ISSN 0554-6397
Stručni članak
(*Professional paper*)

Tin Matulja
E-mail: tin.matulja@riteh.hr
Marko Hadjina
E-mail: marko.hadjina@riteh.hr
University of Rijeka, Faculty of Engineering, Vukovarska 58, 51000 Rijeka, Croatia

Expert Approach Methodology as Basis for Sailing Boat Outfitting Improvement – Case Study

Abstract

The market conditions demanded the adaptation of exclusively touristic sailing yachts to specific race requirements. The hydrodynamic aspects of this problem have been successfully solved using modern tools for CFD analysis. But, the practical aspects of outfitting such vessels to meet the highest tourist requirements while respecting specific racing requirements for deck equipment required a different methodological approach. In fulfilling these requirements, the author indirectly participates in multi-year cooperation with the prominent European manufacturer of sailboats. For the purpose of cooperation, a special methodology was developed for the improvement of the equipment of the defined sailing boat in four stages. In the first stage, an analysis of the impact of sailing equipment and deck configuration of the existing B40S model on sailing performance is suggested using RaceQs computing application and expert approaches for different sea and wind conditions. In the second stage, the analysis of the collected data is carried out by expert approach towards guidelines for improvement. The third stage impacts on redesigning the existing model by implementing the obtained results. In the fourth stage, the effects on the upgraded new B41S model are analyzed repeating the first stage. The methodology is iterative and converges to the optimal solution for the defined criteria.

Key words: small sailing vessel, equipment of a small craft, outfitting improvement, expert approach.

1. Introduction

Continuing the cooperation and exploration of the influence of deck equipment on the performance of sailing, [1], expanded the research by the market conditions that influence the adaptation of exclusively sailing yachts to specific regatta requirements. The goal of all charter companies lies in the better booking of the sailing boats, except in the season also in the pre-season and in the post-season to achieve more profits, Figure 1. One way is to organize various group events such as regattas, team building, etc., these “sporty” oriented activists retreat to the additional requirements that the charter sailing boats must fulfill.

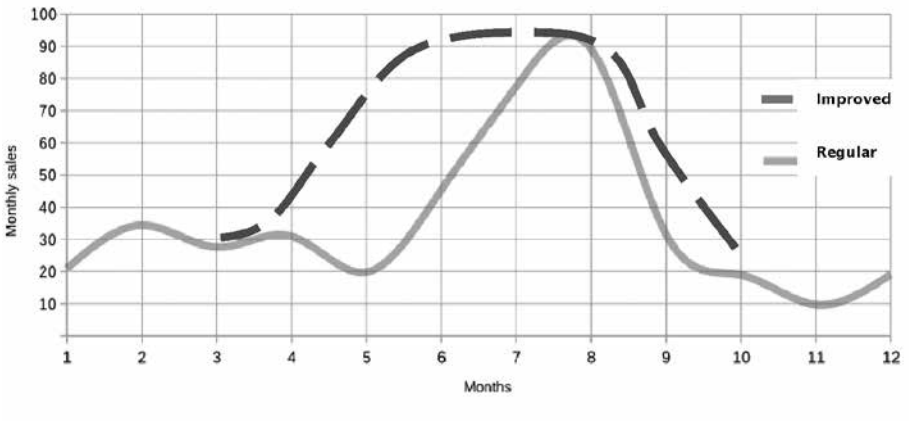

Figure 1. Regular monthly sale vs improved monthly sale

Such additional requirements relate in the first place to higher speeds in sailing because of attractiveness and to appeal "sporty" clientele, which entails the practical aspects of deck layouts and the choice of equipment conditioned by race sailing. Figure 2 shows a typical sailing boat that is combined as cruiser and racer.

