An Holistic Approach to the Design of Electric Canal Boats

By Alastair Hunter

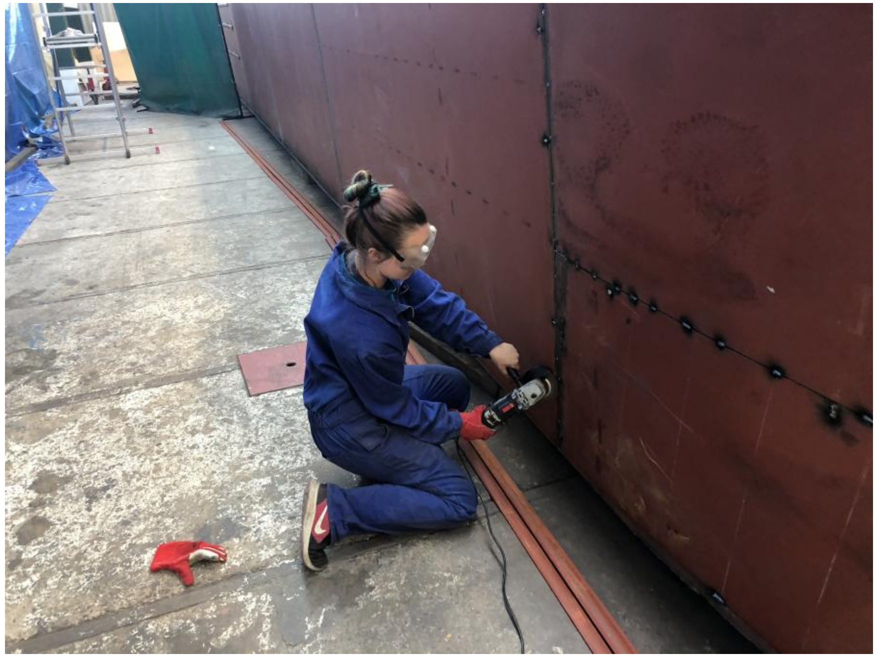
The holistic approach to design views a project as an interconnected ecosystem rather than a collection of isolated parts.

It goes beyond basic functionality to consider how an entire product, space, or service impacts the end-user, the environment, and the broader society throughout its entire lifecycle.

electrik@

Who are we?

Naomi Hunter MA – CEO and Interior Designer



Alastair Hunter FRINA – Naval Architect

To understand a product fully – get involved in the entire process

Going Green with Ortomarine

AQUAVISTA

History of Narrowboats

The Canals and River Trust observes:

"The narrowboat as we know it now is attributed to James Brindley. A highly influential canal pioneer, Brindley reached an agreement with the Trent & Mersey Canal Company to build the first lock that standardised the maximum narrowboat dimensions of 7 feet by 72 feet.
The narrow proportions made sense for a number of reasons. It would be easier to tunnel under hills and require less effort to expand the canal network throughout the midlands and beyond."

Going Green with Ortomarine

AQUAVISTA

electrik@

Introduction

Why have we revisited the design of canal boats?

- Innovation drives the evolution in design
- In this case
  - Improved battery technologies
  - The societal need to reduce the use of fossil fuels
  - A movement towards sustainable solutions

Overall design philosophy

- Our key aim is to produce elegant, tailored designs with a focus on detail.
- This applies to all aspects of the design, be it in the engineering solutions or, importantly, the use of space, choice of materials and finishes which express the individual Clients tastes.
- What does this process look like with our clients?

Engineering design philosophy

- All good hull designs consist of a set of compromises balanced against each other to produce the optimum design for the specific application.

Design constraints

- In the case of developing a design for a new boat for leisure use within the UK canal system, there are a number of key drivers for the engineering solutions. These are:
  1. The three dimensional constraints of the UK canal system.
  2. The operating speeds and wash generation profile.
  3. The particular Clients’ use profile.
  4. The type of propulsion package preferred, Diesel, Electric, and so on.

