HydroTesting Alliance (HTA)

An alliance to enhance the maritime testing infrastucture in the EU

Project 031316

Instrument: Network of Excellence

Thematic: PRIORITY 1.6.2 Sustainable Surface Transport

Publishable Executive summary

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Project coordinator: Mr. A.B. Aalbers

Project coordinator organisation: MARIN

An Alliance to Enhance the Maritime Testing Infrastructure in the EU

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HTA ACTIVITIES

Hydro-Testing Alliance (HTA) project is the European Network of Excellence (NoE) to facilitate the continuation of world leadership of the European Hydrodynamic testing facilities. HTA is supported with funding from the European Commission's Sixth Framework Programme under DG Research, project number 031316. The Network of Excellence started on the 1st of September 2006 and it will have the duration of five years.

The main interest is the measurement and analysis techniques that are used for testing ship and offshore structure models in the water basins of the institutes. Various groups of researchers will be developing new technologies under the framework of the Joint Research Projects (JRP) of HTA so that these technologies can be used in the basins. For such new technologies, there is a need to develop measurement and analysis policy and procedures for hydrodynamic and related structural testing. This will ensure uniform approach which can be adopted and implemented by the industry. Several activities within the HTA project were used to raise the awareness of the marine hydro-testing facilities and also to promote the industry to both male and female students and researchers.

In the following sections the activities in the 5 years of Hydro-Testing Alliance between September 2006 and September 2011 will be reviewed.

1.1 Joint Research Programmes

JRP1: PIV operation in hydrodynamic experimental facilities

During the five years JRP 1 has been working under the umbrella of HTA project on the improvement and exploitation of PIV techniques in operation in hydrodynamic facilities, as well as changing technical knowledge and know-how between the researchers of 14 HTA partners on:

- PIV-3C operation in towing tanks, cavitation tunnels, in shallow water tanks for flow measurements in wake flows (ship wakes, propeller wake, rudder wake, bench-mark flat plate wake) covering the following issues: particles seeding, optical adaptation, synchronization of measurements, PIV calibration procedures.

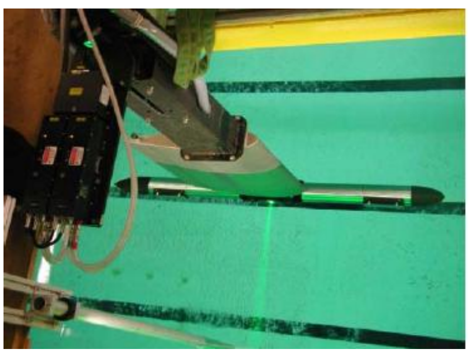


Fig. 1: Integrated light sheet probe

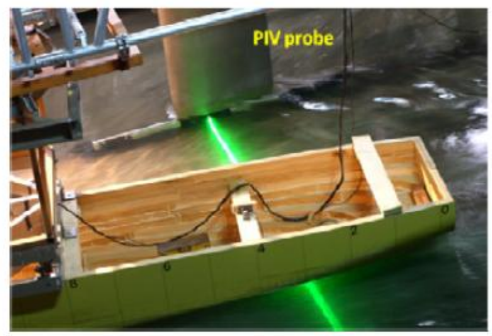
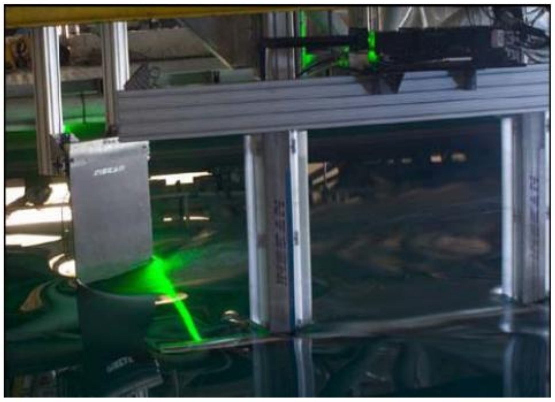


Fig. 2: PIV probe in towing tank

- PIV-3C operation in surface flows (waves, water surface run-up, shallow water wakes) including the following issues: particles seeding, optical adaptation, light reflections at the surface, flow unsteadiness
- Nuclei measurements (with three different techniques): small nuclei sizes under the constraints relative to the large cavitation tunnel (nuclei size, concentration, distribution), simultaneous measurement of nuclei size and velocity field downstream a propeller
- Organisation of a benchmarking programme (flat plate wake in towing tank, and in cavitation tunnel) which is open to HTA members as well as to organizations external to HTA network (with particular interest from ITTC Specialist Committee on Detailed Flow Measurements), the delivery of bench mark specifications (available on HTA website), data-base of PIV measurements (restricted access). Nine benchmark experiments has been con-ducted by JRP1.
- Inter-comparisons of PIV-3C and PIV-2C systems of the different partners of JRP-1 (including their mode of operation: seeding techniques and calibration techniques) through the benchmarking programme
- Development of best practice guidelines for practitioners in hydrodynamic facilities, based on JRP-1 experience

- Dissemination of results and work in progress (HTA website, participation in HTA work-shop in Gdansk in 2008; participation in conferences AMT09, AMT11, PIV07, PIV09, Laser application in Lisbon in 2010)



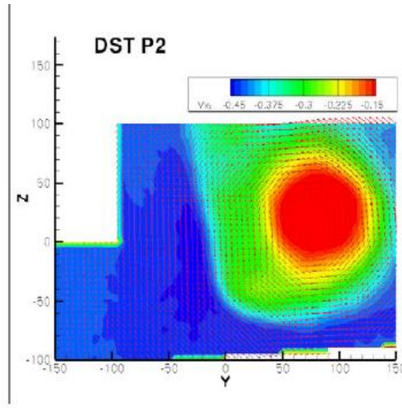


Fig. 3: Flat plate in the towing tank

Fig. 4: PIV results in transversal plane

Apart from this valuable technical knowledge it has been the major achievement of HTA to have an open minded and trustful working atmosphere amongst the 14 JRP partners. Applications of PIV techniques were openly discussed to share experiences on the preparation of experiments, presentation of results, inter-comparison of techniques and results, visits to facilities during tests. Existing hardware have been listed and demonstrated.

For the future, it has been agreed between JRP1 partners to continue the cooperation on a voluntary basis by holding yearly meetings, also including technical workshops on benchmarking activities and on best practice guidelines. Here the latest PIV applications in hydrodynamic facilities will be reported as much as possible with respect to customer confidentiality. Cooperation between ITTC (Detailed Flow Measurement Committee) and JRP1 will be continued, regarding benchmarking activities and best practice guidelines. Dissemination of results will be continuously updated on HTA website, through HTA Forum Network meetings and Newsletters and scientific publications. Further to that the PIV hardware and software inventory list established within HTA project will be kept updated by the latest purchases or through presentations of hardware providers (cameras, lasers, PIV systems). Developments of services (exchanges of hardware, software, expert practitioners, sharing equipments) and technologies (new equipments, new types of PIV systems) between JRP1 partners will continue through dedicated collaborative projects and JIPs.

JRP2: Flow data analysis and visualization

After several years of fruitful co-operation between the members of JRP2 (flow data processing) we found that it is time to say goodbye. Within JRP2 we have studied the feasibility of a decent number of flow visualization tools, to assess their capabilities to visualize the flow structures that are typically of interest in (ship) hydrodynamics. With respect to the extraction of complex flow structures from data sets we have worked on the detection and visualization of vortex-like structures in a flow. Several methods have been proposed in the literature to distinguish a vortex from its surrounding flow, but not all methods are useful in all cases, especially when the vortex in embedded in, for instance, a boundary layer. The detection of these vortices is not only useful for visualization, but can also be used in numerical methods to define criteria for adaptive grid refinement.

