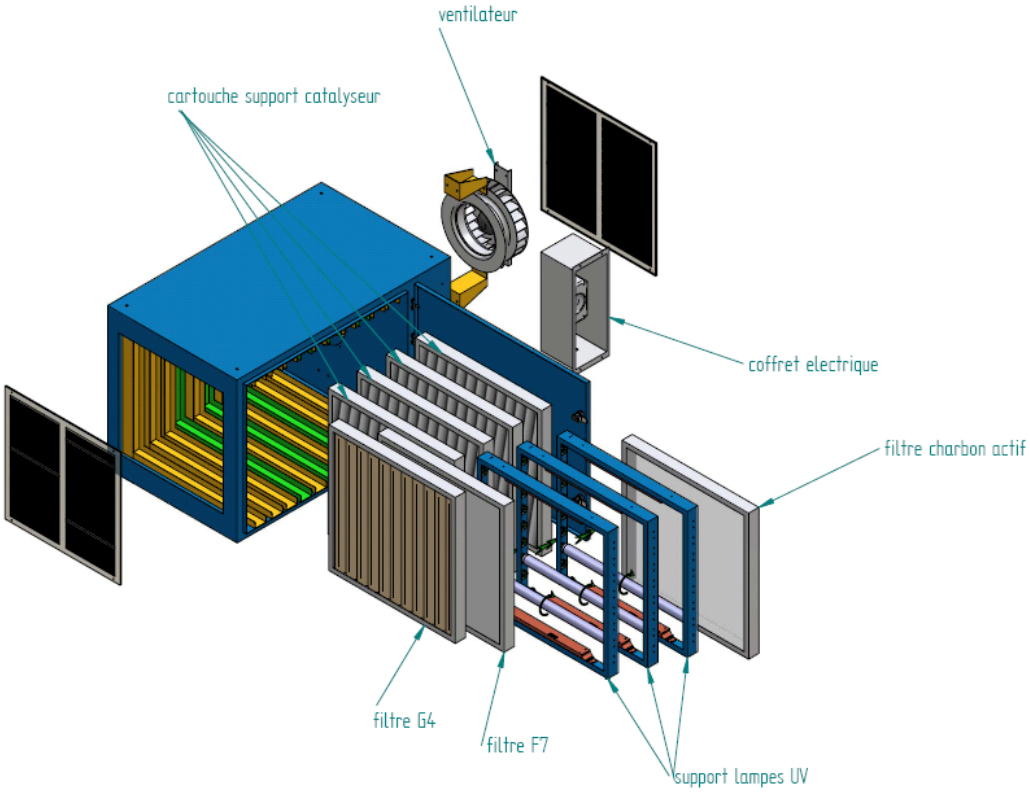


(A) Activation of a semiconductor particle with promotion of an electron from the valence to the conduction band, with the simultaneous creation of a photo-generated hole within the valence band.
(B) Schematic evolution of a photogenerated electron / hole pair within a light-activated semiconductor particle.

During the tests performed on site, a photocatalytic unit was used to treat gaseous emissions from engine exhaust and during fuel loading operations. This unit, as described, is made of stainless steel and composed of different air treatment steps:

- Dust filters: a G4 filter is placed at the input of the unit to filter gravimetric dust (90% of particles having a size > 0,4 m are stopped). It is followed by a F7 opacimetric filter than can stop more than 90% of the particles having a size ≥ 0,4 m

- Photocatalytic part: it is constituted of alternative ranks of photocatalytic filters (5) and UV lamps (4). Each rank of UV lamps is constituted of 8 lamps having each one 95W of electrical power. The photocatalytic part consumes so around 3200W
- High efficiency filter: the HEPA filter is optional and were not used in our tests. It is used to filter eventual catalyst particles that could stall from the photocatalytic support
- Fan: the blower used has an electrical consumption of 500W. The maximum air flow is 950 Nm^3/h.



Scheme of the photocatalytic unit used during in situ tests

At the particle surface, the redox reactions are separated into reduction and oxidative steps, involving on one hand, conduction band electrons and adsorbed electron acceptors following $e_{CB}^- + A \rightarrow A^-$ (O_2 from air playing

the role of electron acceptor), and on the other one, valence band holes and adsorbed electron donors following h_{VB}^{+} + D → D^{+} (organics playing the role of electron donor). Water can also be oxidized by photogenerated holes to create highly oxidative OH° hydroxyl radicals, further directly participating to the mineralization of organic molecules into CO_2 and H_2O.