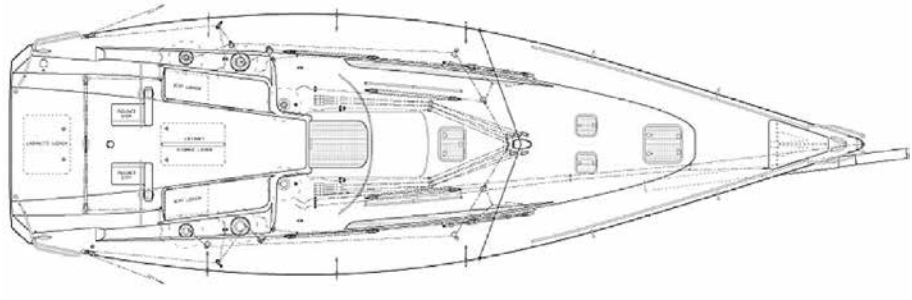

Figure 2. Typical cruiser-racer deck layout, [2]

Higher speeds of sailboats are achieved with selected design features with additional optimization using modern CFD analysis tools, [3], [4].

From the point of view regarding the practical aspects of the deck layouts selection and the choice of deck equipment that will meet the regatta requirements, the author indirectly participates in a multi-year cooperation with a prominent European manufacturer of small sailboats. For the purposes of this cooperation, a specific methodology for improving the equipping of a defined sailing boat was proposed and it is described in following chapter.

2. Methodology for Sailing Boat Outfitting Improvement based on Expert Approach

The proposed methodology is implemented in four phases:

Phase 1. represents the analysis of the impact of sailing equipment and deck configuration on the sailing speed and performance of the existing model called B40S. Within the phase 2. an analysis of the collected data by expert approach in reading directions for improvement is suggested, [1]. Then in the phase 3. a disigners suggestions for redesign of the existing model are given by implementing the obtained results. Finally, in the phase 4. an repeted analysis of mentioned impact is checked on the new, improved model called B41S.

As an extension, an upgrading of the observed model B40S is proposed by replacing standard sailing equipment (sails, ropes and other moving equipment) with appropriate racing equipment to provide an adequate boat that suits the first phase of the proposed methodology, as shown in Figure 3.

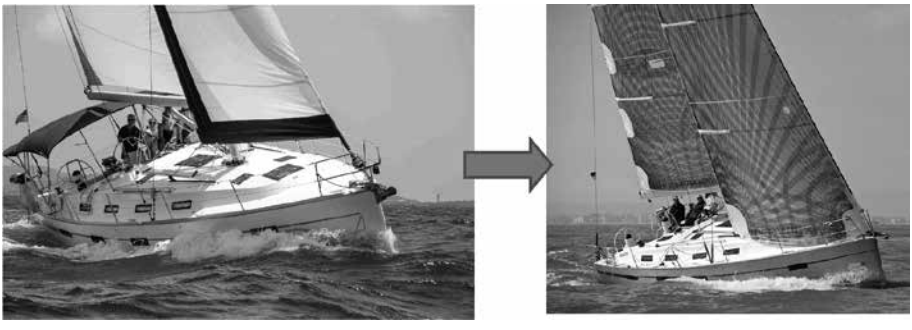

Figure 3. Standard equipment vs Regata equipment on the same model B40S

2.1. Phase 1 - The analysis of the impact of sailing equipment and deck configuration on the sailing speed and performance of the existing model B40S

The large data collecting and analysis of deck equipment positioning regarding performances in sailing is suggested, [1]. The raceQs' tracker tool is suggested for monitoring and recording sailing data. The raceQs' besides tracking also monitors and records the motion of the boat using the accelerometer and gyroscope in measuring equipment performances. Finally, it is possible to evaluate boats tacking patterns, boat handling, heel angle, and more other data during testing in different wind and sea conditions and for different sailing angles.