Design constraints

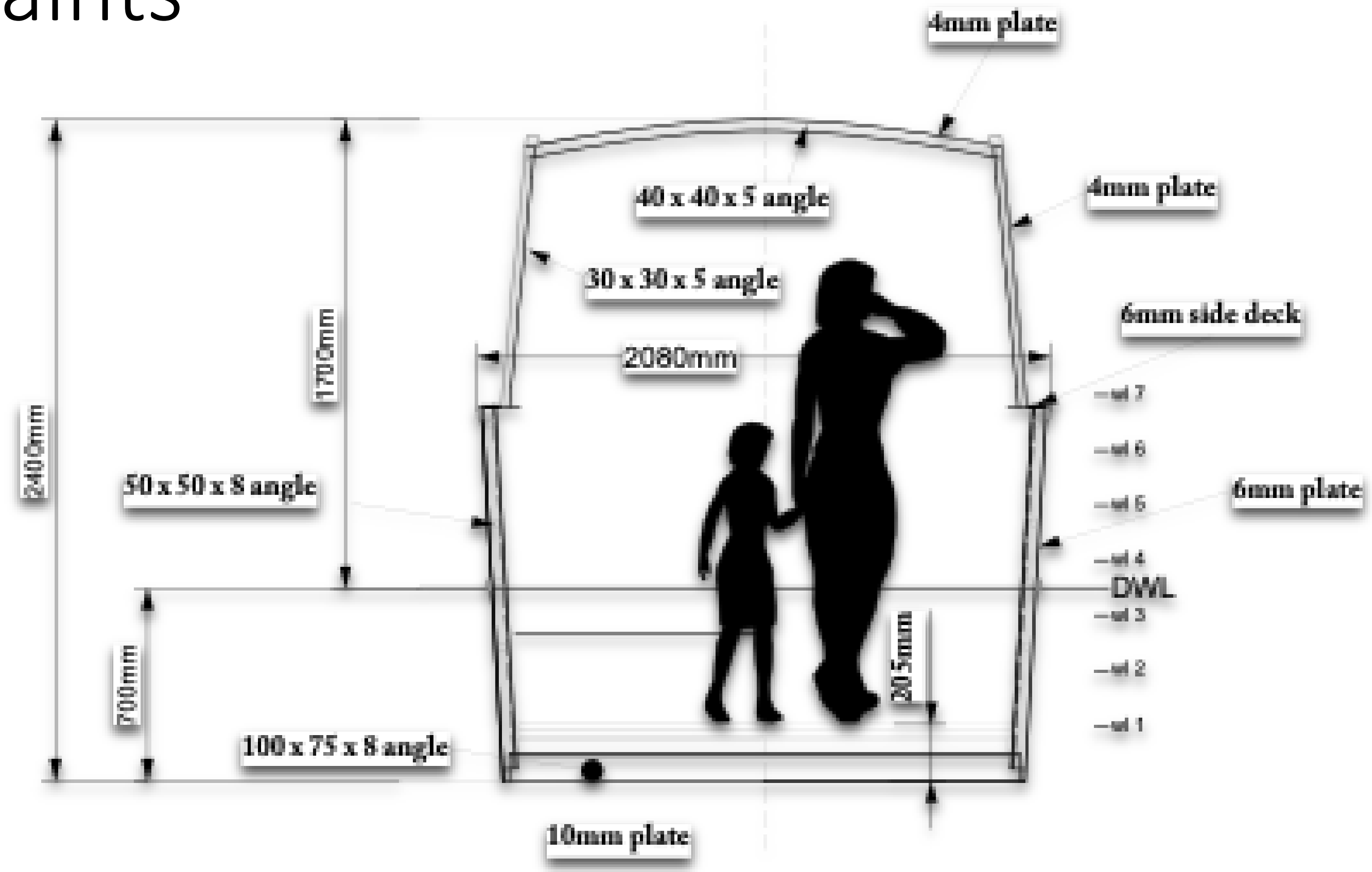
- It can be very easy (or even seductive) to focus on a single aspect of design.
- It is important to maintain in clear focus what the boat is for!

Design constraints

- We have used the Canal and River Trust Waterways dimensions document as the basis for the physical restrictions to be complied with.
- *<u>So, to access the whole system we find that the following maxima apply:</u>*

    1. an air draft of 1.7m (Coventry Canal)
    2. beam of 2.13m for narrow canals
    3. and a maximum draft of 0.7m (Aspley basin to Standedge Tunnel, Llangollen canal and Ribble Millennium canal)
    4. As far as speed and wash are considered the Canal system has a 4mph (3.48 knots) speed restriction and a low wash policy

Design constraints



Wholistic design

- With all the above in mind it should be recognised that the primary function of most canal boats is accommodation.
- The Floating Ohm Design team have designed a hull that maximises the internal volume dedicated to the accommodation together with the external deck spaces fore and aft, whilst at the same time optimising the propulsive efficiency of the hull within the constraints described above.
- We also focus on engineering systems design - It just needs to work!

