Decades of development

As we celebrate 60 years of technical journalism, the UK-based Wolfson Unit celebrates a landmark anniversary of its own. Barry Deakin, senior engineer at the Wolfson Unit, looks back on developments in testing and consultancy for the small craft industry.

In 1967 the University of Southampton had an active yacht research group, a collection of enthusiasts researching the science of sailing, predominantly using the wind tunnel. It was perceived that there was a market for a specialised commercial service to the small craft industry, but the university would take no financial risk in such a venture, and it was eventually made possible by a modest grant from the Wolfson Foundation.

The Wolfson Marine Craft Unit, as it was then called, started to generate revenue immediately and soon had a healthy number of clients. The concept was then, and still remains, unique in the industry, with a group of full time professional engineers providing a commercial consultancy service from within a university.

The engineers have no academic commitments to distract them from their commercial duties, but have the extensive and diverse resources and expertise found in a large university to assist them in unusual projects.

The staff increased steadily to a maximum of 13 engineers, but for the last 10 years has found a team of 10 – with administrative support, to be ideal, and the group is very unusual in that four of those each have over 30 years of service.

Testing and towing tanks

Initially the unit was led by John Flewitt, who came from the British Hovercraft Corp testing facilities (now run by GKN Westland), on the Isle of Wight. The towing tanks there were originally set up by Saunders Roe to develop flying boat hulls, and later used for commercial ship testing and hovercraft development.

The well-established techniques developed there were transferred to Southampton, and Mr Flewitt's services to the industry were recognised by The Royal Institution of Naval Architects when he was awarded the Small Craft Group Medal in 1979, shortly before he retired.

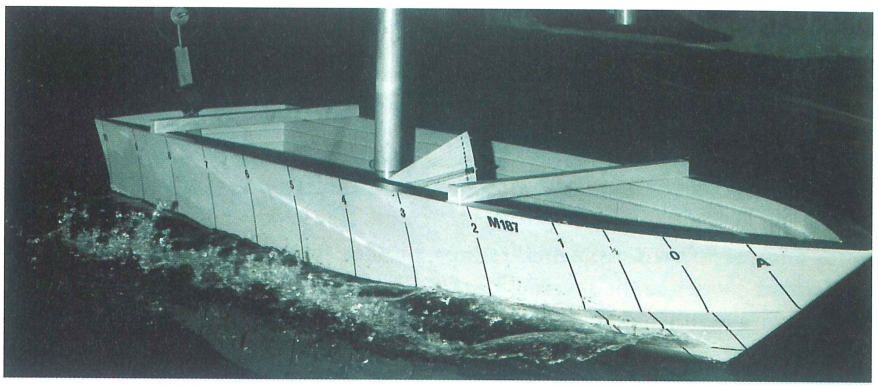

Fig 1. A typical 1.5m-long model of the 1970s. The trim measurement quadrant is visible at the foot of the tow post.

Much of the early work was on small craft such as pilot boats, motor cruisers, or sailing yachts. The university had only a very small towing tank, which had limited use for commercial work, so the larger tank at Southampton College of Higher Education (now Southampton Solent University) was equipped by the Wolfson Unit with a new dynamometer, and this was where most of the testing was conducted for the first 20 years. Instrumentation was minimal, with force measurements averaged by eye on analogue meters, and heave and trim read on visual scales, Fig 1.

The market for small working and recreational craft was healthy, and the Wolfson Unit soon built a solid reputation in this field, when most towing tanks concentrated on much larger merchant and naval ships.

Although the principles are the same, small fast craft demand rather different test techniques because of the variation of trim, spray, wetted area, and stability with speed. These factors resulted in the development of specialised dynamometers, test techniques, and methods of analysis which differed from the conventional ones promulgated through the ITTC.

Increases in the speed of small craft, and in the size of motor yachts, have necessitated continuing developments in test techniques, and transfer of most of the motor vessel testing to the high-speed towing tank on the Isle of Wight. Determining wetted surface area is fundamental to the resistance scaling process, but is difficult at very high speeds, with multi-hulls and with stepped hulls.

Similarly, knowing where the laminar to turbulent transition occurs, or even placing studs to trip it, can be highly problematic in such cases, and this aspect of testing has been the subject of extensive in-house research. Flow visualisation, underwater photography, and systematic tests have been used to refine the test methods and scaling process.