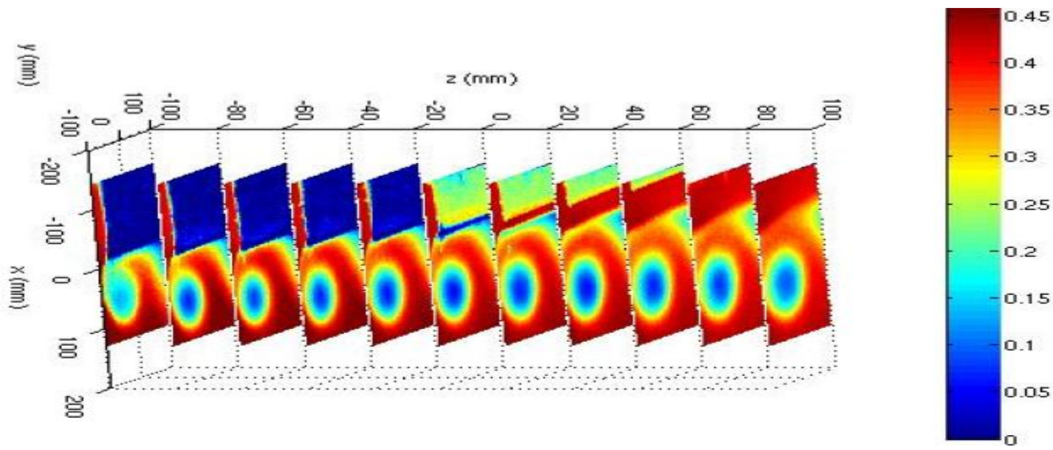


Fig. 5: Visualization of vortex flow behind a flat plate under an angle of 20 degrees; source: PIV benchmark (HTA-JRP1, contribution MARIN).

Finally a lot of work has been devoted to the definition and the introduction of a common data file format. Evidently a single data file format streamlines the exchange of data between members and thus it was decided to focus on the so-called CGNS data format that is already used extensively in the CFD community. We have written data converters and provided them to the other JRP's, and to minimize the required effort to start using this format (it can handle much more than a single user normally needs). We have written two reports that can be used as an introduction to this format, which are available on the HTA website. It is now to all of us to start using this format.

JRP3: 3-D wave field measurements

A Joint Research Project (JRP) has been completed on the development of improved and new laboratory equipment for 3-D Surface Wave Field Measurements in wave basins and towing tanks. Six European testing institutions were partners in the work. Results from the work include two main types:

1. Improved multi-probe point measurements for efficient routine use.

- A simple routine analysis method for laboratory calibration of multidirectional wave spectra has been developed and tested, with special focus on resolution of 2-peak spectra. A good resolution is obtained, and the tool is ready for final validation and optimization.
- A prototype of a new cheap underwater ultrasound probes for use in large arrays to measure ship waves in shallow-water towing tanks has been developed with thorough investigations, and is subject to further testing, optimization and production.

- A new design for a resistive wave staff has been developed and tested, leading to more functional and efficient use in the lab.
- The optimal use of servo point probes in sea-keeping tests has been explored experimentally in a wave basin, and useful experiences have been reported.

2. Experimental feasibility studies on the use of a Stereo-Vision Video Method in indoors wave laboratories.

- It is found that the stereo vision approach can in principle be used for laboratory surface wave measurements, which opens for a range of interesting applications, but the lighting and image quality conditions represent a critical challenge due to indoor conditions.
- A diffuse lighting is preferred, and points on the sea surface should be identifiable (e.g. by ripples, project pattern, seeding) for the photogrammetric algorithms to work satisfactorily. These requirements may be difficult for routine tests in an indoor laboratory, and conditions need to be further explored and improved before a useful system for practical use is achieved.
- Another advanced optical method, the Laser Sheet method (existing method, not developed in this project), has been demonstrated and proven to produce good results on ship waves in a towing tank.

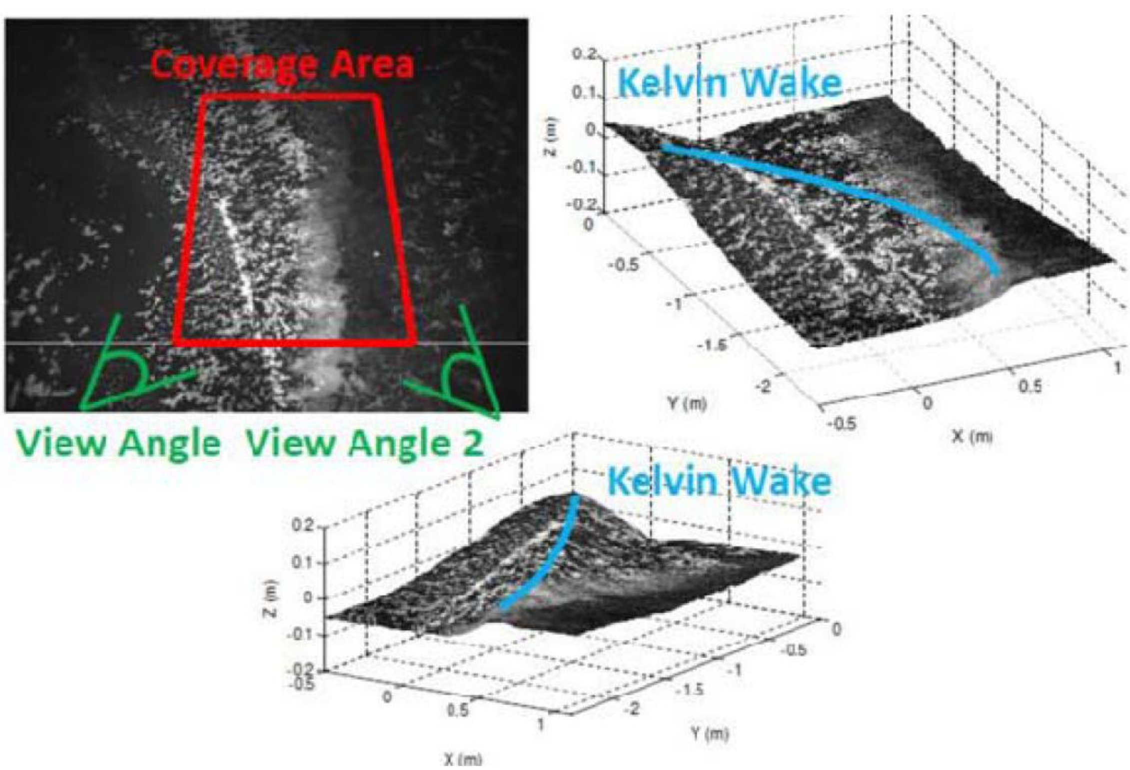


Fig. 6: Stereo imaging measurement of ship waves in a towing tank using seeding of water surface.

In conclusion, multi-point array methods will still continue to be in use, and optimized equipment and analysis procedures for robustness and accuracy will be important tasks. At the same time, promising optical methods are in development, and it is expected that future experiments can be completed by more detailed information from such techniques. In particular, the stereovision method has been addressed here. There is still a way to go before a useful optical system is achieved, but useful experience has been gained in this project for future development. The topic may be further developed within the new HTA Forum Network.