Conclusion

As volatile organic compounds emitted during loading and discharging operations of hydrocarbons are considered carcinogenic, it is a must for ports and terminals to search for solutions to avoid health impacts. The only possible solution to render VOCs harmless is at it's source.

The EFFORTS solution provides a workable prototype of a photocatalytic device tested with satisfactorily results. There is certainly a long way from a prototype to a marketable product at costs accepted by the industry but reactions by ports and terminals are encouraging.

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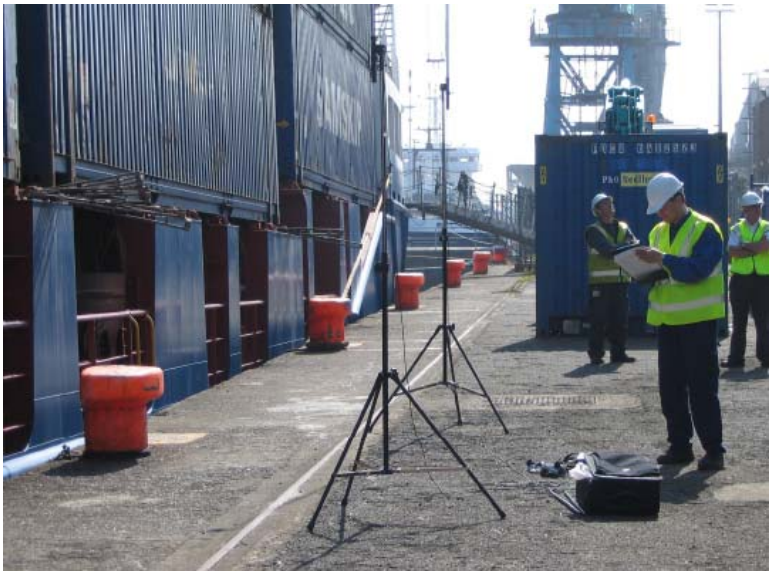
Noise Annoyance

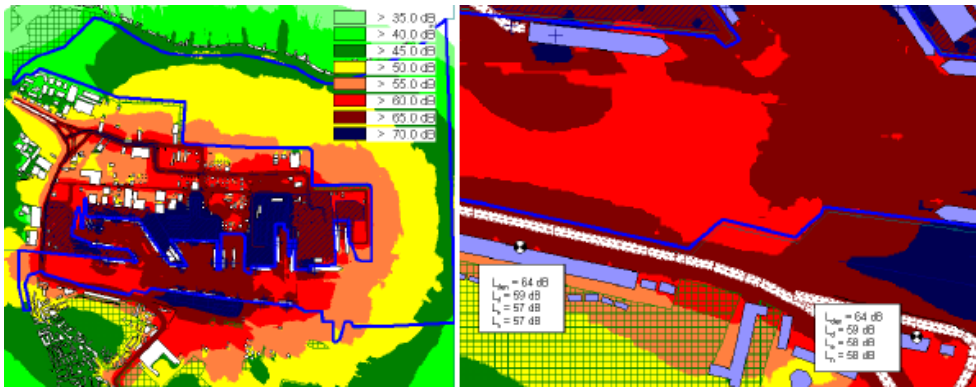
Alert signals of vancarriers and the bumping of containers on top of one another or on the ground, together with the wide variety of port noises can really become a pain in the neck for nearby residents. It will, however, not be very efficient to combat all kinds of noises in the same way and with the same priority. Further knowledge needs to be gained about the annoyance factor of port-specific noises. The difficulty is that this factor is subjective rather than objective. So rather than just to measure, one must conduct empiric studies to identify annoyances due to noises, their sound power level, frequency and regularity or irregularity. Because

the amount of annoyance sensed is subject to individuals, their condition and mood, the results can only match a majority of a certain collective rather than all individuals at all times under all conditions.

Noise mapping has been performed in two test ports: Dublin and Turku.



Soundpower measurements in the Port of Dublin



Noise Maps Port of Dublin

The most significant factors affecting sound propagation are:

- Geometrical attenuation
- Atmospheric absorption
- Wind gradient
- Temperature gradient
- Turbulence.

Weather can have a significant effect on sound propagation.

Environmental noise monitoring was used to assist and validate noise mapping but also to develop a concept to support port and terminal operators to deal with complaints from nearby residents concerning noises from operations of existing facilities and to design new ones.

Conclusion

Measurement of sound pressure and frequencies within an industrial environment is nothing new, however, the EFFORTS approach to consider subjective perception of noise annoyance and to identify standards contributes to the fact that human beings feel differently bothered by the same noise under distinct conditions.

