FACT SHEET

Shell Technology Centre Amsterdam

Edition 2016

IN BRIEF

- Established in 1914.
- One of the three major Shell technology centres worldwide.
- Over 1,000 employees, of whom 20% - 25% are women.
- The majority of the 15 Shell employees who are also connected to a Dutch university as a part-time professor are based at STCA.
- Approximately 30% of the employees have a foreign nationality. This number is growing. STCA currently employs about 50 different nationalities.
- 80,000 m^2 of laboratories, test halls, workshops and offices. As many as 11 UEFA-sized football pitches.
- 900 small and large technical installations.
- The majority of the test equipment is designed and built in-house. For this purpose, STCA has every possible metalworking technique, including a 3D printer that can produce metal components.
- STCA is expanding and will add a new 8,500 m^2 wing for innovative Hydrocarbon Recovery research in 2017.
- Research budget in Amsterdam: approximately 1 million dollars per day.
- Close collaboration with Shell's own technology centres, universities, knowledge institutions and other partners worldwide.
- Since the 1990s STCA researchers also conduct scientific art-historical research.

SHAPING THE FUTURE OF ENERGY THROUGH INNOVATION

Globally, Shell invests more than any other international oil and gas company into researching and developing innovative technology – more than 1 billion dollars annually since 2007. In 2015 research and development expenses were 1.09 billion dollars.

In the coming years, Shell expects to invest a few hundred million euro per year in research and development in the Netherlands. Much of this will be spent in STCA. This ranks STCA among the top for research spending in the Netherlands.

In STCA, more than 1,000 people from various disciplines work together to improve products and production processes in the field of oil, gas and chemicals. They also conduct research into affordable alternative energy solutions. Our staff aims to make current energy sources cleaner and more efficient and they aim to produce and distribute energy in potentially new ways.

STCA employees also support Shell partners and clients, which embodies everything from design and build, to maintenance, troubleshooting and enabling them to improve their performance.

STCA is an integrated part of a global network of Shell technology centres and one of three technology hubs of Shell worldwide. STCA's core expertise is in:

- Gas technology (Gas-to-Liquids, Gasification, Carbon Capture, Gas & Liquid treating, Liquefied Natural Gas).
- Downstream technology (Process Development, Catalysis, Hydrocarbon Refining, Base Chemicals, EOG/Solvents, Analytical Techniques).
- Engineering (Pipelines, Flow Assurance & Subsea, Fluid Flow & Reactor Engineering, Mechanical Materials Integrity, Materials & Corrosion, Utilities & Heat Transfer)
- Hydrocarbon Recovery (Rock and Fluid Science, Enhanced Oil Recovery)
- Future Energy (Renewable Energy, Hydrogen, Energy Systems Integration & Storage)

STCA also plays an important role in Shell's technical partnership with Scuderia Ferrari, one of the most successful collaborations in the history of motorsport. 50 Shell scientists from all over the world invest around 21,000 hours per year in research and development of engine fuels and lubricants for Ferrari. The research is concentrated in Shell's technology centre in Hamburg, Germany. Except for a crucial part of analytical diagnostics which is done in Amsterdam.

11 FOOTBALL PITCHES, 900 TESTING FACILITIES AND TEST EQUIPMENT

Shell in Amsterdam has been housed in one building since 2009, Shell Technology Centre Amsterdam (STCA). A state-of-the-art location, currently comprising 80,000 m^2 of laboratories, test halls, workshops and offices – comparable to 11 UEFA-sized football pitches – with 70,000 metres of pipelines and 900 small and large technical installations.

STCA is constructing a new wing which will add 8,500 m^2 for innovative lab scale research in the field of rock and fluid interaction. This offers Shell insights in how to extract more efficiently from current and future wells. Combining these research activities with existing activities at STCA will bring more Upstream and Downstream research activities together, increasing Shell's innovative power. The new wing is expected to be completed in 2017.

The technology centre has a sustainable and innovative character. In order to ensure flexibility, the laboratories and test halls are equipped in accordance with a plug-and-play principle. This means that facilities are widely available and test installations and test equipment can be set up according to research requirements.

The majority of the test installations and test equipment is designed and built in-house at STCA. The technicians in the Experimental Installations Department are responsible for this and possess all possible metalworking techniques, both classic and ultramodern. Such as a lathe from 1948, (that is still used on a weekly basis) and, since 2012, a 3D printer that can produce metal components (e.g. titanium, Inconel and cobalt-chromium). As a result, it is possible to "print" parts that were previously impossible to manufacture.