JRP4: POD / Dynamic forces

The following works were executed within the Joint Research Project No. 4 (JRP4):

- The overview of the methods, devices, practices and problems in experimental investigation of pod driven ship models
- The test campaign consisting of ab. 50 different benchmark tests related to the investigations of pod unit's characteristics. The analysed case was selected in cooperation with ABB Oy (Industrial Partner), taking into account some previous experience and research works. The sets of experimental analyses consisted of open water tests of the propeller, the pod housing, the pod unit (the propulsor housing with the dedicated propeller) as well as additional experimental analyses in oblique flow, carried out for wide range of test parameters
- Elaboration of guidelines, conclusions and observations made during the benchmark tests, incl. description of standardised procedure applied for the benchmark tests and discussion of guidelines for other test cases (not analysed experimentally within the JRP, but discussed during the meetings)
- Design and manufacture of standardised pod unit model (allowing for application of alternative measuring systems) and other components of measuring test stands. Studies related to applied, non-standardised equipment used for the tests as well as other hardware issues (discussed during the meetings)
- Review of scaling procedures and CFD comparative studies performed in both: model and full scale for wide range of parameters (as propeller modelling, turbulence models, density of computational mesh, etc.).

All Tasks were summarised in the related deliverables. Moreover, some additional works were executed within the JRP, incl.:

- Elaboration and distribution of the questionnaires: "internal" (in order to verify the actual experience of JRP4 Participants) and "external" one, related to full scale problems plus correlation between experimental investigations in model and full scale (dedicated to external users as Industry Representatives).
- Participation in both AMT Conferences (Nantes, 2009 and Newcastle, 2011) - 4 papers.

- Participation in the 1st HTA Summer School (Gdansk, 2008) incl. set of lectures and test demonstration.

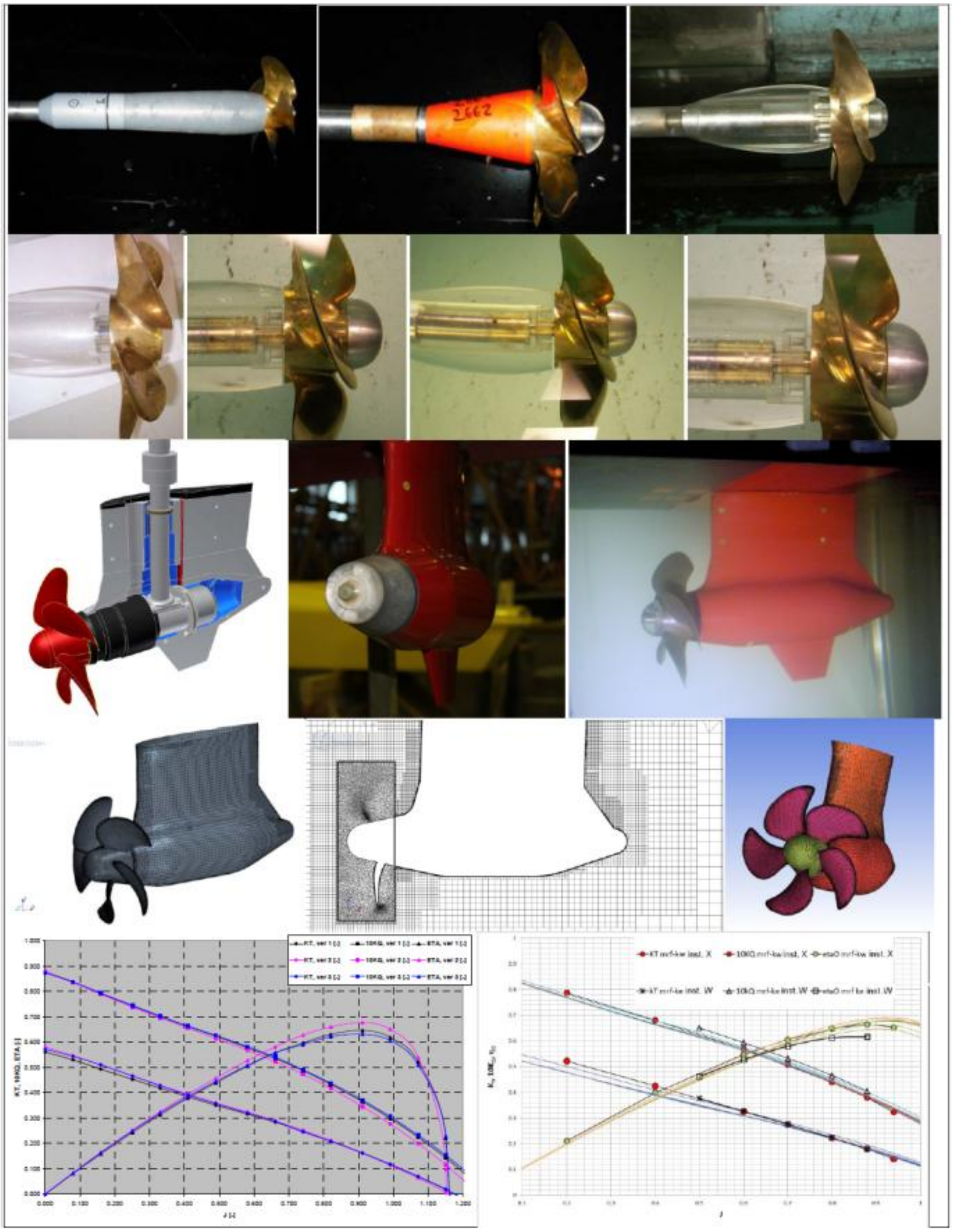


Fig. 7: Collage of drawings and photos presenting different tasks and stages of JRP4 – exemplary alternative configurations selected for benchmark and parametric tests (rows 1-2); visualisation of the universal pod housing and the model of pod unit during the tests in towing tank and cavitation tunnel (row 3), some examples of applied computational meshes (row 4) and exemplary results of the experimental analyses (influence of fairing cone geometry) and CFD studies (in relation to experimental data) (row 5).

Last, but not least, a direct cooperation between JRP4 Participants allowed for exchange of knowledge (related not only to pod issues), establishing both: scientific and commercial relations. 13 JRP4 meetings were held, incl. presentations of Participants' facilities and some demonstrations. Taking into account the experience of last 5 years, JRP4 Participants have agreed to continue their cooperation on the basis of the lasting structure of Hydro-Testing Alliance Forum Network.

JRP5: Wireless data transmission

The activities performed by JRP5 during these last few years have been aimed to simplify and improve the utilization of wireless instrumentation and data acquisition devices in hydrodynamic model testing. There were five partners participating, DST, INSEAN, MARINTEK, SSPA and VTT. They all started their work in 2007, sharing their experiences about their experimental test setup in order to identify the suitable applications "in need" of wireless solutions.