RaceQs Analytics Features, figure 4, [5]:

- Create match-ups between any two boats
- Your Boat ranking at each mark
- Leg and Overall Statistics (Avg. and Max. speed, elapsed time, number of tack)
- Tacking and Jibing Data (Time Lost, Duration, Tacking Angle)
- Boat Handling, Helm, and Driving (Groove Analysis)
- Wind Shadows
- Separation Distance Lines
- Multiple 3D and 2D Views
- Embedded comments and easy sharing

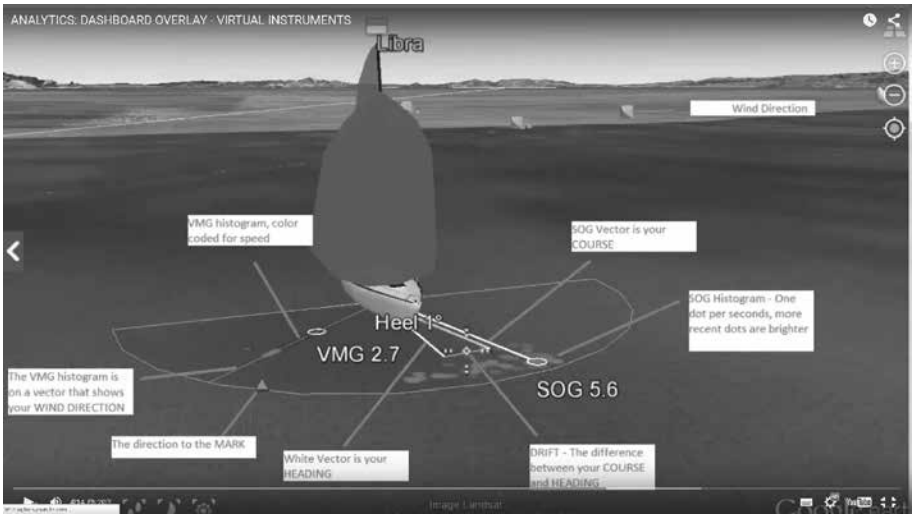

Figure 4. Screenshot of RaceQs tracking data explained

All the presented data was recorded during testing in different wind/wave conditions. For example, for each wind/wave conditions the position of deck equipment i.e. *jib car* was combined from first extreme point to end extreme point as shown on figure 5. This influence on the sail form and leach shape. Different sail shape results in different lift/drag combination that directly influence the boat VMG speed.

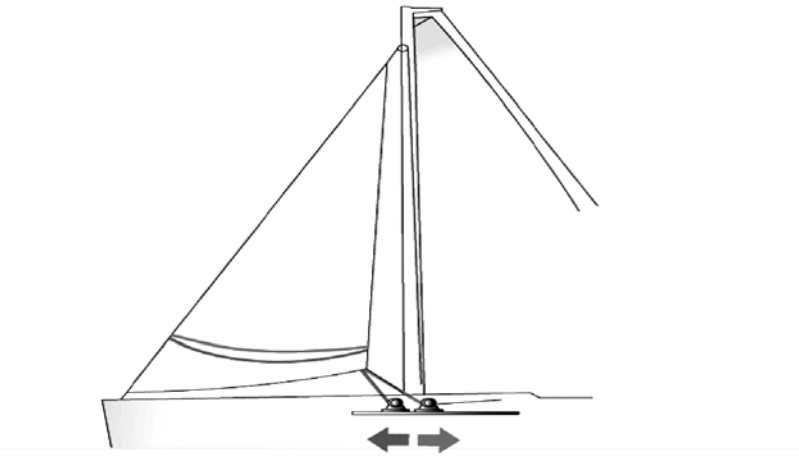

Figure 5. Jib car forward and aft effect on foot depth, [1]

The testing was performed on several sailing areas depending on different wind conditions and waves.

2.2. Phase 2. Analysis of the collected data by expert approach

Within the proposed methodology the following are analyzed:

- the longitudinal and transverse sail-cars positions, and the sheet trimming.
- transverse positions and size of the main sails tightening
- Efficiency of deck equipment (e.g. adequate dimensions of deck winches ...)
- Trim of masts and rigging.
- Layout deck functionality.

One example of the results for up-wind analysis in moderate wind and waves, for front sails analysis is shown in following diagram, figure 6, where the boat speed is analysed regarding jib car position.