The project findings are a valid methodology to mitigate noise annoyance in ports by focused operational or infrastructural measures, thus optimising the impacts of financial investment. Even more opportunities to minimise noise annoyance exist new ports or terminals are being built allowing effective and efficient measurements to be included in the planning.

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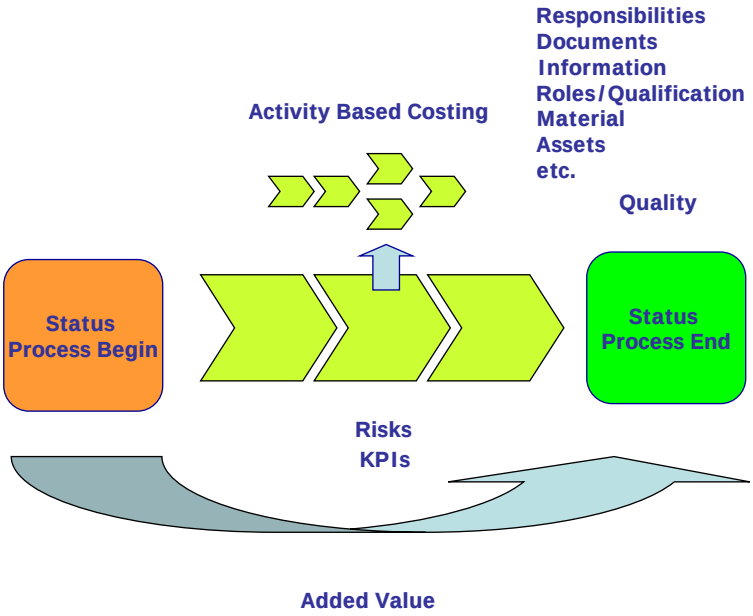
Port Organisation

Besides those ports consisting of just a jetty and a warehouse, medium and large ports are a kind of industrial city of an extremely heterogeneous nature, hosting terminals, storage and production facilities, cargo consolidation and distribution centres and railway stations for cargo trains. Increasing productivity must be achieved on individual service resp. company level but also for the whole port consisiting of a very wide scope of activities. Within EFFORTS the topics “Port Processes” and “Port Risk Assessment and Management” have been chosen to develop further.

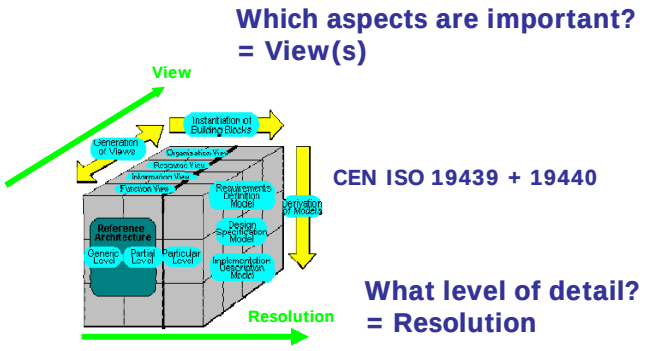
Port Processes

In order to allocate project activities to the overall port system in a rational way so as to allow transparency for those who are not port experts and to ensure sustainability of results to be further amended by follow-up projects, administrational and industrial activities, a process-oriented system approach was developed. Whereas a task-oriented view bears the risk to maintain workflows, methods and tools according to the company history rather than adapt to continuous changing requirements, an objective-oriented process-view allows to consider the activity to generate added values, the purpose of all business processes, as the core of a system to be viewed according to purpose such as resource management, flows and content of information, organisation or cost controlling to name only a few.



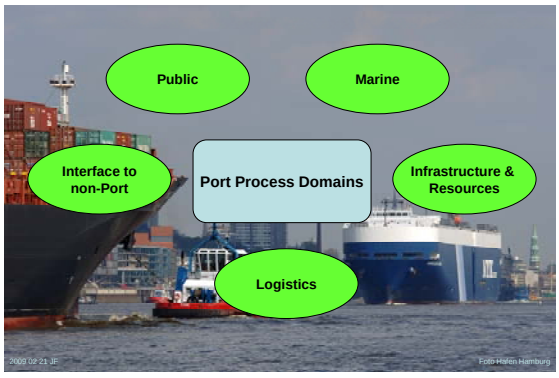
Process-orientation allows various views according to actual management needs

This taxonomy follows CIMOSA (computer integrated manufacturing open system architecture) which became the process standards of ISO CEN 19439 and 19440 which allows treating processes as objects, allocating attributes and defining systems relations, thus also allowing the integration of environmental process aspects into the overall system. Operational, safety, security and environmental issues can be captured, processed and managed under the same umbrella.