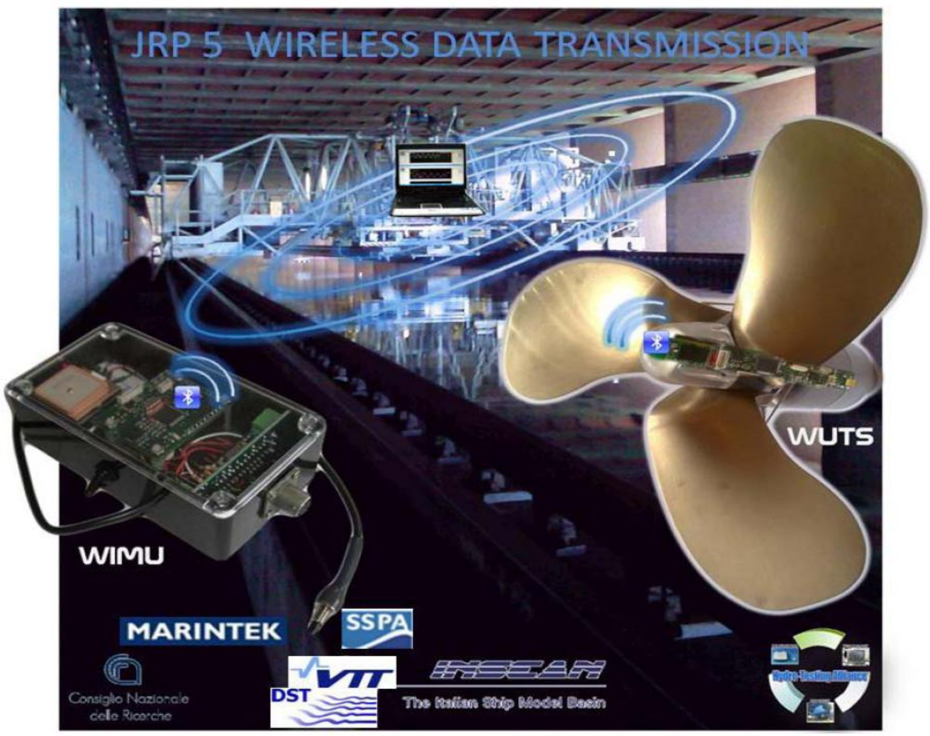


Fig. 8: Wireless data transmission system.

This first phase of our study, allowed us to better understand how similar hydrodynamic test setup have been implemented with different approaches by the partners. In many cases there were common technical problems, partially solved by some of the partners, which became apparent. Looking through these differing solutions it became evident how, applying a wireless technique, a general improvement of the experimental test setup could be achieved.

Within in the first and second year of activities, a complete definition of the requirements in terms of "hydrodynamic wireless setup" have been done and the term "wireless", when applied to the hydrodynamic tests had to be re-defined assuming a more general meaning. This was because usually the term "wireless" implies that it is a wireless data transmission but in our test setup it must be defined as "Wireless test setup" which means that all the data acquisition chain (signal conditioning and amplifiers, power supply system, D/A conversion, data storage…) must therefore be Wireless. Because of this, new unexplored problems have been investigated with results leading us to then be able to apply and use with reliability real wireless systems in our particular environment. Some of the more significant practical case studies have been selected, trying to apply these new wireless solutions where the advantages in terms of time setup reduction, data reliability, improved accuracy in the measurements, can be maximized. The selected case studies are:

- Wireless set-up for sea-keeping model test Wireless setup for free running model with control capability of actuators
- Wireless setup of typical transducer used in towing tank tests
- Wireless setup of a rotating shaft For each one of these one or more practical solutions have been implemented and tested. In some cases the technological setup is based on a full custom design, when, due to some physical limitations, the products availability on the market does not fit with the specifications, in others cases mixed custom- commercial solutions have been used . Many interesting results have been obtained in this experiment, this was mainly due to the fact that within the inside Hydro-Testing Alliance we were able to share in regards to the different partners knowledge and needs.

Among the outcome of HTA activities inside JRP5 has to be highlighted the realization of two products fully engineered and described in two papers submitted to AMT'09 and AMT'11. The first product is a Wireless Inertial Motion Unit to be used in the sea-keeping test based on the Bluetooth technology small (50x30x20 mm) and light (20g + 60g of battery). The technological solutions developed in this applications in terms of power supply management, data acquisition, and signal conditioning have been used as the base for the design of the second product, which is an underwater torque measurement system for self-pitching propellers. In this case most the experiences performed during these years are condensed and applied in this application and two solutions are at the moment patent-pending. As example all the electronics, and the radio link are enclosed in the hub, and the hub itself is a torque transducer. This data link with this kind of frequency range, that also works underwater, is believed to be one of the first available functioning product within the market.

JRP6: High speed video

Among others it is the observation and recording technique, which is decisive for the quality of a propeller cavitation test carried out at model scale in a cavitation tunnel or depressurized towing tank. For more than one hundred years this technique did basically not change: The movement of the propeller blades was frozen by flash light synchronized with the propeller shaft speed, resulting in one picture of the cavitation pattern per revolution. The cavitation dynamics during the rest of the revolution was hidden in the darkness. The temporal development of the cavitation, which is responsible for propeller erosion damages, vibration excitation and noise emission, could not accurately be studied by this conventional technique.

To overcome this shortcoming, high speed video became a very valuable tool, which comes more and more in use by the leading cavitation testing facilities in Europe. This technique provides thousands of pictures every second, i.e. hundreds in each propeller revolution. It provides a continuous recording of the cavitation dynamics. The JRP 6 group, consisting of HSVA as leader, MARIN, SSPA, INSEAN, Chalmers and Twente University, went out five years ago to overcome the problems related to this new technique with joint forces.