Hull design

Photo by Haydn on Unsplash

Fn = V/ √(L x 9.81)
Where L = waterline length (m)
V = speed in m/sec (Knots x 0.51444)
9.81 = gravitational constant

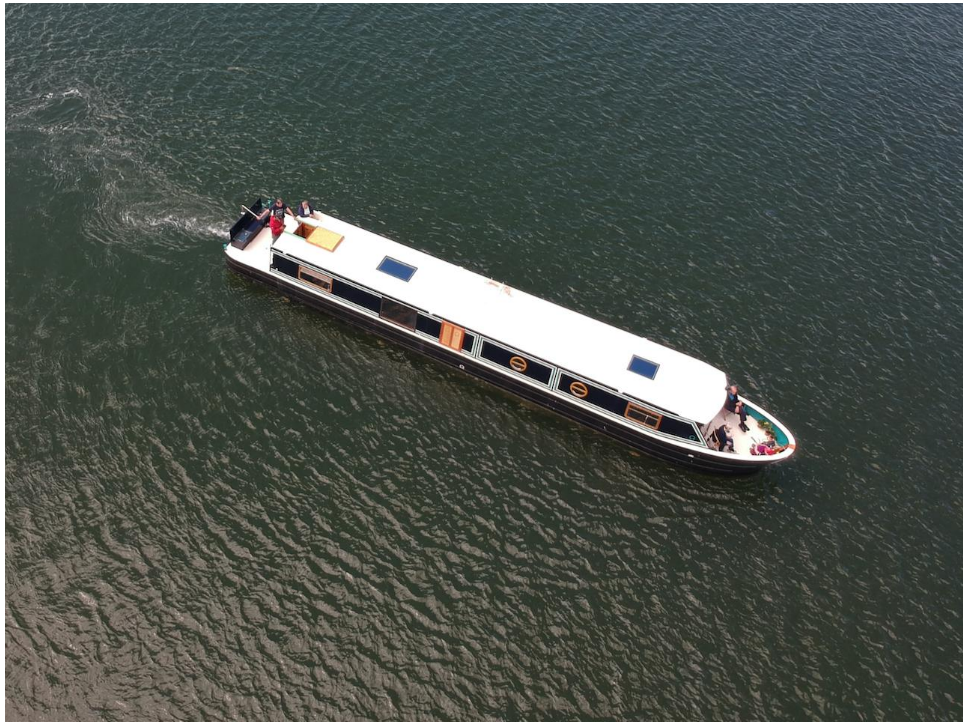
- We started without a pre-conceived idea of what the hull form should take other than the limits observed above.
- What might similar hull forms look like in the ship world?
- Typically such vessels are Bulk carriers. We observe that the bow sections are as shown in the photo.
- *The bow can be seen to be very full and takes the form of a partial cylinder*

Vessel	l (wl length)	V(knots)	Speed (mph)	v (m/s)	Fn
Bulk carrier	300	15	17.26	7.717	**0.142**
Canal Boat	16	3.5	4.03	1.801	**0.144**