Small craft can be prone to handling problems, and to assess new designs,

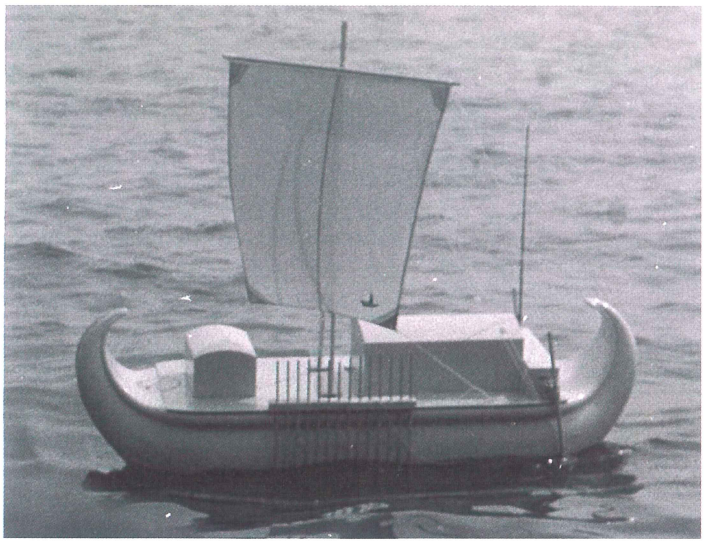

Fig 2. A radio controlled model of Thor Heyerdahl's reed ship *Tigris* during tests in 1977 to study various steering options.

or to address known problems, radio controlled model manoeuvring tests have been used throughout the unit's history (Fig 2). The handling of fast craft is particularly poorly understood, and techniques have developed to enable tests on craft up to 60knots, driven by propellers or waterjets. Digital radio controls, GPS tracking, miniature data loggers, and the availability of scale waterjets have transformed test techniques, and now enable quantitative testing of high-speed craft on a modest budget (Fig 3).

Unique organisation

In addition to working on smaller vessels, the small size of the organisation, and the physical size of the models, has enabled the Wolfson Unit to develop in a distinctive way compared to the big national institutions.

Facilities are hired on a daily basis so testing has to be efficient to minimise cost, and it may not be efficient to interrupt the programme to prepare drawings and return the model to the builder for alterations. The engineers who conduct the tests are responsible for the entire project. Frequently they will make simple modifications to the model or the test programme on the spot, in discussion with the client, so that project development can take place and be evaluated without delay. This flexible and versatile approach is one that many customers find beneficial.

Model making has always been subcontracted, originally to patternmakers, and subsequently to craftsmen with specialised boatbuilding skills. In collaboration with them, an efficient and accurate plank on frame system has been developed to replace the patternmakers' 'bread and butter' technique, and this has now been adopted at many other facilities where the traditional methods of machine cutting and hand finishing were uncompetitive.

Yacht expertise

Tank and wind tunnel testing of sailing yachts was a particularly specialised area, and one for which the unit very quickly gained a worldwide reputation. The tank in Southampton is ideal for performance testing of cruising yachts, and for studies of racing yacht hull development, but to evaluate appendage details, and resolve the small adjustments to America's Cup designs, required the use of larger models (Fig 4).

The much larger facilities at the Admiralty Experiment Works at Haslar, now QinetiQ, have been used extensively by the Wolfson Unit for over 20 years, and test programmes have been conducted in Italy, USA, France, Denmark, and Spain.

As with high-speed craft, racing yacht developments have necessitated many refinements in techniques. Towing 1:4 or 1:3 scale models of America's Cup Class or Open 60 yachts, heeled and yawed, with deep and highly efficient keels, results in very different situations compared with most ship testing scenarios.

The resistance may be as little as 20% of the side force, and this puts particular demands on the need to minimise dynamometer interactions. Even at these scales, some modern appendages have a very small chord, and turbulence stimulation again is an area where continual development has been required.

Evaluation of small adjustments to hull and appendages makes increasing demands on the resolution and repeatability of the towing tank and measurement system, and standard models or planks have been constructed for use during a model test programme to monitor viscous effects. Further details of recent advances in yacht testing are given in Ref 1.

It is a mark of the America's Cup teams' trust in the unit's ability to maintain confidentiality, that testing typically is conducted for several competing teams. Some conduct their testing in their home country, or elsewhere, but few other facilities have any background in yacht testing, so the Wolfson Unit's expertise has been sought in the design, building, and commissioning of dynamometers for towing tanks and wind tunnels in a number of other countries. Furthermore, its engineers are in demand to conduct or monitor the testing, and assist with interpretation of the results.