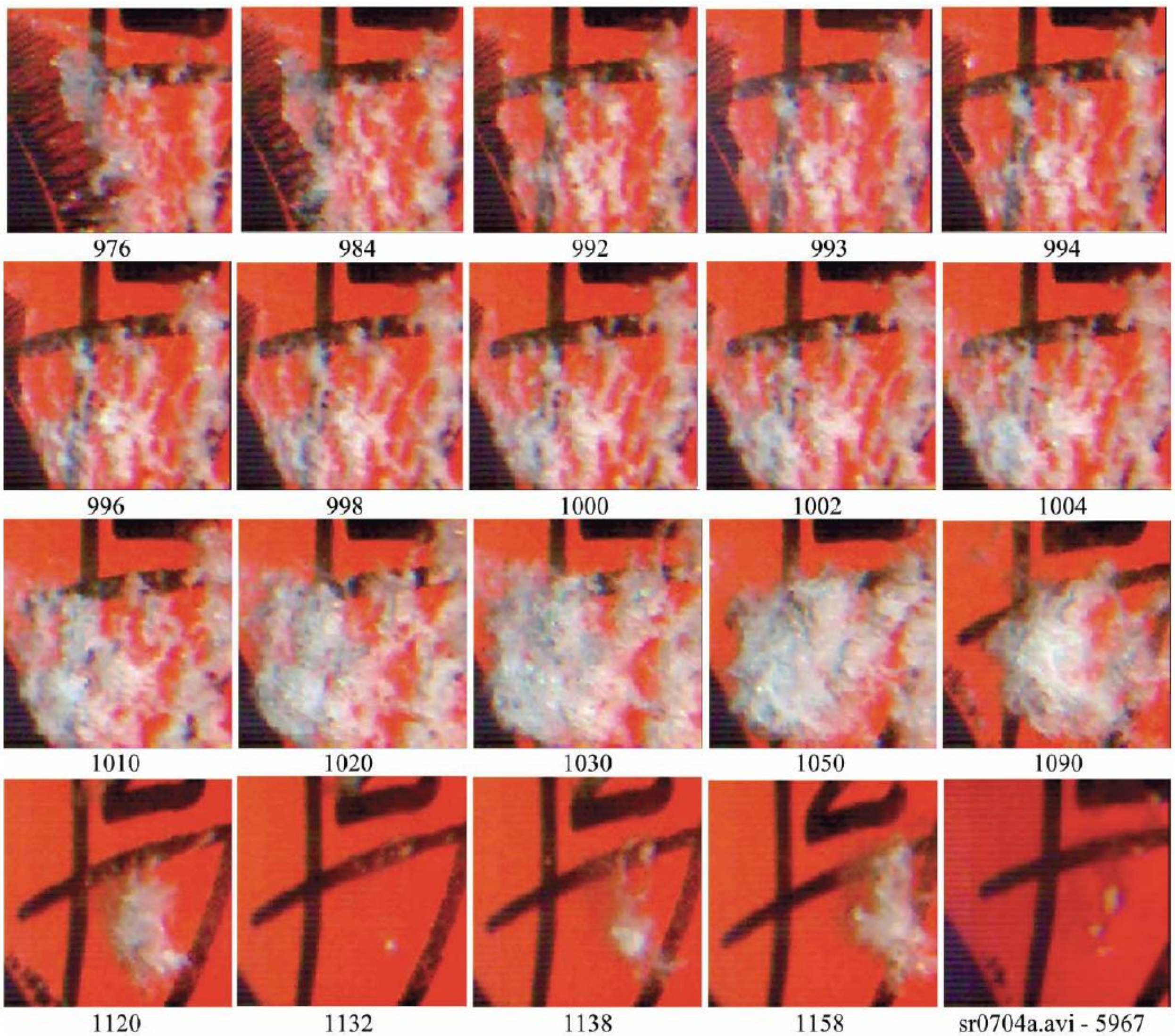


Fig. 9: Selected Frames from a High Speed Video Recording, Showing a Collapsing Sheet Cavitation

A valuable deliverable on interpretation of high speed video records with respect to erosiveness of the recorded cavitation phenomena has been elaborated during the last five years. Even if the mechanisms of cavitation erosion are still not fully understood, this compendium helps to predict cavitation erosion because it explains, how erosive cavitation looks like in a high speed video record. Another highlight of JRP 6 is a deliverable that compiles all the existing knowledge to improve the quality of high speed video records for cavitation testing. The extreme light requirement, limited resolution and focus depth, motion blur or water quality have been addressed here. This helps to arrive quickly at optimum test set-ups and equipment settings.

A hardware inventory has been established, listing all high speed video equipment existing at the JRP partner institutes. This inventory also includes detailed technical information on the equipment and eases share of it whenever necessary. Other problems like the huge amount of data coming with high speed video, the two-dimensionality of a video picture or the need for simultaneous acquisition of other data (e.g. pressures or flow speeds) have been addressed during the past five years and led to valuable deliverables.

All these achievements, together with the quickly ongoing development of faster and more sensitive to light cameras by the industry, will make high speed video a more and more indispensable tool for cavitation testing in future. Besides all these technical achievements it cannot be ranked high enough, that during the past five years an open minded group of researchers from partly competing companies has been established, joining forces without reservations and willing to continue under the roof of the HTA Forum Network.

JRP7: Intelligent materials and new production methods

Six partners were involved in this JRP (SSPA - JRP leader, VTT, INSEAN, MARIN, CTO and MARINTEK and the work was divided into two independent tasks:

- Advanced Model Manufacturing
- Intelligent Materials Advanced Model Manufacturing In hydrodynamic testing model manufacturing constitutes a large proportion both of the total costs and the total lead-time.

By utilising new manufacturing methods the costs and lead-time of model manufacturing can be reduced and the European hydrodynamic testing institutes can improve their competitiveness. A state-of-the-art review was carried out in order to evaluate the most commonly used Additive Fabrication (AF) methods, often called Rapid Prototyping (RPT) and subtractive methods like High Speed Machining. The evaluation comprised the size of parts that can be manufactured, material properties, manufacturing precision such as accuracy and surface finish, manufacturing time and cost. The conclusion from this state-of-the-art review is that Additive Fabrication technologies may be regarded as complementary to subtractive ones. They should be used if the situation calls for:

- complex or intricate geometric forms
- simultaneous fabrication of multiple parts into a single assembly
- multiple materials or composite materials in the same part.

Based on the state-of-the-art review some of the most promising methods were selected for manufacturing of selected trial parts. Propellers, nozzles, pod shells, V- and I-struts, flap rudders and some more parts were manufactured by various techniques and in different materials. The conclusions from the samples that were manufactured and tested are:

- it is important, for each application, to select the right manufacturing method and material to achieve an optimal result
- the new methods have great potential in to reduce both cost and lead time significantly
- the manufacturing methods regarding speed, accuracy and reduced costs and material properties regarding stiffness and strength are developing rapidly Intelligent Materials

The overall objective was to investigate the application of 'intelligent materials' for measuring and visualisation of hydrodynamic variables during model tests. Part of the task was to focus on information management with respect to new materials. Information was continuously uploaded and made available on the HTA website. In another part of the task a specific paint (S3F = Shear and Stress Sensitive Film) for measurement of skin friction was considered. Attempts to test the technology have been made. A lot of different thin, pressure-sensitive products, which are used as pressure array sensors, currently exist on the market. This market was reviewed and a couple of technologies have been tested and evaluated. Both S3F and the thin film pressure technologies are very promising but need further development before they can be in regular use in hydrodynamic testing.

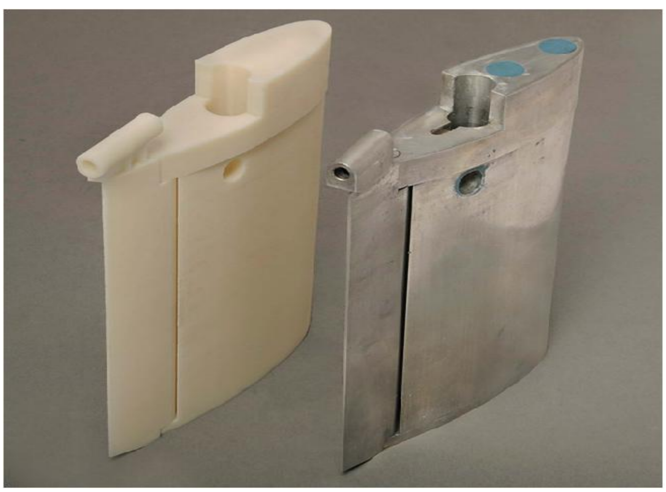


Table 1: Differences between the manufacturing methods.

Manufacturing method	RPT (FDM)	Milling
No. of parts	1 (no assembling)	6
Material	ABS	Al
Cost ratio	1/3	1
Lead time ratio	1/3	1

Fig. 10: Flap rudder made by RPT (left) and milled aluminium (right).

JRP8: Wetted surface

The Hydro-Testing Alliance Joint Research Project 8 called 'Wetted Surface' has successfully resulted in a software called "Water Surface Calculation" (WESC). The program has been developed together by the four JRP8 partners SSPA Sweden AB (JRP leader), Chalmers University of Technology, MARIN and Marintek.

In the very early phase of the project a study were carried out where different possible techniques were examined how to in a practical, efficient and cost effective way, the wetted surface of e.g. a planning craft could be determined. The reason why it is important to determine the wetted surface for planning craft is that the skin friction has to be scaled in a proper way and that the area of the wetted surface that determines the skin friction varies a lot for a planning craft depending on the speed and load condition. Soon it was found out that the method normally used, i.e. using underwater photographs, was the most promising method to develop further.