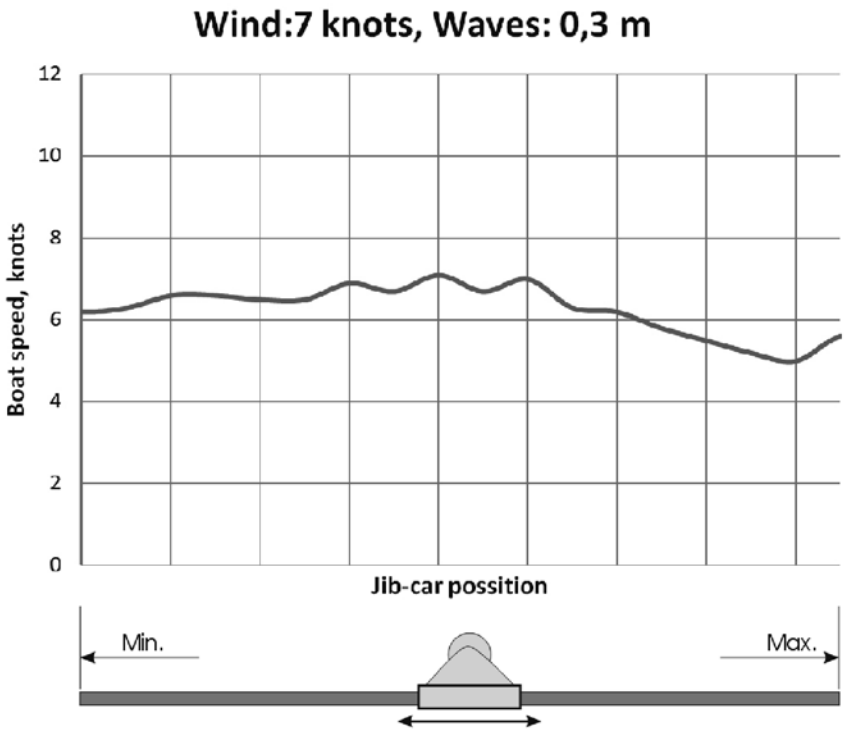

Figure 6. Up-wind boat speed vs. jib car position diagram

2.3. Phase 3. Redesign of the existing model by implementing the obtained results

The obtained results should be implemented in new design. Previous phases of suggested methodology resulted in following list of shortcomings that were sent to the manufacturer and the designer office:

- Jib car position - make a transverse displacement of 8 cm
- Main sail winch - sub dimensional.
- The base of the navigation system on the steering wheel - sticks to the main sail in the maneuvering circle.
- Deck hatches - are not resistant to certain foot pressure - they break.
- Certain ropes are damaging the deck gelcoat in regatta mode.
- Mast base – Break, on the heavy sea.

2.4. Phase 4. Analysis of the redesigned, new and improved model B41S

The new B41S model is characterized by the same hull as the B40S but with the modified deck layout and deck equipment with partially appreciated suggestions and recommendations as the results of previous phases of the proposed methodology. The new B41S model is shown in the following illustration.

Figure 7. New model of B41S, [6]

The new set of analysis were conducted on this improved model and some conclusions have been reported. Accepted or partially appreciated suggestions on the new model B41S are:

- The jib car is moved by 8 cm according to the recommendation. In repeated tests a 5% better results in up-wind sailing was registered, figure 8,.
- The front deck hatch was moved more towards the bow where the lower frequency of foot presure is expected, Figure 8.

