The main aim of the project is to improve the safety of modern sailing yachts by developing an understanding of the re-righting tendencies through physical and theoretical modelling with “real world” correlation. Through using the models developed the effects of hull form and stability parameters will then be investigated, resulting in scientifically deduced measures of sailing yacht safety.

The safety of those who sail on ocean going sailing yachts is linked to the ability of the yacht to survive capsize when hit by a breaking wave and to re-right once capsized. Both are functions of the yacht design and its stability. Yacht design parameters which can effect these characteristics include the vertical position of the boat’s centre of gravity as well as the form of the yacht.

A substantial research effort was carried out following the Fastnet race in 1979, where many yachts capsized and there was considerable loss of life (see Ref. 1). The results of this work were used to introduce empirically derived stability considerations into the IMS rules incorporating the yacht’s range of positive statical stability (see Ref 2).

Considerable changes to the design of modern racing yachts have occurred since then. Some of the “undesirable” features of yacht designs exposed by this research have been addressed, for example wide boats with high centres of gravity have been reduced in most modern racing fleets (Ref 3 contains a good listing of the “undesirable” features). Modern racing fleets have developed into very different machines from what the original research from this period was focused on, and the applicability of the empirically derived relationships to modern designs has not yet been evaluated.

An area which was not covered in a great amount of depth in the post-79 Fasnet work was that of re-righting of sailing yachts. As a result of this, all measures of re-righting currently used are based on the single figure of the limit of positive stability (see also Ref 4). It can be quite easily shown that although indicative of a yacht’s ability to re-right, this single figure can lead to incorrect conclusions (Ref 5).
The 1998 Sydney/Hobart race resulted in a number of knockdown capsizes, and in some cases the yachts took longer than expected to re-right (Ref 6). A comprehensive test program is now proposed to investigate the effect of vessel design on the capsize and re-righting tendencies of modern sailing yachts in general. This will be used to compare the different styles of yachts and draw conclusions regarding the effect of design parameters on modern sailing yachts.

References

Photographs
The photographs printed in this document were used with the permission of Ian Grant, and ABC News.

For further information about this project, or electronic copies of what has been presented please contact:

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22 May 2000
“INVESTIGATION INTO RE-RIGHTING TENDENCIES OF MODERN SAILING YACHTS”

Update May 2000

Funding
An Australian Research Council small grant has been obtained by the project, which will cover some project running costs in the first year, allowing for the purchase and testing of one model.

“In-kind” contributions have also been received from Murray, Burns and Dowell (MBD) and Formation Design Systems (FDS). MBD have provided the vital link to industry in giving over use of one of their IMS designs. FDS has allowed the project to use the Maxsurf suite of programs.

Further project running costs will be applied for, for late 2000 and 2001.

Tank Test Session 1
The first tank testing session was completed on 15th March 2000 using a model constructed in 1999 for student work (model number 99-22). Although this model is not an actual design it is considered indicative of IMS designs. The tests provided a direct measurement for time inverted in a given sea state and were compared against results previously measured for another hull. Figure 1 shows these results.

In Figure 1 the horizontal axis is the significant wave height of the sea state used and the vertical scale is the measured time to re-right. The time to re-right was taken to be the average of ten re-rights. The models were tested at equal IMS equivalent Limit of Positive stabilities (LPS), which is the angle at which the yacht will re-right in calm water.

From these results it can be concluded that yachts of equivalent LPS do not have equivalent inversion times, in fact one yacht

Figure 1: Measured time inverted

Figure 2: Sample screen from video tracking analysis
at LPS=105 is seen to be almost identical to the other yacht with LPS=110.

The other method of testing yachts for how well they re-right uses a solitary wave generated in isolation in the towing tank. Results from this series of tests will be used to relate this method to the more direct method of irregular seas, which was used to produce Figure 1.

During the first session a motion analysis system was also used (see Figure 2). This system is capable of tracking high speed motions using input from a digital video camera. For this session of testing a “drop” test was performed, where the model was heeled over, then released, thus giving the motion for the model when it has no forcing function. This information will provide the basis for the numerical model, as well as quantifying the effects of hull shape changes in terms of hull motions.

**Tank Test Session 2**

Tank testing has been scheduled for mid 2000 and construction of the first model specifically for this project is underway. The plug has just been finished (see Figure 3) and hull no. 1 from the mould should be ready for testing by late May. The design is one from MBD, which they have given as an “in-kind” contribution to the project. The construction of the first hull from this mould will be in carbon/foam sandwich, which is required to reduce the weight of the models to a minimum. The mould will then be able to be reused with much more robust layups (such as chopped strand mat) which can then be used for captive model tests.

**Hydrostatic Modelling**

Complex deck geometry has been modelled and analysed using the Maxsurf suite of programs. The Maxsurf suite is being used because of superior graphical representation of results in all heel angles and because of basic inviscid motion analysis unique to that suite. A sample of a model has been shown in Figure 4, showing cockpit and transom cutouts, which can be modelled in the same way as they are built, and mast and boom.

**Literature Review**

A literature review was completed and catalogued. 31 cases of sailing yacht inversion and re-righting were found, however only 10 of these have the detail required for use documented.

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