The development needed was to make this method a semi-automatic method instead of the existing time consuming manual method. The development started with a so called 'Development System' which included three main phases:

1. Waterline detection using image processing techniques
2. Camera calibration
3. Waterline projection leading to wetted surface calculation

After some initial studies it stood clear that the most efficient way to create this system was to base it on MATLAB and the surface code Rhinoceros. When the different parts were developed an "Operation System" was created called WESC. The main feature with this code is consequently that a very time consuming manual procedure is replace by a much faster semi-automatic system that provides for higher quality of the calculations mainly by the fact that a number of possible human errors can be eliminated.

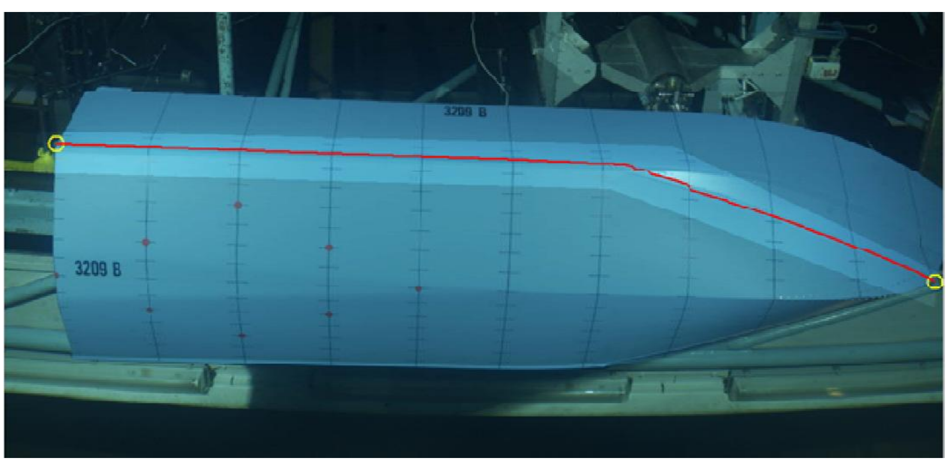


Fig. 11: Underwater photograph taken of a planning craft. The waterline is determined by use of image processing and the wetted area is calculated automatic using the WESC code.

JRP9: Free running model technologies

During five years, technical knowledge and know-how has been exchanged between the re-searchers of the 6 HTA/ JRP 9 partners on improvement of 'Free running model technologies' for a range of indoor and outdoor test applications, on both surface and subsea ships.

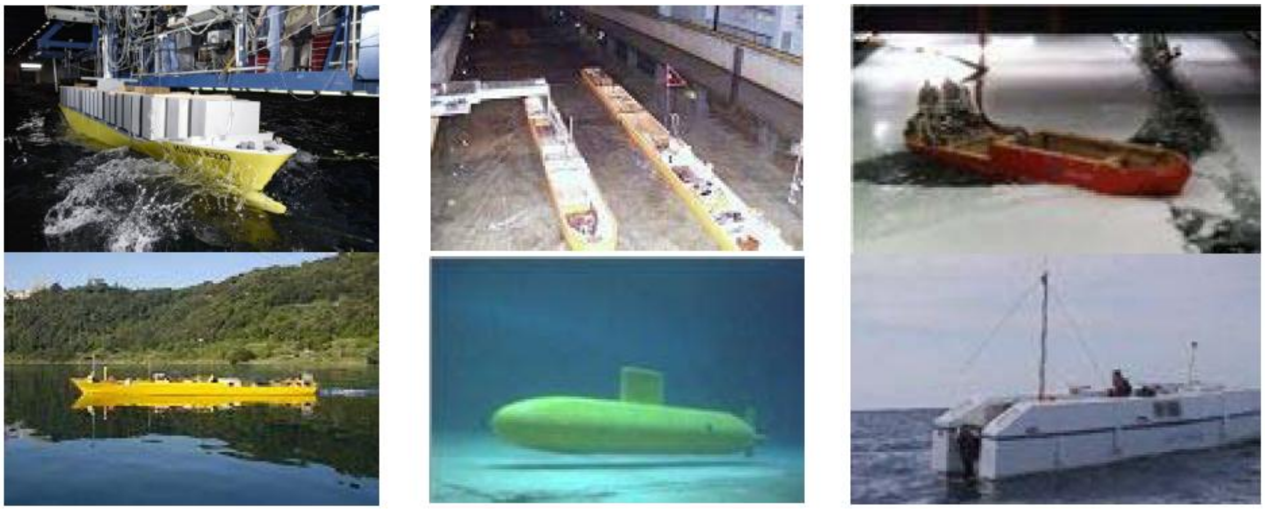


Fig. 12: Various applications of free running technologies.

The main focus of this JRP was to improve knowledge and testing methods and to find and test new technologies. After a complete inventory of technologies used by partners for free running model tests, the four following common research topics has been identified:

- Motion and trajectory measurement systems (indoor/outdoor, surface/subsea)
- Onboard acquisition/time tagging/control "Black Box",
- Subsea wireless data communication,
- Onboard power supply and use strategy

During the first phase of the JRP, requirements and specifications for selected applications to be benchmarked were developed.

Next, a Big Benchmarking Event (BBE) was organized at DST, in order to gather several systems available for motion tracking, measurement and control of a free running model and test / benchmark them together. Contact with JRP5 (Wireless data transmission) has been made to perform this BBE as a joint (integrated) event of JRP5 and JRP9. During three days, about 20 scientists and engineers from research institutes and suppliers joined this event. In total 11 different motion tracking systems and 4 wireless data communication systems were benchmarked and assessed.

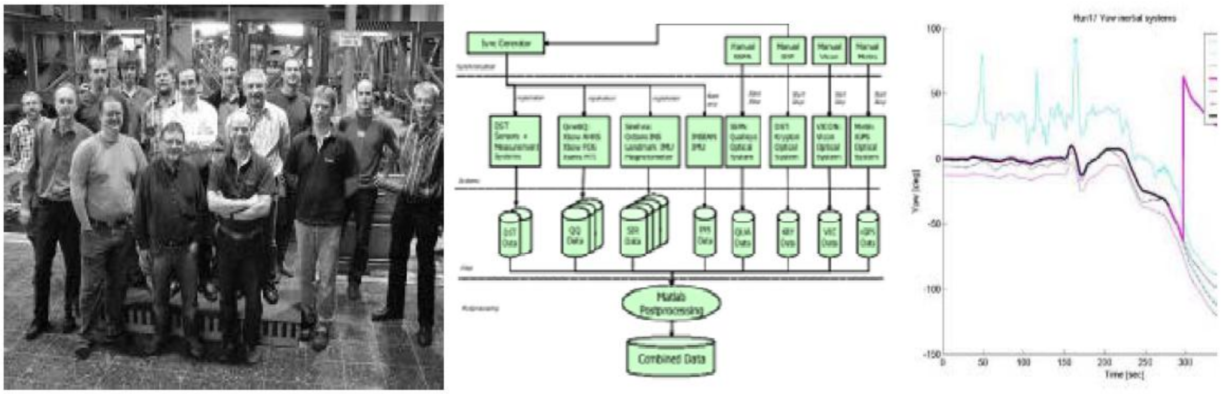


Fig. 13: Big Benchmarking Event.

Finally, in order to share JRP-9 experience, a generic set of 'Best Practice Guidelines for free running model operation' for application within the Hydro Testing Alliance (HTA) community has been edited.

JRP10: Noise measurements

Noise measurement in model scale facilities is still the most reliable method to estimate the underwater radiated noise from cavitating marine propellers during the design stage. Even though there has been considerable advancement within the last 20 years in measuring techniques and facilities for cavitating propellers, the procedures and scaling formula for cavitation noise kept unrevised due to the limited interest of the shipping industry.

