

BAE SYSTEMS Submarines

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BAE SYSTEMS Submarines Business Group (formally Vickers Shipbuilding) was one of the first Flowmaster users. To date they have created over 600 models to design, build and support major UK Naval Warships and Submarines.

Naval vessels contain many complex systems and are subject to numerous operating modes / conditions. BAE Systems Submarines have designed and built several large Auxiliary Oiler and Assault ships, which saw extensive use of Flowmaster during design and later commissioning stages. Currently BAE Systems Submarines are focused on delivering the UK's next generation of attack submarine, the Astute Class.

As a replacement for the Royal Navy's Swiftsure and Trafalgar Class boats, the Astute Class has twice the endurance of the vessels it replaces and will not require refuelling for the duration of its time in-service.

Reliability, safety, operational effectiveness and efficiency (covertness) are key requirements for the Astute Class submarines. BAE Systems Submarines have analysed many of the Astute systems to enhance and de-risk the design. An example includes the trim, ballast and hover systems, which were extensively modelled in Flowmaster to develop and optimise the design to meet the contractual requirements. The Trim, ballast and hover systems play a key role in the submarines operation enabling it to position and hover itself at different





Artist Impression of the Astute Submarines

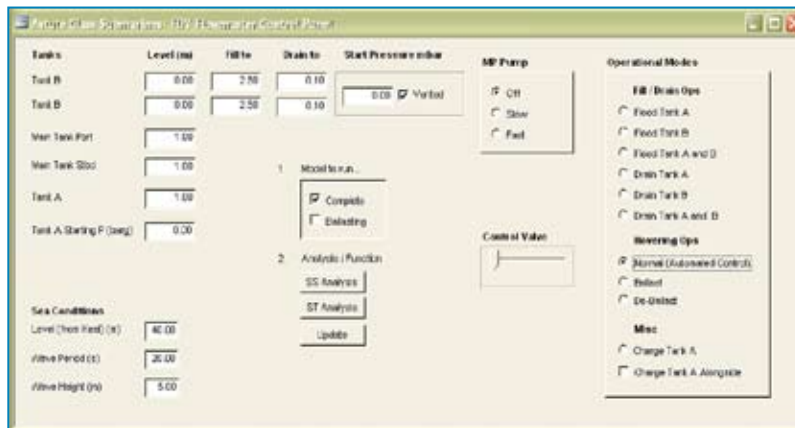
depths and attitudes in the water, and transfer ballast water between tanks. Many performance requirements had to be validated and several components had to be sized for purpose. Additionally, sets of data were required for helping to develop the whole boat platform control systems algorithms.

An expert user of Flowmaster at BAE Systems Submarines explains “we needed a way to organise the models to enable fast accurate batch analysis runs and enable other engineers to investigate the impacts of design changes themselves”. His solution utilised Flowmaster’s COM functions, and used Microsoft Access to run



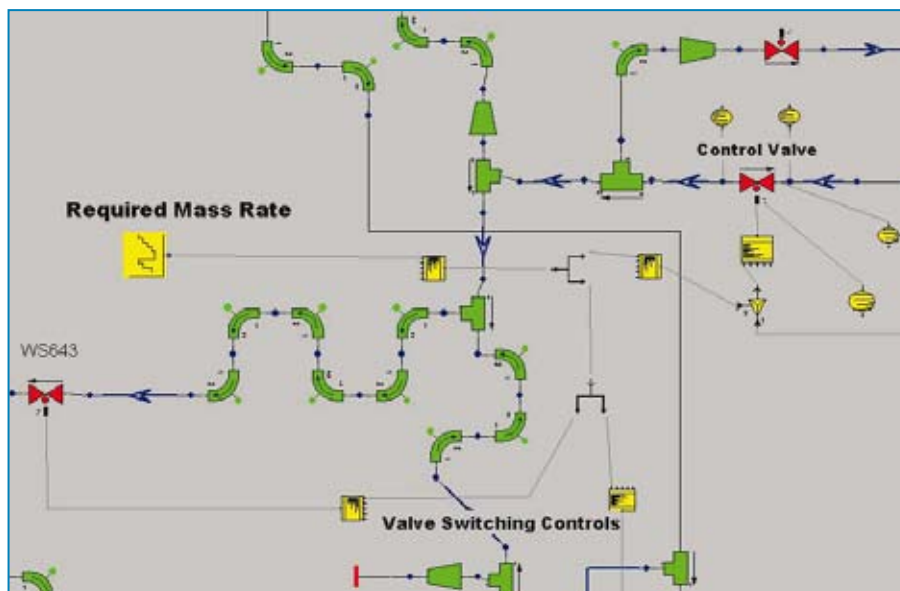
RFA Wave Ruler (Auxiliary Oiler). Flowmaster used extensively on central cooling systems

an operator control panel (an Access Form) which linked to Flowmaster models, performed calculations and produced outputs. The panel enabled design engineers with no knowledge of Flowmaster to get answers to “what-if” scenarios. The ballast and hover models also ran an automated mode and used internal controllers (scripts) to react during transient studies: opening / closing lines, running pumps etc.

