The Changing Face of Naval Architecture

Some comments by Nigel Gee prepared for Paul Van Dyck
Deputy Editor of The Motorship

Naval Architecture has been described as the second oldest profession in the world, with early boats preceding the invention of the wheel, and vessels sailing in the open ocean more than 5000 years ago. Vessel design continued to be based on wooden construction and sail propulsion, until the mid 19th century. The design of these vessels was based largely on the experience and intuition of the naval architect. Following the industrial revolution and due to the outstanding work of many pioneers including William Froude and Isambard Kingdom Brunel, the modern science of naval architecture was established. The basic methodologies established for hull design, resistance prediction, propulsion, stability and structural strength have changed little in principle. In the 20th century a practising naval architect needed to be a well-rounded engineer with the ability to apply physics and maths to the design of ever larger structures moving at higher speeds in the difficult interface between the atmosphere and the sea. Few, if any, aids existed to simplify the computations and drawings which the naval architect must make. A deep understanding of principals and an experienced “feel” for the strength, durability and safety of the floating structures he designed were vital to the successful practitioner.

Following the advent of the digital computer, and more recently a huge increase in processor speed on desktop computers the ability of the naval architect to carry out ever more complex computations has increased perhaps a thousand fold. CFD, seakeeping calculations, finite element analysis and wealth of other software based tools enables the naval architect to complete complex analyses in a few weeks where previously years would have been required to carry out calculations in this depth. The necessity of this level of analysis for some of today’s very large and complex vessels is beyond doubt, but the availability of low cost desktop computer packages for most of these analyses has lead to their use on quite small and simple vessels where their applicability is questionable.

There are two main drivers for this proliferation of analysis; the first is that the analysis is being undertaken simply because it is possible. There is a perception that using these analysis tools an “optimised” or “better” vessel will result; second is an increasing concern on the part of operators and shipyards with possible litigation from the operation of commercial vessels due to vessel damage, loss of life, pollution, etc. This is leading many owners to specify an increased level of technical analysis in their build tenders. Some of these design requirements now involve analysis which would not previously have been contemplated, and this is especially true for the design of smaller vessels under 50m in length. FEA, fatigue analysis and noise and vibration analysis may be routinely requested.

This trend means that the majority of naval architects have to become more specialised in sub-disciplines, and few are able to appreciate the total ship design problem. There is a danger that a design job becomes modular in nature and common sense solutions to overall design questions may be missed. It is interesting to note that the SS United States, one of the largest liners ever built and capable of top speeds of around 40 knots, was designed more than 50 years ago without any of these modern analysis tools. The same is true in the aerospace industry, with rockets and vehicles such as Concorde designed before the age of application of the modern digital computer.

There is a significant danger that naval architects will lose some of their capability to design. The whole process is becoming a little remote with practising naval architects using tools which use processes and equations about which he may know little or nothing. One example of this is the use of the new harmonised damage stability regulations, which use probabilistic methods and are only realistically amenable to calculations using a software package. A naval architect using such a package will find it difficult to judge whether the resulting Stability Index makes sense; whereas under the old deterministic methods, a visualisation of the ship in various flooded conditions was available, and sanity checks easily made. The problem is further compounded by the fact that different packages may give different results. It is of course true that the old deterministic methods were also much easier to solve using a digital computer, but at least the process could be clearly understood and the results judged. The same cannot be said for the probabilistic methods, and we are now using these methods because computers allow us to, but is it desirable?

There is then a danger that naval architects will loose touch with the science (and perhaps the art) of the profession. The modern naval architect given two hull forms and all the information about their shape, coefficients, surface areas, etc and asked to compare them will probably reach for the nearest software package. Not so long ago, a naval architect with his knowledge of the fitness of various coefficients and ratios for hull displacements and speeds, and an understanding of the shape of the sectional area curve and stern form could probably have made these judgements based on his education and experience. Should we be concerned that some of this understanding of this subject may be lost? I think so.

The ever upward trend in world trade, the desire for greater efficiency and eco-friendliness, requirements for speed and diversity in naval vessels caused by the changing nature of world warfare, all point to a significantly interesting period in naval architecture during the next decade. It would be a pity if opportunities for inspirational and innovative design are lost in a welter of analysis.

“A good design” is one that exceeds the owners expectations. Priorities will be that it meets his specification, is safe to operate, provides comfort and habitability for crew and passengers, meets environmental regulations and concerns, and meets the relevant regulations of class, international and national authorities. Meeting the regulations is a question of diligence in assuring that all relevant rules are adhered to, and will produce a vessel with features that comply to an international consensus, but is not necessarily a good design. Comfort and habitability is of increasing concern, and is indicative of the realisation of the importance of quality of life to a seafarer to a successful operation. There is no doubt that good ship motions and well planned ship accommodation are features of a good design. Increasing use of safety case analysis and failure mode and effect analysis in ship design significantly enhance ship safety and is surely a better approach than the previous prescriptive and sometimes arbitrary safety rules. The most important aspect and probably the most difficult is that in providing the shipowner with a vessel that exceeds his expectations as regards specification. His requirements will include speed, deadweight and fuel consumption and also sea kindliness, maintainability, manoeuvrability, and reliability. These are the difficult and challenging areas for the naval architect, and are also the areas where design skills may be lost due to increasing reliance on software based design.