This situation has changed considerably in the last couple of years due to the awareness of the influence of shipping noise on marine life which has resulted in a number of international activities. These activities may lead to noise regulations requiring improved ship and propeller design. The complexity of the topic requires international cooperation of the European shipping industry in general and their testing facilities in particular for which the Hydro Testing Alliance is an ideal platform.

Therefore, Joint Research Programme 10 (JRP10) was initiated in the third year of the Hydro-Testing Alliance with the objective to assess the current status of ship propeller cavitation noise prediction using model scale measurements and to develop guidelines for further improvement. The partners in JRP10 are HSVA (Germany), INSEAN (Italy), MARIN (Netherlands, chairman) and the University of Newcastle (UK). The following tasks were distinguished:

1. Aspects of noise measurements at model scale: Four facilities and the sound measurement equipment of the participants were reviewed. Specific aspects that are discussed are extensive background noise measurements in one facility and the influence of gas content and free surface/ship hull/tank walls on the noise transmission and reflection in model scale facilities.

2. Relating model scale to full scale noise measurements: Extrapolation procedures for low frequency hull pressure fluctuations and high frequency radiated cavitation noise are discussed and a relation

between the two has been established. International working groups on full scale ship noise measurements have been reviewed and published full scale noise standards have been discussed. In addition, a candidate for a round robin test, a catamaran built for research purposes, is presented along with the model scale tests that were performed for this vessel.

3. Hydrodynamic aspects influencing propeller noise: Some specific aspects, mostly dealing with the behaviour and consequences of propeller hub and tip vortices are discussed. Results are shown of particle image velocimetry (PIV) measurements in the wake of a submarine and in the wake of a propeller operating in open water. In the latter situation the tip vortices become unstable and break down, as also observed when the vortices are cavitating. In case a rudder is present behind the propeller, both shaft rate and blade rate pressure fluctuations are measured on the rudder which may influence the noise and vibration.

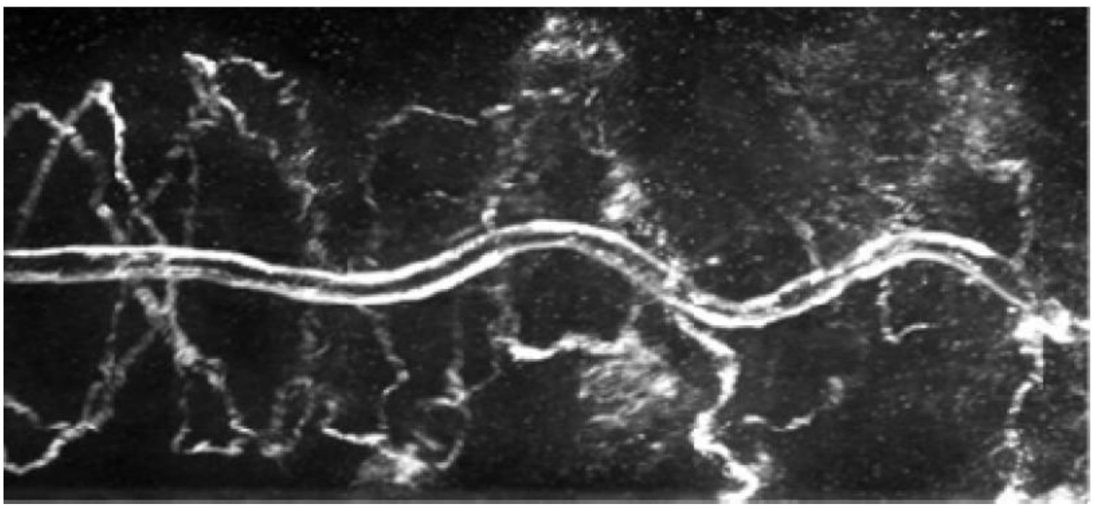


Fig. 14: Example of cavitating tip vortex instability studied by INSEAN

Due to the limited time available for the working group, only some specific aspects could be discussed. These aspects clearly show the complexity of the hydrodynamic phenomena and the measurement and extrapolation of the radiated (cavitation) noise in model scale facilities. The activities of JRP10 will be continued in the formal and lasting structure of the HTA Forum Network.

WP3: Measurement Policy for hydrodynamic and structural testing

How to develop new test equipment? Any new equipment, developed in the HTA, is required: 1. To have documentation of the development process, such as specifications, global design, detailed design and acceptance tests. 2. To provide manuals and documentation for users that enables them to operate the equipment in a safe, satisfactory and efficient way. 3. To meet a measurement uncertainty which is relevant for the validity or application of the results. 4. To have instrument interchanging possibilities no matter which facility it comes from.