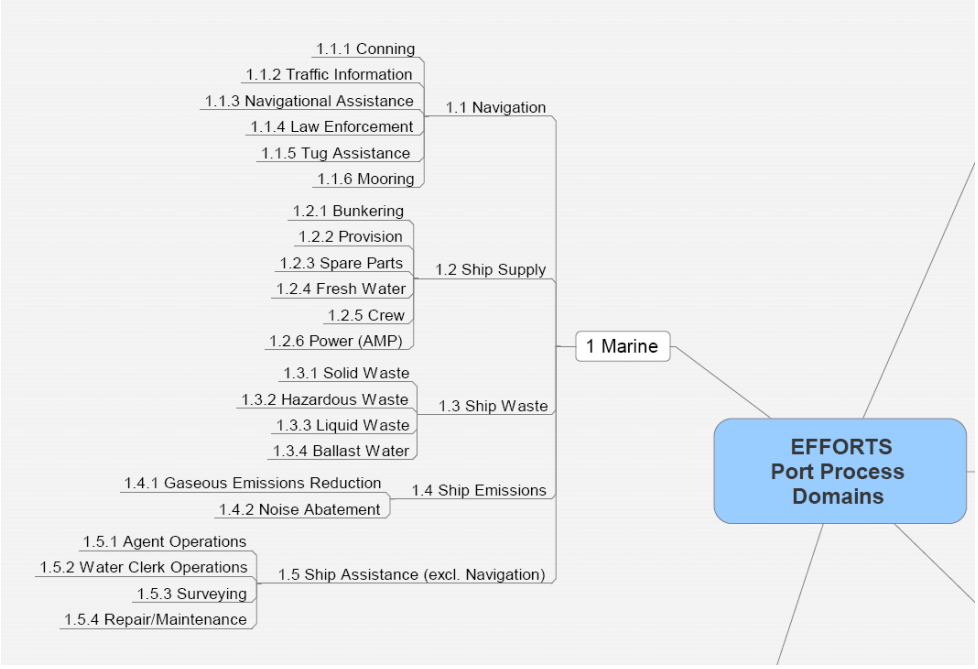


Capturing of processes according to CIMOSA (CEN ISO 19439 + 19440)

Most ports are too complex to easily capture relevant processes so the complexity must be broken down into domains of logically organised operational areas.



Port Processes organized in Domains



Some Processes for the Marine Domain

Ports process parameters must be exchanged between a wide variety of actors, thus information exchange methods, standards and bearers also have been considered and recommendations worked out:

- Conceptual model for process model and specification model as well as the automatic interface via XMI in the demonstrated tools
- Process modelling platform as information portal of port process on generic level
- ICT Tools and ICT Handbook
- Contribution to standards such as ARKTRANS, ISO 28005 and e-Navigation.

In order to reduce the number of required proprietary interfaces between business domains a methodology has been developed to specify standard business processes proven by capturing the exchange of manifest data (Dublin) and ship berthing processes (Thessaloniki).

Conclusion

The EFFORTS approach to disintegrate the complex port and terminal industry including hinterland connections and interfaces to neighbouring industries and residential areas by describing processes allows commencing process capturing in selected areas for all kind of purposes, ranging from mere need to understand the systems to complex re-organisations. The Port Domain Map ensures that fragmented process patches are properly allocated within the overall system to later become amended.

By identifying the processes allows

- to elucidate the complex port and terminal world and to provide a common definition and working platform for collaboration of experts in distinct fields
- a high degree of uniformity in a global port world whereas e.g. a role-based system differs already on regional or national level
- to build a redundant-free system to capture and manage e.g. resources, process costs, key performance indicators, organisational and management issues.

