

## New standards for rocket nozzle design and manufacturing



**FORCE Technology, one of the leading technological consultancy and service providers on the international market, has accomplished great success in the European space and aerospace industry by combining three of their key competences: Welding, sensor technology and NDT (non-destructive testing).**

For the past 10 years, FORCE Technology has actively contributed to the development of nozzles for rocket engines. It all started by an objective set by Volvo Aero Corporation for a new nozzle concept in order to maintain their leading position in nozzles for rocket engines.

During a number of concept discussions FORCE Technology saw a unique opportunity to introduce new process technologies to realise a breakthrough in design never made possible before. A further achievement is improved process repeatability and robustness by introducing more machine controlled processes in the manufacturing of nozzles.

Equally important to this, FORCE Technology focused on using NDT in every step of the production envelope to seek for improvements in the verification of the high quality nozzle which is a top-priority to this critical component.

### Combination of knowledge and skills

In order to achieve these goals, FORCE Technology established a nozzle work group which combined specialist knowledge within the company's key competence areas of welding, sensor technology and NDT. The combination of skills has effectively evolved into a unique manufacturing concept where benefits and restrictions in each area have been taken into account from the very start. This integrated approach, put together in a dedicated project team, has become a huge success.

### Different nozzle designs

Today, there are three different designs of nozzle structures on the market: The European, the American and the Russian. Each with their strengths and weaknesses. FORCE Technology - together with other partners - have developed a new nozzle design, which takes the best features from the three nozzles and tries to minimise their weaknesses.

### Technical challenge

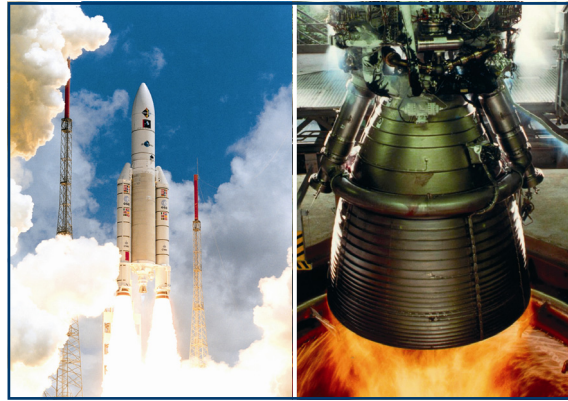
For the new nozzle design to work, FORCE Technology had to overcome the technical challenge of welding a distance of over 1,000 meters with very high accuracy on a large construction made out of carbon thin sheets in super alloys. At the same time the inner wall of the construction was hidden and would move during welding.

### The SeamTracker

To solve this complicated task, FORCE Technology invented the so-called SeamTracker which consists of an X-ray source, sensors and a laser welding machine. The X-ray source sees through the outer layer of the construction in order to guide the laser to the exact spot of the hidden inner wall where the laser welding is supposed to take place. In this way, an extremely precise method of welding can be achieved over and over again.

### First commercial nozzle order to Pratt & Whitney

With its SeamTracker technology, FORCE Technology became a subsupplier to Volvo Aero - Space Propulsion where they undertook the laser welding of



Source: ESA

Source: SNECMA

1,540 meters of 0.75 mm hidden inner walls through a 0.80 mm outer shell. As a result of the close cooperation between Volvo Aero and FORCE Technology, Volvo Aero delivered the first commercial nozzle order to Pratt & Whitney in 2002. This new engine will more than double the thrust compared to the legendary RL 10 engine, the most reliable, safe and high performing upper stage engine in the world.

### Future involvement in the Ariane 5

In 2005 through 2007, FORCE Technology will be involved in the evolution of the Ariane 5 main engine. A project that will set even higher standards for increased thrust, reliability, flexibility, shorter lead time and reduced costs. A challenge that will perfectly suit FORCE Technology's broad range of competences and ability to combine them for specific purposes which without doubt will be of benefit to other industry sectors.

### About FORCE Technology

- International technological consultancy and service provider
- Areas of expertise: Space and aerospace, offshore, nuclear power plants, windmills, ship safety and subsea inspection among others
- More than 60 years experience in transforming specialised knowledge into practical solutions
- More than 1,100 highly qualified employees
- Companies in Denmark, Sweden, Norway, Russia, Holland, Canada, USA and Brazil.



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