Very different from the Whitbread 60 of the same name that went around the world in the 1997/98 race, but as you get a little more mature every yacht owner deserves a little more comfort and a little less freeze-dried food. Luxurious or not, the performance profile of the new *Chessie Racing* is cranked well up, pushing the sail area/displacement ratio well beyond the point where it is most efficient with respect to rating. This emphasis on outright performance is common to a growing number of today's new yachts – and at all sizes. Go fast, have fun and let the rating systems keep up if they wish to

BILLY BLACK

Creation and prediction

With 495ft of groundbreaking yachts launched in the past 12 months, it is designer Bill Tripp's new 62ft Chessie Racing that Seahorse readers are most likely to encounter on the racecourse

Chessie Racing

I had a conversation with my neighbour, who is an economist, over dinner recently on the subject of creation vs prediction. He had been looking at some photos of our most recently launched boats and asked how we could possibly deliver on a complex set of expectations involving so many unknowns.

Despite the fact that his expertise is economic modelling, he said that in his world predicting anything approaching an exact outcome was a pipedream. To him, the idea that in the design and engineering world we could use predictive modelling to achieve an exact outcome was close to miraculous. I told him that predicting designing and engineering results was what we did well – it was predicting how to make a living at it that was the iffy part! Ah, if an economist could only help us there.

We went on to speak of the differences between the chaos theory in economic modelling of an open system vs chaos theory in fluid dynamics and structural analysis within the confines of our more ordered systems. We are both regularly using CFD and FEA tools to look into the future, but his economics training taught him that no effort, however disciplined, would overcome the randomness of unforeseen events. I, on the other hand, described how as engineers we work with a combination of exact sciences and predictive models to overcome randomness – not something that we want at sea!

Where our two implementations of predictive modelling differ is that in naval architecture and design ours can be checked and benchmarked against existing forms. In fact, in the design and engineering sciences we cannot be afraid to seek change, but we had better be able to predict the outcome.

This year we delivered three very different boats. The biggest is *Aquijo*, an 86m (282ft) ketch built in steel, that, while enormous, is a true sailing yacht with two 300ft masts. The second, *Skade*, is a 46m (151ft) modern world-cruiser built in aluminium that was delivered in May and is already out in the South Pacific. Both of these vessels were built in Holland.

Moving back to the US, our most recent launch is the 62ft café racer *Chessie Racing*, built by New England Boatworks for an experienced owner looking for a very particular boat that is sexy, fast, easy to sail shorthanded and comfortable for both daily use and cruising. She is also the perfect boat to review the creation vs prediction design and engineering spiral that I spoke to my neighbour about in something less than 200 pages.

This owner is coming off a bigger cruising boat and wanted something both easier to sail and faster, but having enough accommodation, rather than as much as possible, to simplify how he went sailing. The primary focus lay on three things: the ability to go very fast, take friends and family out daily in comfort, and have fun racing offshore. Beyond that he needed to have shoal water capability for his dock and beauty to look at. What an old friend of mine boatbuilder Bill Green once called 'a Tour de Force'.

In the pure raceboat world there is a constant seeking of relentless simplification or minimalism – the best way to save weight is to not have it. In the world of dual-use boats there are systems, equipment and volumes to accommodate. While our bigger boats had their own set of challenges, putting all these worlds into what we describe as a pocket-rocket is nothing less than a 'mission'. To meet this challenge one must get the balance just right and, while this also includes some level of simplification and optimisation, it will exist at a higher level of complexity.