Going Green with Ortomarine

AQUAVISTA

Hull design

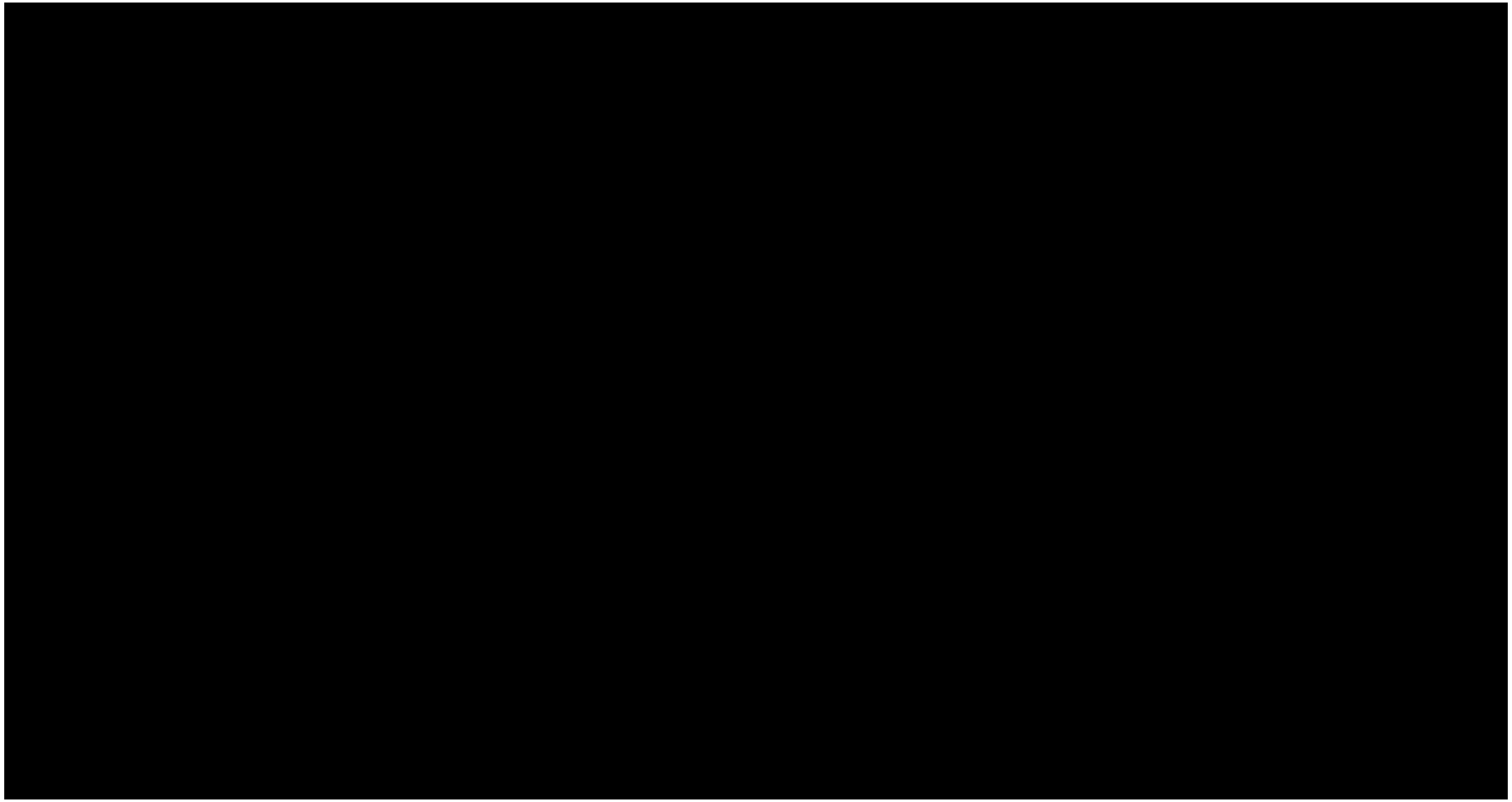


There are other similarities as well.

- The ship is designed to have maximum volume in the hull for the cargo and ship Owners are very focused on fuel efficiency.
- The key drivers are the same.
- The design of the Floating Ohm afterbody has a very narrow ‘pod’ housing the electric motor and thus presents a much cleaner flow into the propeller disc. This improves propeller efficiency and reduces noise.
- The added benefit is that we end up with a larger machinery space than is achieved by a conventional swim.