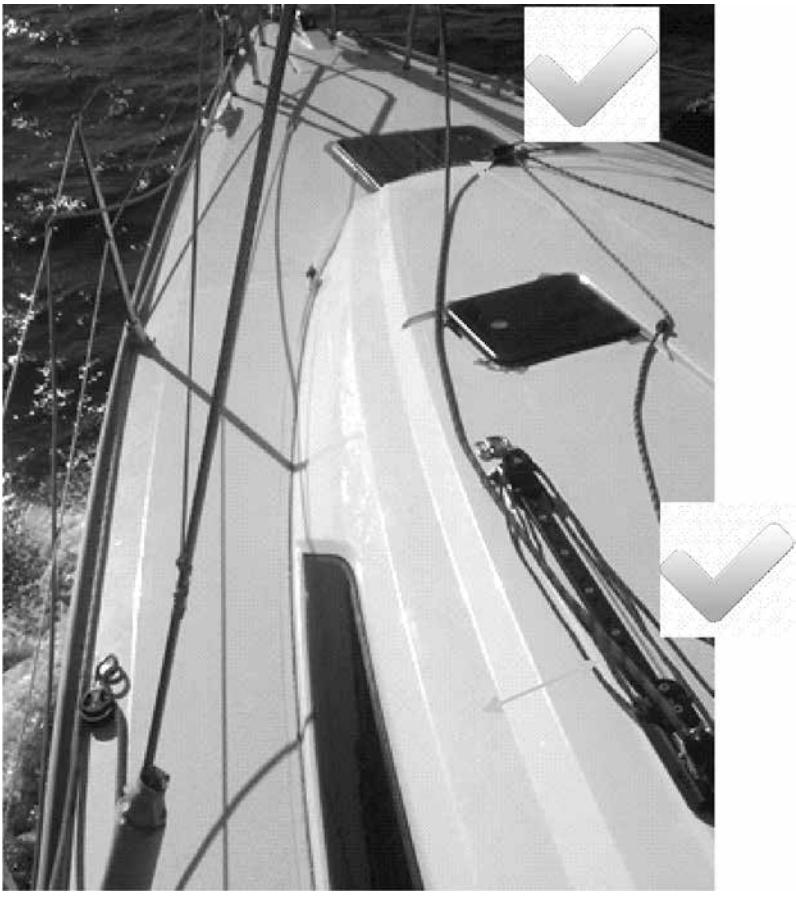

Figure 8. New Ji b car and hatch position

- Main sail winch is adequately dimensioned following the recommendation and the main sail trimming is measured as 10% faster with less load or effort.
- The navigational system platform problem was solved by moving beck the mainsail traveller. This solvet one problem but generated a new one, a security problem for the crew when tacking or jibbing, Figure 9.
- The foot stop is adequately positioned according to the recommendation, Figure 10.

Figure 9. New safety problem

Figure 10. Foot stop on ideal position

A whole series of recommendations have not been taken into consideration by the designers or manufacturer. The reason is unknown. Some of them are:

- poor deck hatch design,
- lack of protective metal plates in the places where the rope is engraved in the deck gelcoat,
- poor choice of bits,
- poorly positioned sprayhood attachments,
- illogical arrangement of deck equipment causing the crossing of the rope, etc.

Some of above mentioned are shown in the next assembly figure 11.

There are some speculations about not taking such recommendation's in consideration, like technological limitations, need to finish inventory equipment, deal with repair/service teams of charter bases, etc.