Design brief

In our brief the owner called for a dynamic boat to be used primarily to sail extensively as a day boat in New England and Florida as well as in some of his favourite distance races. These races run the gamut of handicap rules, including IRC and ORR, and with an eye to ORCi for further down the road. All in a simple state-of-the-art design, rather than a rule-centric boat. Some specifics:

- Ultra-modern carbon daysailer
- Three private sleeping cabins, two heads, a comfortable main saloon

Good to see a big new dual-purpose high-performance yacht aimed at a programme that specifically includes offshore racing. It is surely ironic that, while the entire Maxi 72 fleet pulls out of the Bermuda Race because of the 'risk of' boat damage, with a few notable exceptions today it is largely left to boats like the new *Chessie* (*above*) and Mike Slade's *Leopard* to show what today's big boats are capable of when released onto the open sea. A healthy offshore component also helps to keep righting moments sensible

- Single-level cockpit and shallow angle companionway
- Easily sailed by three people including docking
- Shoal draft of 7-8ft
- Six-day autonomy
- A/C at the dock only
- Can run in silent mode (no audible power generation) for day sailing and day racing
- Offshore racing: Bermuda, Key West, Block Island, Vineyard, Palm Beach, Jamaica and others under multiple rules
- Finally, the boat was to be a monohull that was as fast as possible given the balance needed across the above factors.

The virtuous design spiral

Along with new challenges come new opportunities. In design these can be answered via a symbiosis of experience and technology. Technology is relentless in providing better means and ways. We use high-tech tools and controls to first develop a better design and then manage (fine-tune) the outcome. In a pocket rocket there are a lot of pieces to control; the tying together of the modelling, the engineering and the distribution of mass are critical to realise the project.

We choose to break the design process down into discrete sections, allowing us to manage them as tasks within which we achieve concrete results. We use ESWBS (US Navy Ship Works Build System) to organise the sections and tasks. Starting with a detailed spec tied to our weight calculations, we use CFD to model the hull and FEA to model the load structure. It is important that we co-operate and communicate well on the different tasks both within our office as well as with outside technical experts and suppliers. Weight control is a 'team event' from design to delivery.

Unlike a racing boat, which has a singular purity of purpose, *Chessie Racing* had a defined length with a corresponding weight (before ballast), freeboard and interior volume. Within the design brief we need to optimise the principal parameters of beam/stability/sail plan/foils/ballast. We can also optimise shape and some weight options. This optimisation starts what we call a virtuous design spiral.

- For *Chessie* we started with several parametric designs and a VPP. Reviewing that output, we manipulated the parameters, creating a base boat shape that then went into a panel code run with automatic parametric iterations (robot) to more accurately investigate various influences – for instance, beam and sail area vs stability and wetted area/drag.
- We saw early on that stability was a better driver, and if we could mode the sail plan between day sailing and racing, then the boat would be faster racing and easier to sail when not.

Parallel to this, we had three different handicap frameworks to work within – two VPP-based and one a typeforming single number rule. A complex equation.

While not wanting to dive into the single number vs VPP issue here, we have seen what we think is an unintentional effect in IRC around the 62ft+ size. When confronted with big dual-purpose boats, the black box of IRC typeforms and rates their larger sail areas more heavily than it 'de-rates' their higher displacement; as a result more complex bigger boats suffer as they add sail area to compensate for the weight of their many systems and all of the luxury add-ons (this perceived imbalance was a factor in the superyacht fleet moving away from IRC in its present form). For the same reasons, J-Class boats rate well in IRC – heavy and with comparatively little in the way of sail area.

This is not, however, an issue for IRC grand prix boats — these boats drop their weight, removing anything not strictly there for performance goals, thereby increasing the responsiveness per kN of drive force from the sails. It is this better responsiveness, as much as the pure sail area/displacement ratio of a raceboat that often allows it to beat very much bigger boats around the racecourse, especially in variable conditions (it also makes for a much more entertaining boat to sail).

The result for us… we didn't design strictly to IRC regarding sail area because we all wanted our boat to also power up in light air (fun), and plane offshore in a breeze (more fun).