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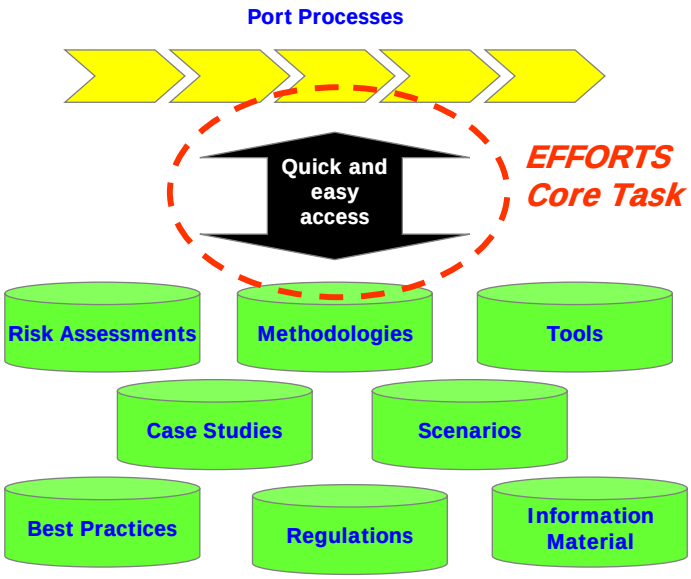
Risk Management Framework

Risk assessment and management in ports is difficult and cumbersome because risk experts usually are not familiar with port processes and port experts do not know how to determine and manage risks. To bridge the two worlds of port and risk experts the RAPORT platform was developed.

Target groups are port and terminal operators to understand the risk methodologies and tools in order to competently prepare risk studies once required and to implement and operate risk mitigation measures.



Access to risk-related information

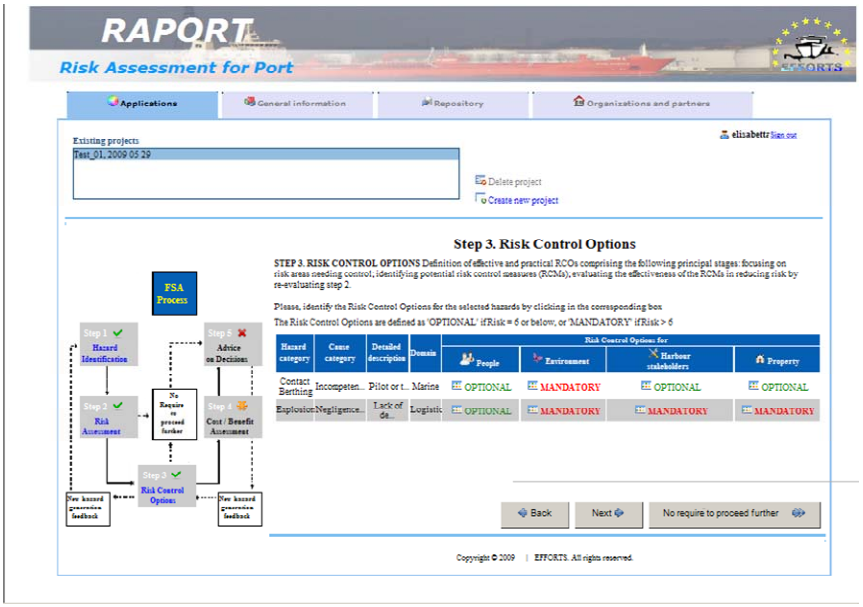
A web-based platform to perform the different steps of the risk management according to the FSA (Formal Safety Assessment) process – a widely accepted methodology recommended by IMO – had been developed.

This RAPORT (Risk Assessment for PORT) platform is an information platform aiming to provide a guideline\framework of how ports can deal with risk assessment in a simply understandable way. The platform contains different sets of toolboxes to support risk assessment activities in port. It also includes description of how the port operators can use specific information for FSA process in an effective way. The environmental and secu-

rity aspects will also be considered with the identification of the related hazards and the linked risk control options (RCO).

RAPORT platform enables the port stakeholders:

- To assess mitigation measures by selecting the required risk control option (RCO) or by adding new ones
- To evaluate the effect of the selected or added RCOs and to compare the different solutions by the cost benefit analysis.



Web access to RAPORT

Conclusion

RAPORT allows integrating risk assessment into the daily routine of port managers but also under non-routine conditions like infrastructural modifications. The approach does not aim at making risk experts redundant but to qualify port managers to properly determine terms of reference once a professional risk assessment is required. Better understanding risk issues

results in really exercising risk mitigating behavior during all operations rather than just describing these in experts' reports difficult to understand by port and terminal staff.

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Education, Training and Human Resources Development

Lack of sufficiently qualified and properly trained staff on vocational as well as academic level poses a serious threat to further development and competitiveness of European ports.

Main project achievements on vocational level are:

- Observatory of Skills: EU Ports Training Needs Monitoring System
- EU Port Passport of Skills of Competencies.

