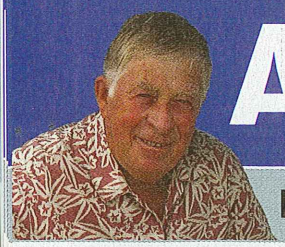


Andrew Simpson

Monthly musings

Yacht surveyor and designer Andrew Simpson cruises in his own-design 11.9m (39ft) yacht *Shindig*. Read his blog at www.offshore-sailor.com

The Nova Scotia gaff rig schooner *Bluenose*

Publiphoto Diffusion Inc/Alamy

Is bigger better?

No matter how big your boat bank balance, nothing beats the simple laws of mechanics

For much of the final decade of the last century I was living in Texas. One day the telephone rang and I found myself talking to a man whose name resounded loudly in the world of oil.

He told me that despite his business associations he was a romantic at heart and had a particular fondness for classic sailing vessels – most particularly Grand Bank schooners, of which the famous Nova Scotian *Bluenose* shone as the brightest star. He had a project in mind, had heard that I designed boats and wondered if we could meet at his country club to chat about it.

Now, since I was engaged at that time in the process of designing and building lightweight multihulls, I doubted I was really the man for the job, but he swept aside my reservations. "I'm thinking of building a *Bluenose* replica," he told me. "The same general design but bigger – much bigger. Maybe twice as big."

Scaling factors

I could see an immediate snag. If you were to double the size of a boat would you get twice as much of everything?

The answer is no and that's because we come face to face with the law of 'mechanical similitude' – a conversation-stopper of a phrase that describes a scaling law that's central to our understanding of what we can expect from dimensional changes. The principle is best explained by example.

Let's take a boat of any length and scale it up to exactly twice its original size. It would be tempting to think that its various dimensional properties would simply double and, indeed, some do. But not all.

- Linear measurements such as length, beam and draught vary in proportion to the scaling factor. The results of doubling the size being: twice the length, twice the beam and twice the draught
- Those values that involve areas, such as wetted surface and sail areas, vary as the square.
- Anything that has a volume, like displacement, varies with the cube. So, incidentally, does the heeling effect of wind velocity on the sails.
- Stability varies by the power of four.

So, what does this mean numerically? Well if, say, we double the size of a boat we get:

- Twice the length, beam and draught (x2)
- Four times wetted surface and sail areas. (2x2 = 4)
- Eight times the displacement and heeling effect. (2x2x2 = 8)
- Sixteen times the stability (2x2x2x2 = 16)

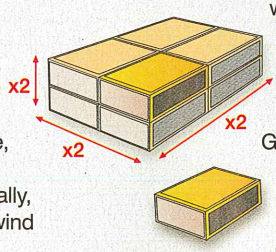
To understand the principles better, let's imagine taking a single matchbox and being asked to build a cube of matchboxes exactly twice the size in every dimension. We would need a stack of eight matchboxes to accomplish this – exactly what the arithmetic tells us.

Of course, it would be nonsensical to scale up a design in such a simplistic manner. After all, we can expect people who sail small boats to be roughly the same height as those who sail larger ones, so there's no need to have twice the headroom. But these dimensional relationships give us an important, though inexact, means of comparing the properties of boats of different sizes. If, say, comparing a 10m boat with one of 20m we might conclude that the larger boat would have roughly four times the accommodation area and be sixteen times more stable – two very significant advantages that go with size.

And since build costs roughly follow displacement we could guess that the larger vessel is also likely to be eight times more expensive!

Incidentally, it was the law of mechanical similitude that helped kill off commercial sailing ships. Faced with a growing threat from steam, they struggled to compete by building bigger and bigger ships – only to hit the scaling factors wall head on.

With displacement advancing by the cube and sail area only by the square, they soon found they couldn't set enough sail to propel all that added weight. Bizarre five- and six-masted schooners were their last desperate attempts. Meanwhile, steamers were discovering that they could carry more cargo (cube) for relatively less wetted surface area (square) so, for them, big was definitely beautiful. Game, set and match to mechanisation and a sad end to a glorious maritime era.



Matchbox example of mechanical similitude