- After we had our weights refined we then optimised the shape around this and the better parametric results. At a DLR Displacement/Length ratio (DLR) of 77 and an upwind Sail Area/Displacement Ratio (SADR) of 41, we had a very exciting boat. Even if not Grand Prix, it would be state of the art.
- After a verification of our panel code results through some point checking with a RANS program, we settled on a new base boat and then ran another hull series around the most promising parameters, focusing on shape variation this time, again initially by robot and then moving to two perfected 'drawn' shapes. We took these two forms and ran them through the North VPP, while finishing the hull study with a two-boat RANS test (this time run at KND Sailing Performance) as a check against our work. Everything aligned and after another spiral we had the design we wanted.

- For construction we optimised the materials as the principal place to save weight, and utilised NEB's strong expertise in building lightweight pre-preg carbon-Nomex structures and components. We iterated between compliance requirements (in this case CE) and FEA to optimise the construction; the FEA was kept particularly busy on detail items.
- For racing we turbo-ed the sail plan, with a big 105% jib led to fore-and-aft tracks and an inhauler, and a square-top mainsail. However, for day sailing we went with a self-tacking jib and a pinhead main – so no runners. This aligned well with the respective stability requirements – there are no hikers day sailing – and the resulting sail plan is easy to handle. Under IRC the boat would be likely to fair better in non-turbo mode, but be less dynamic and fun to sail.
- We knew already that we would have a furling boom with a furling foil on the headstay. A bit of weight, a bit of windage, but these systems allow such a powerful boat to get sailing quickly and easily.
- On a separate design spiral, we evaluated sailing systems for weight and usefulness. In the end we split the power requirements between hydraulics for a mainsheet MagicTrim, allowing super-easy mainsheet trimming for day sailing, and electric power for the winches to make sure that we didn't have speed losses when racing on account of needing high hydraulic flow to multiple winches simultaneously.
- We worked with Mike Toppa and Chris Williams to optimise the sails and the balance of the boat using their yaw VPP.
- Working with NEB, we decided upon an electric bow thruster. We were also able to ditch the generator and use two engine-driven alternators to charge the lithium-ion house batteries that drive everything. Smooth and silent, as instructed.

The result

We designed to and achieved a boat weighing 15,500kg that was both wider and with a heavier bulb than we initially thought.

- The boat is equipped with a lifting keel and twin rudders – driven by the shoal-draft requirement
- We chose a Hall Spars deck-stepped, swept-spreader rig for simplicity and location (the rig sits above the lifting keel box, which offers a nice structural solution)
- With only 75HP (the biggest Yanmar engine with a saildrive) the boat makes 10.5kt with a Gori three-blade folding prop (which is surprisingly low drag when folded)
- The boat has a Cariboni MagicTrim mainsheet, Harken electric winches, a Reckmann recessed furler headstay, a removable furling staysail, a self-tacking jib, a Hall furling boom and a square-top main plus runners for racing
- Power consumption is well within comfortable limits (in our early trials we completed a full day under sail including numerous manoeuvres and drew only 15% of the yacht's available battery power)
- *Chessie* is easy to steer and has good stability. We comfortably carry one jib (J1) up to about 20kt of true wind
- The boat powers up quickly, the crew hiking downwind from 6 to 7kt TWS.

We used exactly the same tools and technology to 'predict outcome' on both the state-of-the-art carbon 62ft *Chessie Racing* and the groundbreaking steel/aluminium 282ft *Aquijo*. The modern tools that have become de rigueur in the global design arena are CFD and FEA – both can accurately predict the outcome when used correctly.

That said, they won't design the boat. It is still up to the human brain to read the physics, see the vectors and visualise triangulations or projections as necessary.

The tools themselves can't look or see into the future, but the proper use of new tools does move design forward, just as new technology keeps opening up further opportunities. The next state of the art is always out there if we look.

A big thanks to the teams at NEB, North Sails, Hall Spars and Harken, and to my colleagues David Egan, Stephane Leveel and Nate Yeater for all the help in looking.

Bill Tripp, Norwalk, Connecticut ❑