How to sail an Olympic Laser class dinghy - towing tank tests

The Laser dinghy is a strict one-design Olympic class and very few, if any, alterations are allowed. So what can be done in a towing tank to provide new insights for sailors? There is no meaning in just measuring the resistance since nothing can be done to the hull to minimize it. So what's left? The way people sail the boat! Where the crew is positioned in different speed ranges and how much to heel the boat in different conditions could be a new contribution, or could confirm the way the best sailors sail the dinghy based on experience. In addition, a small thing like how much drag the self-bailer is generating when open is a typical question asked by keen sailors that we have now verified. Another question is how big an influence does my weight have on the performance?

Optimum heel for downwind sailing in the speed range of 3 to 8 knots.

Collaboration with Chalmers

SSPA has joined a project with Chalmers University of Technology in Gothenburg focusing on sports and technology. Education and research at Chalmers is well known and aims to contribute to a sustainable future for our society. For the past few years, the Area of Advance Materials Science has supported the project. The initiative has generated external funding and been welcomed at Chalmers, among staff, students, the sports movement in Sweden, and large and small companies.

The action of a small group of researchers and students, most working on an interdisciplinary and voluntary basis beside their normal work, has created a surprising impact. One noticeable thing is in recruiting new students, who have been attracted by the activities in five sports: Swimming, Equestrian, Sailing, Athletics and Floor ball. The exhibitions, informal lectures and presentations that the research group have held have attracted students, who previously would not have considered engineering as an option.

For research, the distance between research projects and ideas can be reduced compared with research projects involving industrial partners. For instance, new materials and usable products can be tested by interested and inquisitive users. The driving force is that individual athletes are eager and willing to test new ideas that promise to provide the slightest advantage.

The sports and technology group has come up with a number of research proposals and applications, ideas for master thesis work, bachelor thesis work, an international summer course for engineers, and developed a new master's course starting in 2014. Networks with local, national and international players in the sports industry have been created, making the results of the research known to various new sectors.

The main objective for 2014 is creating a Sports technology centre. This includes five professorships and the following areas, of which several are close to SSPA's competence: sailing dynamics, materials science in sport, measurements and modelling in sport, biomechanics in sport, and mathematics.

The centre will contribute to a more sustainable society through excellence in research, education, outreach and recruitment. The knowledge generated by the centre will improve the performance aspect in sports and to health and wellbeing for the public.

Tow tank testing

In the sailing sector, SSPA has carried out tow tank testing on a Laser class dinghy, showing very interesting results about how to sail a dinghy.

A dinghy was provided by one of Sweden's top sailors. A towing rig was constructed so the hull could be towed without making holes in the boat. The dinghy was towed with a rod connected to a dynamometer close to the mast position about 20 cm above the deck. The actual towing point in this study was not important since we aimed for the actual sailing conditions regardless of how the trim and heel was achieved. In a small boat like this the person sailing it will be able to adjust position by moving forward, aft or sideways to heel or trim the dinghy to the desired condition.

The set up to the carriage allowed the hull to move freely in heave, pitch and roll but was restricted in surge, sway and yaw. Our attempt was to restrict the tests to downwind at a limited number of speeds. If upwind conditions were included in the test matrix, this first attempt would have been too extensive. Parameters such as leeway, load distribution between rudder and centreboard, righting moment etc., would have been included in that case. The rudder and centreboard were also excluded and we left these for two students doing their Masters' at Chalmers to add afterwards using Computational Fluid Dynamics (CFD).

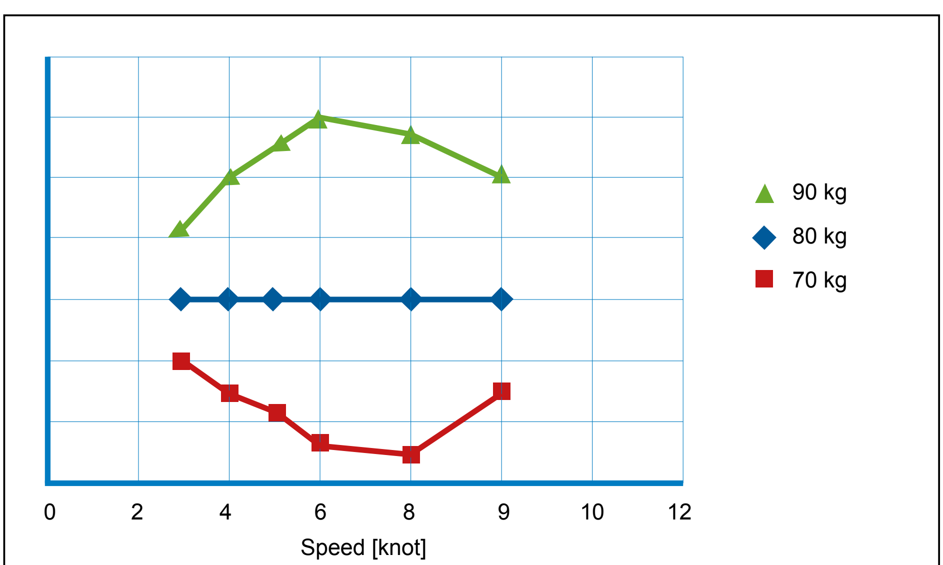
A Laser sailed at the venue for the 2012 Olympics in Weymouth by Swedish Olympian Rasmus Myrgren. Photo: The Swedish Sailing Federation.

