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Problem Solved.

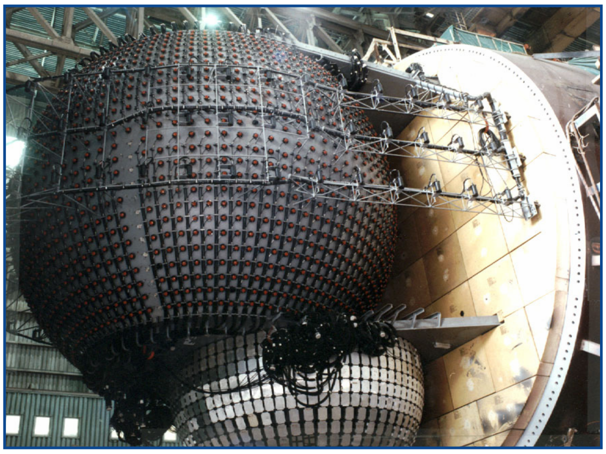
CASE STUDY | Ears Hearing Under Water

The Seawolf attack submarine was originally commissioned by the US Navy as an advancement in defense against the world's most capable submarine and surface threats. Commissioned for use in 1997, the Seawolf boasts sophisticated electronics for enhanced indications and warning, surveillance and communication.

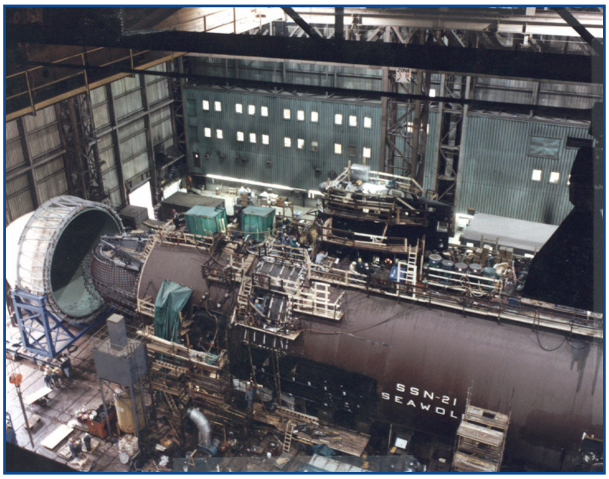
One of Seawolf's major systems is its passive sonar array – a combination of one array in the fore of the boat and one array in the aft. Passive sonar is important because it converts the pressure caused by sound waves into an electric signal, which is then used to formulate a digital picture of surrounding objects. Passive sonar is a technological advancement because it avoids having to transmit a sound wave outward to discover the presence of surrounding objects.

The core of this technology is the sonar array, as shown in the picture, a huge ball-shaped structure onto which hydrophones are attached and covered with red caps. A hydrophone is a specific piezoelectric device that converts sound pressure into an electrical current, even under extremely harsh under-water conditions.

SONOSPHERE AND HYDROPHONES



SEAWOLF SUBMARINE



Each hydrophone needed to be hermetically sealed, along with all associated wires and cables, to keep it safe from water and other detrimental conditions. The picture shows the sonar array under construction, and you can see how the smaller cables from each hydrophone are combined into a thicker cable, which feeds through a system of signal processing boxes (about one per eight hydrophones), which in turn send signals to a processor that pus all signals together from all hydrophones into the complete picture.

A very complex extrusion molding system was used to encase the assembly in polymer, or plastic. Extrusion in this case is the process of pushing hot, molten plastic into a mold, then removing the mold when the plastic hardens. Engineers believed that a consistent extrusion process over the length of the mold would yield the best performance, and this was then kept constant while polymers and general system parameters were optimized using Design of Experiments.

Despite these efforts, the polymer extrusion would not adhere to the polymer on the cable assemblies, even tough they were both the same specific form of polymer, polyethylene. Nevertheless, after numerous failures in test mode, the design was scrapped and engineers went back to the drawing board, looking for a better solution to the problem of keeping the sonar system water tight.

Stated as a physical contradiction, the engineers wanted extrusion for water-tightness, but did not want extrusion because of its unreliable results. The separation in space principle sparked a question: What if the extrusion process could be divided into different zones, or instances? Using further experimentation, the design team determined the best way was to slice space in eight zones, or "layers," each with its own different extrusion parameters.

With this solution, engineers could control such factors as temperature and pressure during extrusion much more accurately-according to the requirements of each zoned sub-system. The new solution was implemented, no test failures occurred and the sub was ultimately delivered to its customer, the US Navy.

This case study was excerpted with permission from Insourcing Innovation, an Auerbach Publications book, the lead author of which is BMGI's CEO David Silverstein.