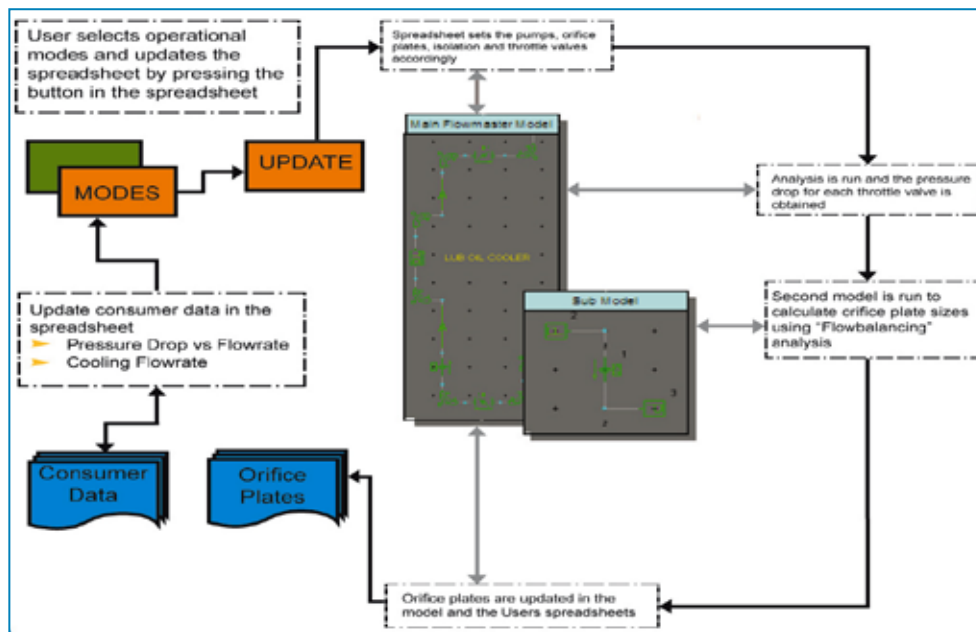


Operator control panel built in MS Access and linked to the system model so that design engineers with no Flowmaster knowledge can run “what if scenarios”.

Using controllers enabled BAE Systems Submarines to run the sea water systems and the tanks vent systems (air) simultaneously without the need to perform compressible analyses (blowdown tank), which greatly increased speed and accuracy. BAE Systems Submarines have produced similar software programmes linked to Flowmaster, aimed at reducing the amount of manual operations and to reduce user errors. On one of Astute’s cooling systems, they developed a customised link to Flowmaster to quickly balance the system and update the design engineers bill-of-materials. The process again used Visual Basic and enabled system rebalance of over 20 consumers in ten minutes. Normally this would have taken several days to perform.



A portion of the Flowmaster network showing controller components with embedded scripts.



Process chart describes the customised link with Flowmaster to balance cooling systems and update design data. Using Visual Basic, this system interacts with two separate Flowmaster models and the users spreadsheet.

Throughout the design process parameters changed. The process model (above) was run many times to action such changes to ensure the system analysis was always current. Flowmaster has also been used on the Vanguard Class in the later design stages and has recently been used to improve the boats efficiency by optimising pump duties to reduce dissipated energy. The work involved extensive modelling and on board testing for validation.



HMS Vanguard. Flowmaster used to improve efficiency by optimising pump duties.

Further information on projects:

[Astute](#)

www.baesystems.com/programmes/sea/astute/index.htm

www.naval-technology.com/projects/astute/

[Vanguard](#)

www.naval-technology.com/projects/vanguard/

[LPH01 Ocean Helicopter Carrier](#)

www.naval-technology.com/projects/ocean/

[LPD \(R\) Albion Class Landing Platform Dock](#)

www.naval-technology.com/projects/lpd/

Wave Class Royal Fleet Auxiliary Large Fleet Tankers

www.naval-technology.com/projects/wave/

[Information on BAE services](#)

www.baesystems.com/programmes/sea/astute/

designservices/index.htm

www.naval-technology.com/contractors/warship/bae/

[LPD \(R\) Albion Class Landing Platform Dock](#)

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