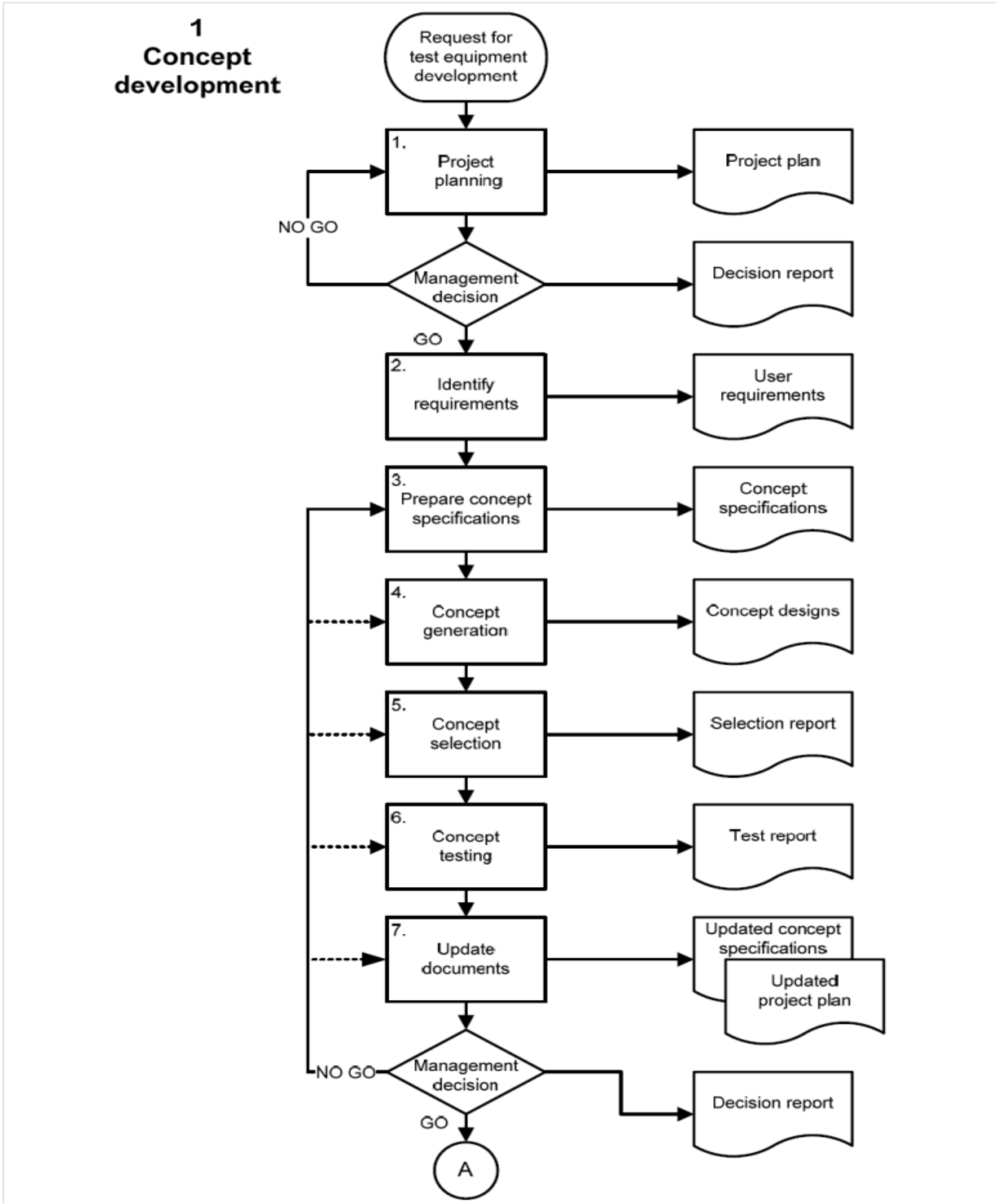


Fig. 15: Flowchart of the concept development phase

In Work Package 3 of the HTA, documentation guidelines for the development of hydrodynamic and structural testing equipment have been developed. The development process for novel test equipment is divided into three phases:

1. Concept development
2. Prototype building
3. Final production

Each phase is first described as a sequential process in a flowchart, see Fig. 15 above. In practice, several iterations may be necessary and some activities may start prior to the completion of the previous activity. For each step in the process, the activities are described and guidelines are given for proper documentation, along with some examples.

Dependent on the complexity of the envisaged equipment, the activities and corresponding documentation can be carried out with more or less detail.

1.2 Workshops

Within the JRPs there have been some events, such as workshops that have also acted as a promotion tool. Of course that was at a smaller scale than with other events organised by the project due to confidentiality issues within the JRP.

As an example, in JRP4 a benchmark workshop on POD drives was organised and that included the participation of a PhD student as well as collaboration with a major pod drive stake holder company who provided data for the benchmark study conducted in this JRP. At a different period there was also a female researcher involved with the JRP and performing some of the work for it. WP3 was collaborated with an outside US institution who had expertise on advance wave measurement system and this resulted in workshop seminar by this institution and joint papers in AMT'11 conference.

WP1 had close relations with the 26th ITTC Specialist Committee on Detailed Flow Measurements which resulted in very useful contribution to this Committee's activities and hence ITTC in general.

1.3 Summer Schools

During the course of the project two summer schools were held (first one in Poland in 2008 and second one in Norway in 2010). The summer schools were held at hydro-testing facilities to give the chance to the students to see the facilities in operation. The summer schools were promoted by all HTA partners and also by WEGEMT.

The schools consisted of three days of lectures on different topics and half day of a career sessions where the hydro-testing facilities had a chance to entice the students. The summer schools were well attended and included students as well as researchers from the facilities. The summer schools not only provided its students with knowledge about certain topics, but it also gave them a real insight to the working environment in a testing facility. This being done by:

- Holding it at a testing facility
- Having a HTA workshop in parallel with the summer school so that HTA researchers could interact and talk to students during breaks.

Organising specific demonstrations and sessions that students could participate in and see the real tests taking place.

1.4 AMT'09 and AMT'11 Conferences

Two conferences were organised during the duration of the project: **Advanced Model Measurement Technologies for the EU Maritime Industry**. The first one was held in Nantes in 2009 and the second one in Newcastle upon Tyne in 2011. They were international conferences and as such attracted people from various countries around the globe, but the majority of participants were European. The conference served not only as a way to disseminate the work performed during the project but also as a networking and promoting event for the industry.

As the events took place at Universities there was a good participation from students (including female students), which again created good opportunities for interaction with researchers from other institutions. The second conference (AMT'11) also had several companies exhibiting their products. These companies provide instrumentations and equipment to testing facilities and were interested to discuss different advances in the technologies required for the facilities.

The feedback from the conference participants indicated that most participants would like the AMT conference to continue as a series. This shows that although there are many other marine and topic specific conferences there is still the need for an event which gets all interested parties together. Because a lot of the technologies used in the testing facilities is used in many other ways in other industries the more general or individual focused conferences tend to discuss the advances in technology but not the application side of it. And this use of the technology and benchmarking that seems to create the link of the participants at the conference and as such their interested in being able to have further events where they can share and discuss issues they related to using these technologies.

1.5 Website

The HTA website on its own is not an activity, but it is the main point of contact with the external community and way of promoting the project and the industry. With the conclusion of the project the website will be modified so that it accommodates the requirements of the new long lasting structure, but will still be the primary way in which the group communicates with the external community.

1.6 Newsletters

Every 6 monthly Newsletters were produced and distributed as hardcopies (in first year) and later electronically worldwide. Hardcopies were also distributed during other HTA occasions to raise public awareness. In each newsletter one of the JRPs' activity was highlighted in details together with a review of other general developments took place in HTA.

1.7 Posters

Series of HTA posters were prepared for HTA and JRPs and they were distributed amongst HTA partners to display on their institutions, especially in open days and other networking occasions as well as during HTA workshops and conferences to raise public awareness. University partners used these effectively during their open days with the students and their parents.

1.8 E-signatures

HTA colleagues were encouraged to promote workshops and AMT conferences and hence HTA awareness through their electronic signatures.

1.9 Visiting lecturers

Universities are excellent places and sources for the promotion of technical developments in HTA and public awareness of the NoE. Some expert HTA members were appointed as visiting lecturers/professors to give occasional lectures at the HTA universities (e.g. Dr Bas Buchner of MARIN; Mr Juergen Friesch of HSVA appointed by UNEW).

1.10 Student summer placement

Summer placement scheme of HTA provided visiting students with increased knowledge and awareness so that they can pass onto their class mates and others effectively.

1.11 HTA-Forum as lasting structure

The Hydro-Testing Alliance Network of Excellence has been active for 5 years with knowledge sharing and joint R&D work by 70 researchers in the hydrodynamic laboratory testing technologies. Funded by the EC under a Network of Excellence grant of the 6th Framework Programme, it has developed sufficient momentum to continue as a self supporting network organisation, the HTA Forum network. As per 31st August, most of the 17 member organisations have signed the contract of admission to the HTA Forum, under which they will have access to Communities of Practice (CoP) on subjects as:

- Particle Image Velocimetry (PIV) in hydrodynamic laboratories
- High Speed video technologies
- Cavitation Noise technologies
- Podded propulsion modeling technologies

These subjects are continuations of initiatives existing under the HTA Network of Excellence and parties which are interested to qualify for joining such Community of Practice, can apply under the conditions given below. The Forum network will organise twice a year a Meeting and Forum day, in which the CoP's will meet and in which a half day forum will be held on general topics of interest for the international hydrodynamic model testing society. Herein members can present ideas for joint projects (JIP's, with institutes and industry) on testing technology, e.g. measurement system qualification, analysis tools & methodology, etc. But the Forum will also provide opportunities to initiate a new Community of Practice on a subject of interest. Good enough reasons to be a member. The HTA Forum members pay a small fee to sustain its organisation, dissemination and website, and therewith enable you to meet and liaise with the European hydrodynamic testing research society. An organisation may become full member of the HTA Forum network after a maximum trial membership of 1 year. It is not possible to enter a CoP or JIP without being full member of the HTA Forum Network. For further information on the HTA Forum Network and to join the Forum please contact the HTA Forum Manager via the Forum website www.hta-forum.eu.