DEFENCE

Delivering a sea change

BAE Systems' human factors team is helping to develop submarines and warships designed to meet the challenges of living at sea

Submarines and naval ships are among the world's most complex socio-technical systems, crewed by dozens of personnel who live and work in a restricted space on or underneath the ocean for months at a time.

BAE Systems is the UK's main provider of naval vessels and its expanding human factors team is central to the effectiveness of its design and products. As Alan Felstead, Whole Boat Design Lead for the Specialist Engineering and Technology Group, pointed out, human factors is at the core of efforts to make sure vessels are safe, operable and deliver the performance demanded by the Royal Navy.

"One of the great things about submarine design development," he said, "is that almost every aspect of human factors is considered. We support the design of the interfaces, both consoles and human-computer interaction (HCI); we provide guidance and assess the spatial ergonomics of operational and accommodation areas; we consider the environmental aspects; we conduct user trials; we determine the crew and their duties and we conduct human reliability analysis to support safety."

The areas taken into account are manifold. They include habitability, lighting, noise, thermal environment, burn hazards, accommodation design, traffic flow, mess design and layout, workplace and workspace design and layout, manning, target audience and anthropometry, human-machine interface, human reliability, safety, manual handling, damage control interface, hazards to health, risk of injury, access on the casing, control room design, workload, alarms and warnings, communication and situation awareness, along with experimental design.

Alan Felstead

Martin Thody

Anna Welch

To achieve this, the human factors team works hand in hand with the Operability team, which comprises more than 15 ex-submariners who have decades of experience living and working on board all classes of UK submarines. They bring the experience of living on board a submarine to life, adding operational context through sharing invaluable insight and knowledge of its capability, mission and operation.

Careful balance

Alan's colleague, Martin Thody, Engineering Manager – Human Factors, said: "Taking account of human factors ultimately enables crew to successfully execute their missions to protect our nation. Human factors applied in this environment is based on a careful balance between theory, experience and hard-core pragmatism and requires our specialists to be as expert in stakeholder management and diplomacy as they are in human factors itself."

In every situation human factors must be balanced against many other factors. A submarine can only be so big and there's a trade-off to be made in terms of working and living spaces.

Anna Welch, Senior Engineering Manager – Human Factors and Operability, added: "There are so many constraints when designing a submarine that you have to understand the implications of not following a human factors recommendation. Cost benefit comes into it – if something costs a lot to incorporate but has a significant benefit to crew wellbeing there are substantial rewards for that cost. Some are intangible or immeasurable, for example the effect on crew wellbeing and mental health.

"Buildability is a big constraint. If you can't physically build it then the human factors benefits are unattainable. Therefore, you must recognise the limitations and work with the designers and engineers to reach the best achievable position."

Expanding team

As Anna explained, the BAE Systems human factors team has grown substantially over the years. "When I joined 13 years ago we had three human factors specialists – now we have more than 20. We have specialists at the start of their careers and some with nearly 40 years' experience. We come from a range of backgrounds including psychology, industrial design, physics and healthcare. With a strong mentoring and coaching ethos, we have four Fellows and many Chartered members of the CIEHF."

The team's expansion has come as its scope of work has changed significantly in recent years from purely platform design to include site infrastructure, safety culture, manufacturing, engineering and the build of new facilities. As a result, the team's membership

now includes human factors specialists and safety specialists.

Alan added: "The changes have been driven by a new multi-programme delivery approach and changes in regulatory oversight. Equally, I think there's a growing understanding in our business of the importance of human factors and its benefits. Human factors is now integrated across multiple programmes leading to safer, more optimised design. Individuals are becoming more agile, with the ability to move across programmes rather than focus on one project."

Looking to the future, the team works with a technologist to understand the technology and human factors themes of the future. Team members keep abreast of MoD research themes so that they can align their interests with those of its key customer.

Alongside day to day delivery, the team aims to strengthen its research capability. The goal is to use technology to its best advantage in human factors methodology and submarine design. Wearable technology, augmented reality and artificial intelligence are some of its main areas of focus for the coming years.

Like almost every other large employer, BAE Systems has adapted to the post-Covid working environment. The application of hybrid working provides flexible arrangements, allowing people to be more geographically dispersed while still coming together as a team to gain the wellbeing and developmental advantages of seeing each other face to face.

Alan concluded: "We're now engaged in several submarine programmes, all at different stages in the life cycle, from early concept to in-service. Similarly, we're continuing to develop the wider support we provide to BAE Systems Submarines including safety cases, new facilities, training and investigations. And we're always looking at new techniques and technologies.

"We have some really interesting work programmes coming up – the future is very exciting." ■

Improving life on board vital vessels

As with submarines, human factors impacts almost every aspect of a ship's design and development, from the working spaces to the living and eating areas.

Monica Sen Gupta, Head of Human Factors Discipline in Naval Ships, pictured above, said: "A warship is incredibly complex and large and to effectively apply human factors, our processes must be human-centred, systematic and structured. Our approach is in line with the MoD mandated Human Factors Integration (HFI) process. This helps make sure we cover the whole ship design life cycle, from concept to final manufacture.

"Some areas are of high priority. One of these is the 'brains' of a complex warship, namely the combat system, which is subject to in-depth design. Crew members depend on this area to operate effectively in the world's most difficult and dangerous environments. The integration of equipment in these areas and the operability of people and equipment is vital."

As well as ensuring the safety of the ship, human factors helps the crew stay motivated and effective in their warfighting role. Human-centred design across the whole platform means that everywhere the crew works and lives is considered, from walkways and compartments to accommodation spaces, eating and recreational areas.

Monica said: "Human factors in warship design has not always been applied across the whole ship. Previously, a human factors engineer would look at an area of the ship or the design of a specific piece of equipment. Now, because we apply human factors across the whole platform we can make a greater impact."

To stay at the forefront of warship design the BAE Systems team maintains close contacts with commercial shipping and regulatory bodies such as Lloyd's Register. And, as in all industries, team members attend conferences and exhibitions to keep up to date with latest developments and thinking.

Monica believes that human factors in warship design won't intrinsically change in the future. However, there will be constantly evolving challenges such as new global threats and how BAE Systems designs ships to keep up with competitors.

She said: "This will mean embracing emerging technologies such as the concept of autonomous ships and artificial intelligence built into platform design and equipment."