Fig 3. Manoeuvring tests on a patrol craft with twin waterjets.

Since adopting the wind tunnel dynamometer and techniques established by the Yacht Research Group, the unit has been the world leader in testing of sails. Dynamometry and techniques have come a long way in 40 years, and the major developments and innovations are described in Refs 2 and 3.

Whilst ship testing frequently tends to take the form of insurance, checking that a design will perform as expected, sailing rig testing tends to be used for sail wardrobe selection, sail design, or significant rig development, in addition to the gathering of performance data. Because it enables repeatable measurements in a controlled environment, it also provides an invaluable tool for sail designers and trimmers to study the performance effects of sail adjustments.

Beyond marine

The wind tunnel is not limited to sail tests; important work has been done to quantify heeling moments of ships, catamarans, and hovercraft, map helicopter fight paths, assist with funnel and yacht exhaust design, and measure the wind environment on decks to ensure passenger comfort.

Outside the marine industry, the Unit's Industrial Aerodynamics role takes it into the fields of wind tunnel testing of civil engineering structures, building developments, racing cars, and trains. It also has a long history of consultancy and testing of internal flows, with on-site measurements and scale modelling of furnaces, chemical plants, ventilation systems, and blast freezers.

Technological advancements

The unit was founded in the days of mainframe computers operated by punched cards. A highly innovative suite of programs to compute the stability of ships had just been created by one of the university's academic staff, and this was developed by the Wolfson Unit to provide a bureau service to designers.

Even 30 years ago, the service included lines fairing, damage stability, and ship motions, as described in Ref 4. The service is still provided for specialised cases, such as in expert witness work, but when it became clear that desktop computers would be used in design offices, Wolfson Unit software was rewritten and offered for sale.

As computer systems have developed, so has the need to update the software, and this has proved to be a continual process requiring full time support. The unit does not have a large staff of software engineers, and does not attempt to compete with those companies that do.

Instead it provides a core of programs for the naval architect, designed to provide accuracy and flexibility, which have been developed by naval architects who understand the important issues and requirements. These have been adapted for use onboard, in particular to provide information on loading and damage control, and are in use on a range of ships, including most of Cunard's fleet.

The importance of publicity for a client and his projects should not be overlooked, and the advances in camera and video technology have transformed this aspect of the business. While normal practice was once to glue some black and white photographs into the client's copies of a report, current expectations are likely to be for an edited, subtitled record of the tests, and a comprehensive set of digital images of each test run, from several angles, all on DVD.

Over 70 technical papers, articles and books on the Wolfson Unit's work have been published, and a full list can be found on its website. ***SBI***

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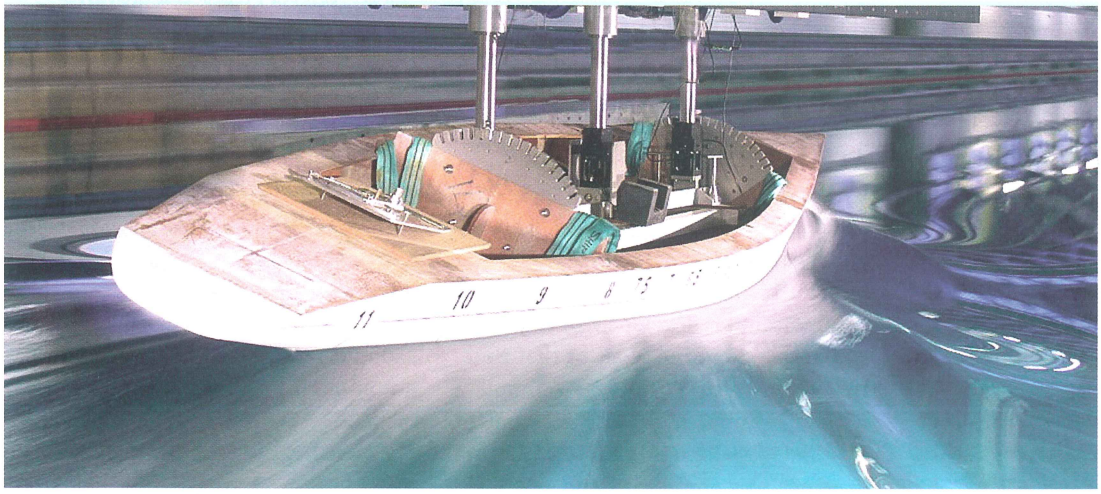

Fig 4. A 5m-long model of an International 12m class, a modest yacht model by today's standards.