The concept of a European port passport of skills will allow greater mobility for port workers across the industries and across Europe based on a much enhanced system of training for port operators.

The overall aim was to provide a package for port HR and Training Managers to align their training needs and relevant courses to identified gaps in training.

As a result from close cooperation between the ports of Livorno and Dublin, the Observatory provides the state of the art in port training management software. It takes into account the competencies of knowledge, skills, capacity, attitudes, behaviours and capabilities of port workers and where in their work life cycle each individual worker is at any stage. It is a multi-layered tool aligning company structures, business processes, competencies and training.
With relation to the academic level the following work has been performed

- Documentation of state of the art
- Review of existing courses and training programmes geared towards port operations and processes, port administrations and authorities, port roles and inter-modal processes based on information from
- Contact to universities in UK, Germany, Ireland, Italy, France, Poland, Belgium, Netherlands, Denmark, Norway, Sweden, Spain, Portugal and Greece.
- Contact to organisations such as ELA, ESPO, Livorno Port Authority, Port of Dublin, Port of Marseille, Port of Le Havre, HPTI, UN.

Collected information was catalogued according to country, organisation, course title/content, related port role, language, duration, etc. and stored on the European Port Training Inventory database. This exercise facilitates the identification of existing training gaps and the establishment of a benchmark for integrated training in European ports.

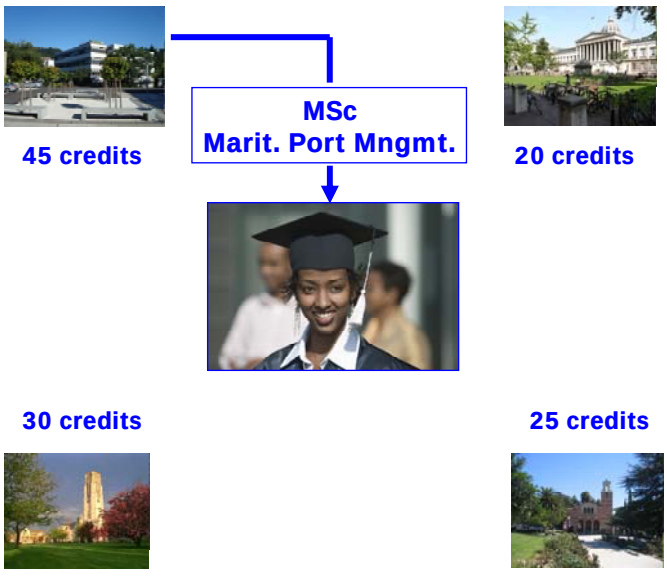
Port Staff Qualification Concept

The EFFORTS Port Staff and Qualification Concept

- allows for selective improvement of individuals‘ qualification in relation to the port industry
- fosters European qualification standards allowing for easy transfer of professionals across European ports
- ensures transparency of said standards to also improve transferability from the port industry to other industries and vice versa.

Port industry-related European academic education as any other European academic education must comply to the „Bologna Model“ providing a bachelor (BSc or BA) on the undergraduate level and a master (MSc) on the graduate level. After successfully concluding a master course it is possible to achieve a PhD.

There is currently no university in Europe offering a comprehensive port industry-related course program concluding with an academic degree. EFFORTS proposes a University network (not restricted to Europe) offering a catalogue of port-related and general modules for executive courses based on „blended learning“. This approach allows combining the relevant course competencies distributed all over Europe and beyond. Participating universities mutually acknowledge credits and one university will issue the degree upon fulfilment of specified requirements or graduates will receive a joint degree from cooperating universities.



MSc-degree achieved by combining courses from cooperating universities including a blended learning concept

Conclusion

Port staff on operational as well as managerial level is increasingly challenged by clients demand on one side and process requirements on the other, however, there is currently no tailor-made qualification concept or program available. The extraordinary skills and knowledge of port staff is not adequately recognized by other the port industries.

The EFFORTS approach bases vocational training and academic education on port and terminal requirements and appropriately bundles qualification measures efficiently and effectively, at the same time generating European port skills and competencies standards. The opportunity to extra-occupational qualification measures contributes to the fact that the port industry challenges like in other industries cannot satisfactorily be met by once in a life-time training and education. Life-long learning is the key and this must be possible without quitting job. The EFFORTS didactics concept of blended learning, i.e. combining presence courses with distant learning, provides the solution. Combing port and terminal knowledge distributed to various universities and to issue a cooperative graduation certificate is another EFFORTS feature to optimum integrate further qualification into the working environment.

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