

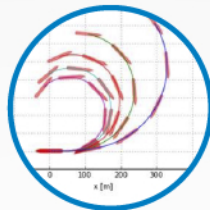
## 1 Concept evaluation

- Hull main parameters
- Location and size of the sail and control surfaces
- Choice of propulsion arrangement

## 3 Power Requirement

- Resistance and self-propulsion tests in the towing tank
- Wake flow distribution
- Rudder forces and moments

*Simulation of turning circle manoeuvre in Submo. The interface to Submo can be entirely web server-based either in-house or in the cloud.*



## 5 Manoeuvring performance

- Captive tests in wave basin, hydrodynamic coefficients for simulation model
- Simulations of standard manoeuvres and depth change
- Autopilot and depth controller design
- Stability in the horizontal and vertical planes



*A submarine in a simulator environment. The crew can practise repeat manoeuvres and practise operations which are not easy to perform on a real submarine.*

Designing the submarine

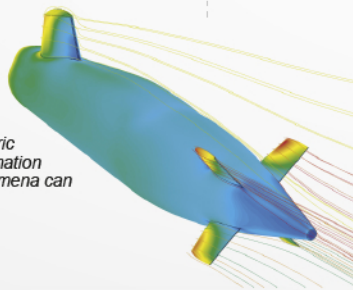
Verifying the design – model tests and simulations

In operation

## 2 Basic hydrodynamic design

- Hull
- Sail
- Control surfaces

*CFD calculation of a generic submarine. Detailed information about different flow phenomena can be obtained.*



## 4 Propeller design

- Cavitation tunnel tests
- High efficiency
- Good cavitation properties
- Low radiated noise



*Model of the IZAR P650 tested at SSPA. The same model was used in all SSPA facilities.*

## 6 Simulator

- Crew training
- Development of hardware for a submarine's bridge

### In operation

- Depth keeping in periscope conditions under a seaway
- Simulation of emergency recovery manoeuvres
- Compensation and trimming
- Safe operation envelopes



TOWING TANK



CAVITATION TUNNEL



MARITIME DYNAMICS LABORATORY