The weight tests were carried out using an 80 kg manikin as norm. Tests were repeated with ±10kg. The relative change in resistance is shown in the diagram. The initial results indicate that the weight has the biggest influence in the middle speed range (around 6 knots) but for both higher and lower speeds the influence is less. Would the curves coincide for 13 knots? The next test session in the tow tank might possibly provide an answer.

Tests followed with a variation of trim versus speed. As expected the lowest resistance was found with the most possible forward trim for very low speed. For speeds below 3 knots the sailor should preferably sit forward of the mast. However this is prohibited by classrules (no part of the body in front of the mast). At higher speeds, 4 knots and upwards, the weight should be moved more and more aft as the speed increases. This is nothing new for an experienced sailor, but interesting to validate and obtain data about.

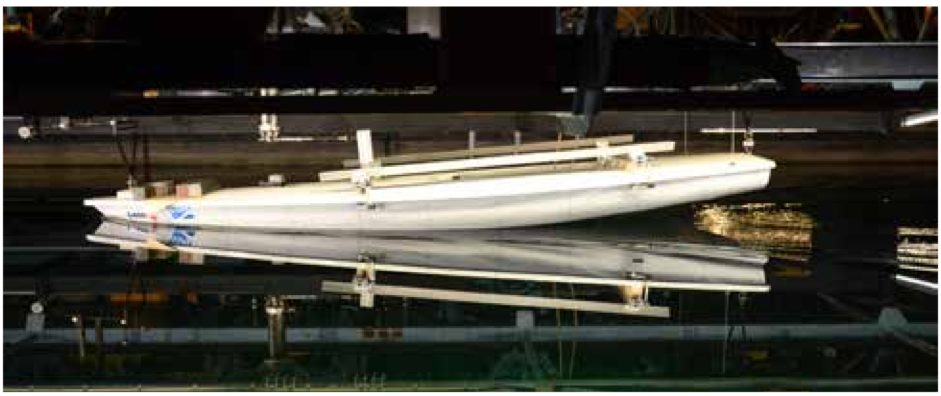
The explanation is that for low speeds, minimizing the wetted surface is the most important factor but for higher speeds, when wave resistance starts to be a dominating factor, long waterline is what gives speed (and lower resistance).

Heel is also an important factor and it was seen at all speeds heel all the way up to where the shear line with the curled deck edge was touching the water was favourable. It should be remembered that this was downwind and no aspects were considered regarding the effectiveness of the sailplan. Again the effect from minimizing the wetted area was the explanation and at heel the long waterline could be kept for all speeds.



Relative comparison of resistance for 3 crew weights in a Laser dinghy.

Open and closed self-bailer at 6 knots.



Best sailing condition below 3 knots.

The self-bailer

An attempt to detect the resistance from the self-bailer was carried out at 4, 6 and 8 knots. Even though it was small, the influence was detectable. And how to handle the resulting insight is the secret of the ordering customer, Chalmers University of Technology.

TOWING TANK

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SSPA's vision is to be recognised as the most rewarding partner for innovative and sustainable maritime development. To always offer the latest knowledge and best practices, about 20 per cent of the company's resources are engaged in research and development. The Swedish government founded SSPA in 1940 and in 1984 it was established as the limited company SSPA Sweden AB. The company has been owned by the Foundation Chalmers University of Technology since 1994.

SSPA offers a wide range of maritime services, including ship design, energy optimisation, finding the most effective ways to interact with other types of transportation, and conducting maritime infrastructure studies together with safety and environmental risk assessments. Our customers include shipowners, ports, shipyards, manufacturers and maritime authorities worldwide.

Our three focus areas are:

- SSPA acts as a bridge between theory and practice, research and imple mentation, the present and the future. The foundation is the ability to provide unbiased expertise, advice, and services to our customers and other stakeholders.
- SSPA ensures sustainable development through proper risk management in close cooperation with the customer.
- SSPA has the financial, environmental, human and technological factors in mind for optimal energy efficiency.

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