Abstract – CFD analysis of square transom single rowing shell

Liaison: Bill Lind. bill.james.lind@gmail.com

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Introduction

Rowing is the oldest collegiate sport and the quest to design & build faster, lighter, and stronger rowing shells in order to win races is part of the sport's heritage. The purpose of this research effort is to use CFD as a design & analysis tool to determine if a square transom single rowing shell is faster than the traditional double-ended single rowing shell. The premise for the square transom is three-fold:

- Laminar flow is improved if the transverse shape at the transom is essentially the same as that of the maximum beam midship section.
- Squaring the transom increases the moment to change trim 1" at the catch (the rowers most unstable position).
- The traditional double-ended shape was superseded by a square-transom on most other conventional vessel types many years ago.

In competitive rowing, the margin between the winning boat and the rest of the fleet over a 2,000-meter sprint is often quite small. Representative speeds are as follows:

Level (single rowing shell)	Split Time (min:sec for 500 m)	2,000 m time (min:sec)	Knots
Olympic Men	1:37	6:28	10.02
Olympic Women	1:44	6:56	9:35
Competitive Masters Men	2:00	8:00	8.09
Club Rower	3:00	12:00	5.40

A rowing shell that was 5 seconds (1.2%) faster over 2,000 meters at the Men's Olympic Level would be a breakthrough design.

Project Description

To date, our development of a squared transom rowing shell that is faster than a conventional double ended heavyweight men's single rowing shell has proven to be elusive. A prototype hull form has been developed (7.25 m L x 0.26 m BWL and Displacement 107 kg), however, the analysis tool, NavCad ADVM, that we have been using to date is based on slender ship wave theory. As the program uses a relatively simple wave model and flat plate viscous drag assumptions, we believe they do not fully capture all the hydrodynamics required for high accuracy estimations of calm water resistance. The student team will analyze and optimize the prototype hull forms with a RANS Code (Siemens CCM+ or similar) to further improve the hull form and develop a winning design.

Expected Outcomes

The student team will do the following as part of their project:

1) Develop drawings and 3D models of the proposed rowing shell.
2) Develop the structural scantling and weight estimate.
3) Prepare input files using Rhino
4) Carry-out CFD analysis of the prototype hull form and compare the results with a conventional hull form.
5) Optimize the prototype hull form.

The analysis would start with a fairly straight forward analysis but we would like to make it more sophisticated later. This would involve a time domain analysis that includes the motion the CG of the rower and the dynamics of the rowing force.

If time allows the team will compare the prototype with competitors including: Hudson (Canada), Empacher (Germany), and Vespoli (Italy)

The final objective is to develop a breakthrough single rowing shell. As UBC has one of the leading Canadian collegiate rowing team the next step would be to see if the UBC rowing team would be interested in joining the program. We would offer the design to UBC rowing team to secretly build a rowing shell(s) and then test it full scale.

Rowing is a traditional sport. Advances in design must generally fit the spirit of rowing. For example, oar blade shape has advanced from Square, Macon, to Hatchett and the shell itself had transitioned from wood to carbon fiber. However, the use of foils, first tried approximately ten years ago, is banned in competition. We believe that a square transom design would fit within the spirit of rowing. However, convincing the international rowing community to approve the design is not automatic. We will need to build consensus and win converts.

If this design proves successful, the squared transom hull shape would also be applicable for both sculling & sweep doubles, quads, and eights. Follow-up UBC projects could include design analysis and verification for these vessels.

IP for the design would remain with McGreer, Ferrer, and Lind. NDAs would be developed throughout the process as project develops from concept to race.

Resources Available from the Sponsor
The project sponsors consist of the following individuals:

- Dan McGreer – Principal Naval Architect at Vard Marine (29 years) and Adjunct Professor at UBC

- Tony Ferrer – retired YD/ME after 35 years in industry with Sparkman & Stephens (10 years), Langan Design (15 years).

- Bill Lind – retired NA/ME after 40 years in industry with Sparkman & Stephens (10 years), American Bureau of Shipping (21 years) and Vard Marine (5 years). Bill has been a rower for 17 years and help coach high school rowing for 3 years.

The status of the project is:

Date	Milestone
16 Nov 2019	Hand drawn lines plan of a competitive heavyweight men’s rowing shell
24 No 2019	Hand drawn lines plan of a square transom heavyweight men’ rowing shell
April 2020	Prototype hull form developed with encouraging results in NavCad ADVM

The project sponsors are able to provide:

- Mentorship of the team and will provide technical assistance when needed.
- Design information for rowing shells and their configuration/arrangement.
- Guidance for CFD methodology and analysis.

Customer Requirements

The project sponsors expect to meet regularly with the project team to discuss progress (at least once per month via Zoom). The results of the study should be documented in a comprehensive report.