electrik@

Hull design



Going Green with Ortomarine

AQUAVISTA

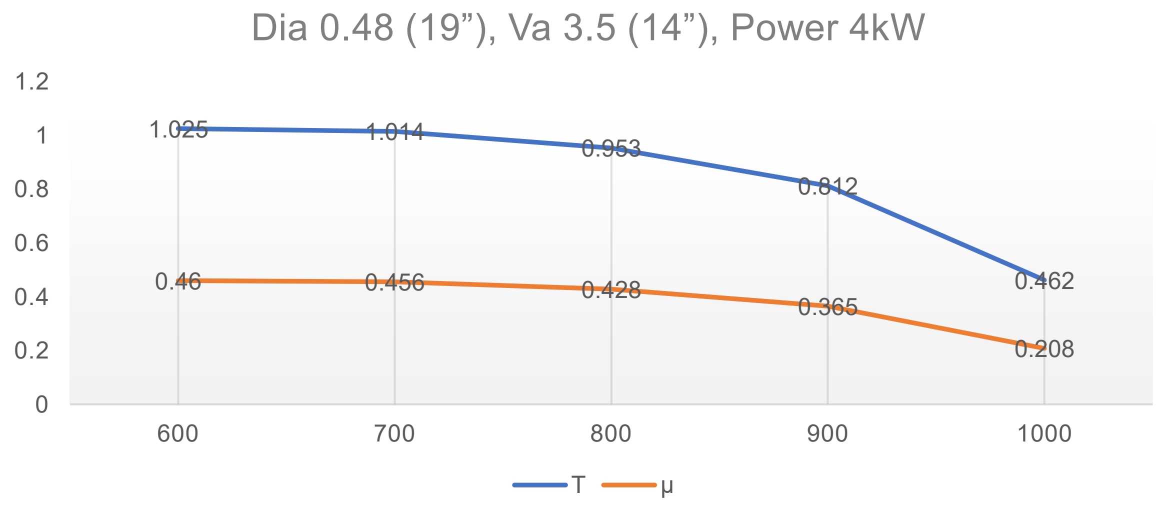
Powering and wake

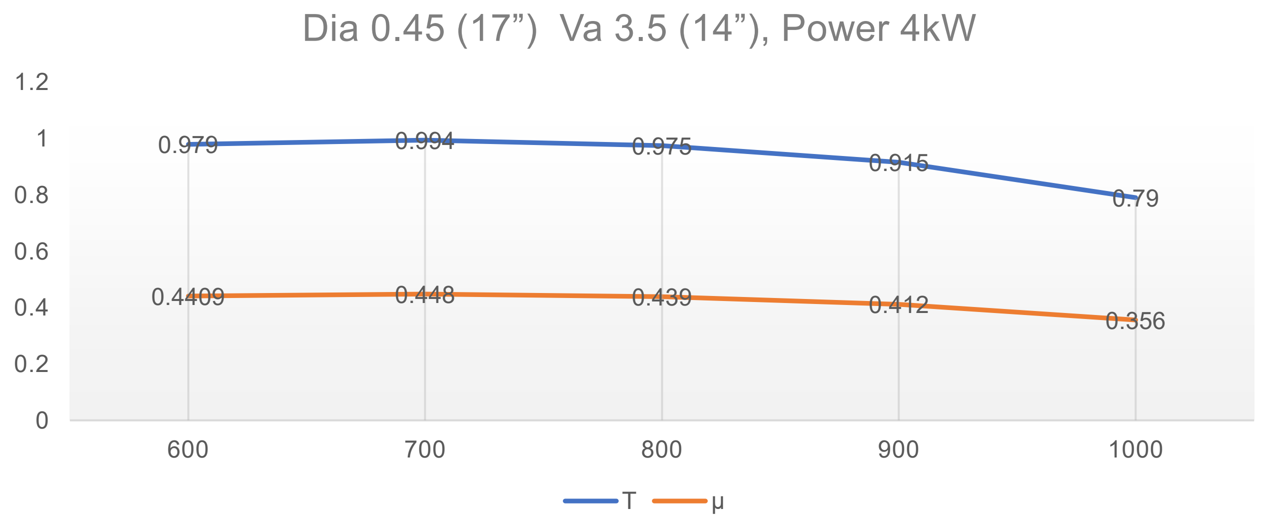
- Overall, we see an improvement in powering when compared with a conventional narrowboat of similar proportions of around 10%.

- There are also visible improvements in wake distribution and wash at cruising speeds.

Propeller design

- We undertake detailed propeller design to establish the optimum efficiency and thrust as can be seen from this example :
- Maximising thrust (T kN) and propeller efficiency (μ) drives us towards a larger diameter in this example (0.48m) 19” with a pitch of (0.355m) 14” (BAR 0.52) running at 600 rpm
- We then look to match the motor torque and power to the propeller.





Going Green with Ortomarine

AQUAVISTA

Squat

- We are often asked “yes!, but what about the squat and running your radical hull form in a canal? Have you done trials etc etc….”
- Squat is a well understood phenomenon and can be calculated:
- We choose to have a draft of 0.6m and the block coefficient is very similar to a conventional hull of equal proportions and as a consequence we perform in a very similar manner.

$$Squat_{max.} = \frac{C_B}{30} \times S_2^{2/3} \times V^{2,08} \, [metres]$$

(by Dr. C.B. Barras)

	FO vessel	Reference vessel
Cb	0.814	0.822
wd =water depth (m)	0.800	0.800
cw = Canal width (m)	15.000	15.000
beam (m)	1.981	1.999
draft (m)	0.690	0.695
speed knots	3.640	3.640
S2 = As/Aw	0.114	0.116
As =b*t (ship)	1.367	1.389
Aw = wd * cw	12.000	12.000
Squat	0.069	0.070
clearance under keel	0.041	0.035

Conclusions

- To summarise:
  - Explore what the project needs to deliver
  - Examine the constraints
  - Discuss key requirements with the Client
  - Start the interactive design process with the Client
  - Agree and finalise design
  - Absorb feedback as the project builds out. (learn)