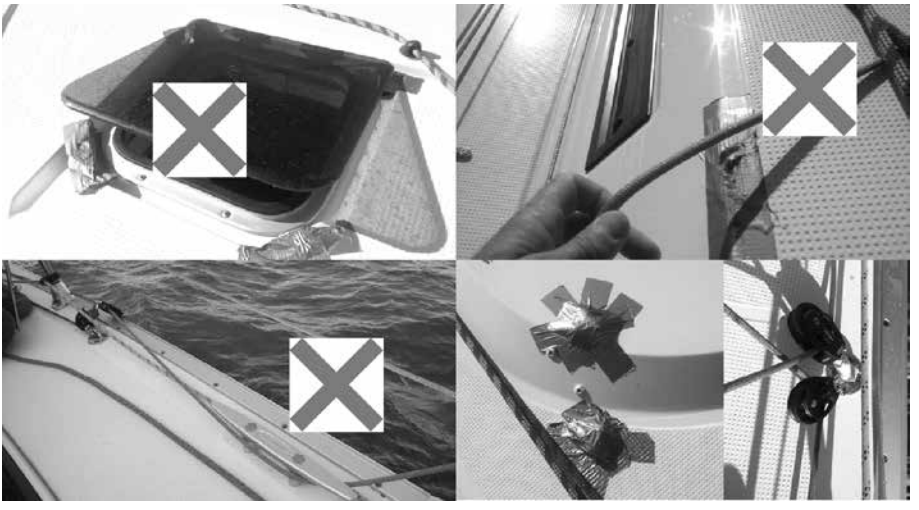

Figure 11. Non solved problems

3. Conclusion

In this paper. The expert approach methodology as basis for sailing boat outfitting improvement is presented as a result of a multi-year collaboration with one of the leading boat and yacht manufacturers in Europe. With proposed methodology, that has an iterative character, it has been proved on the case study that improvements are obtained.

The manufacturer accepted certain suggestions as a result of the proposed methodology, some tried to solve but generated other disadvantages, and some of them did not accept for unknown reasons. In conclusion, the new redesigned model is upgraded and adjusted to the needs of the market in pre-season and post-season, without losing the basic comfort demanded in the peak season.

Acknowledgement

This research is supported by funds from the support research at the University of Rijeka for the project "Improvement of the methodology of design process of ship construction," no. 13.09.1.1.06. and with technical support of Bavaria Yachts d.o.o.

References

1. Matulja, Tin; Jedretić, Luka; Hadjina, Marko; Influence Analysis of Deck Equipment Positioning on Performances in Sailing, Journal of Maritime & Transportation Science, ISSN 0554-6397, Vol. Special, No. 1, p. 101-109, 2016.
2. Bruce Farr; When art meets science, University of Auckland, Business Review, Volume 10 No. 1, 2008.
3. Heebum Lee; Mi Yeon Park; Sunho Park; Shin Hyung Rhee: Prediction of velocity and attitude of a yacht sailing upwind by computational fluid dynamics; International Journal of Naval Architecture and Ocean Engineering, Volume 8, Issue 1, January 2016, Pages 1-12.
4. Larsson, L.; Stern, F.; Vissoneau, M.: Numerical Ship Hydrodinamics, Springer Science, Dordrecht, 2013.
5. RaceQs App; http://raceqs.com/race-analytics/
6. Bavaria Yachts; https://www.bavariayachts.com/en-uk/sailing-yachts/cruiser-line/cruiser-41s/highlights/

Tin Matulja, Marko Hadjina

Metodologija unapređenja opremanja jedrilice ekspertnim pristupom – case study

Sažetak

Tržišne okolnosti uvjetovale su prilagodbu isključivo turističkih jedrilica namjenjenih čarteru određenim specifičnim regatnim zahtjevima. Hidrodinamički aspekti ovog problema uspiješno su riješeni primjenom suvremenih alata za CFD analize. Međutim, praktični aspekti opremljenosti ovakvih plovila u svrhu zadovoljavanja najviših turističkih zahtjeva uz poštivanje specifičnih regatnih zahtjeva u pogledu palubne opreme zahtjevali su drugačiji metodološki pristup. U ispunjavanju tih zahtjeva autor indirektno surađuje s istaknutim europskim proizvođačem malih plovnih objekata na jedra. Za potrebe suradnje razvijena je posebna metodologija unapređenja opremanja definiranog malog plovnog objekta. U prvoj fazi predložene su temeljite analize utjecaja smještaja opreme za jedrenje i konfiguracije same palube postojećeg modela oznake B40S na performanse u jedrenju i to za različite uvjete mora i vjetra primjenom RaceQs računalne aplikacije i ekspertnog pristupa. U drugoj fazi vrši se analiza prikupljenih podataka te se ekspertnom analizom očitavaju smjernice za unapređenje. U trećoj fazi vrši se utjecaj na redizajn postojećeg modela implementacijom dobivenih rezultata. U četvrtoj fazi analiziraju se učinci na unaprijeđenom novom modelu B41S primjenjujući postupak iz prve faze. Metodologija je iteracijskog karaktera te konvergira optimalnom rješenju za definirane kriterije.

Ključne riječi: mali plovni objekt na jedra, oprema malog plovnog objekta, unapređenje opremanja, ekspertni pristup.