Products are built layer by layer from metal powder, with layer thicknesses from 20 to 80 microns, whereby lasers melt the layers into a solid whole. This technique produces almost no waste, which makes it a sustainable method.

STCA was the first within Shell and the Netherlands with a 3D printer that "prints" metal components. The printer is an M2 Concept Laser, also used by NASA for the construction of specific parts for the newest generation of rockets. Read more on Shell.com.

> NOTE: The original name of a micron was milli millimetre (mmm). The mmm was introduced in 1845 by the Dutch biologist and geologist Pieter Harting, who needed a length of measurement for measuring his microscopic study subjects.

Since 2015 STCA is home of the world's first vertical CT scanner with a rotating gantry around a static object. Using the same technology as hospitals, but on a six times bigger scale, the scanner enables Shell researchers to study the physics between fluids and porous rock, and thus helping to optimise extraction from current and future fields. The scanner weighs a whopping 60 tons, as much as 10 African elephants. The essential part of the equipment rests on two granite slabs weighing 6 tonnes each, separated only by a layer of compressed air a mere 2 microns thick.

In addition to the state-of-the-art technology of 3D printing and vertical CT scanning, glass has a unique position within STCA. It is transparent – allowing researchers to see what is happening during research experiments – chemical resistant and extremely strong.

This is why three glassblowers also work at STCA. Over the years they developed a lot of knowledge on the strength and pressure resistance of glass, and pushed technological boundaries. An expert glassblower using a glass blowing flame of 2,500 °C can create the most beautiful glass research instruments. For example, glass research instruments that can work under 70 bars of pressure and withstand heat of 1,000 °C.

STCA is virtually CO_2 neutral because the temperature is controlled by an underground heat/cold storage in combination with heat pumps. The wind farm of Shell and Nuon in the North Sea generates the power for the heat pumps.

PARTNERSHIPS

Shell increasingly looks at open innovation as way of boosting the pace of innovation STCA employees work closely with universities, knowledge institutions and other partners in various countries. In the Netherlands, for example, there is close collaboration with:

- **TU Delft:** the current joint research activities focus mainly on geophysics, Enhanced Oil Recovery, fluid flow & materials and process technology. The collaboration goes beyond R&D activities and includes an exchange programme for scientists to carry out joint projects faster and to strengthen the relationship further.
- **Eindhoven University of Technology:** the current joint research activities focus mainly on fluid flow & materials and catalysis.
- **TNO:** TNO is Shell's largest research partner in the Netherlands. Collaboration intensified in 2013, both for long-term innovation programmes and for more specific development projects.

We also participate in various public-private collaborations, such as:

- **The Netherlands Organisation for Scientific Research (NWO):** various research topics in the framework of NWO programs. For example, Computational Sciences for Energy Research (CSER), CO_2 Neutral Fuels, Smart Energy Systems (URSES), Analytical Science and Technology (COAST) and Electrochemical Processes.
- **CatchBio:** targeting the large-scale conversion of biomass into fuels and chemicals using chemistry and catalysts.
- **The Institute for Sustainable Process Technology (ISPT):** several projects, for example on nanofiltration membranes for extreme conditions and designer solvents for selective removal of trace components from refinery or chemical streams.
- **PETROBOT:** a European project to develop robots that can replace people for the inspection in pressure vessels and storage tanks.

MORE THAN A CENTURY OF INNOVATION – IN A NUTSHELL

Shell began research activities in Amsterdam more than 100 years ago. What began as a modest laboratory in 1914, with nine staff and a limited scope, has become one of Shell's three major technology centres worldwide, from which leading innovations emerge.

The research activities in Amsterdam initially focused on the ad hoc resolution of production problems. Between 1914 and 1927, the lab focused mainly on the (chemical) analysis of oil and auxiliary chemicals, conducted research on oil processes such as hydro generation and cracking, and developed anti-knock dopes that improved engine life and efficiency.

The nature of research in Amsterdam became more fundamental and intensive in 1927 when the lab was expanded with the addition of a chemistry department, with research on nitrogen fertilisers, urea, catalysis, alcohols and ketones from petroleum products. Soon thereafter, research began on soaps and agrochemicals. The number of researchers grew quickly due to the expanded activities.
There was also greater focus on the translation of research results into industrial application. Pilot plants were built and the engineer became an indispensable link between laboratory research and "the field".

Research activity decreased considerably during the Second World War. In those years, the knowledge within the lab was applied in very different areas than previously. Examples include the conversion of cars to use gas as a fuel, research into herbicides and pesticides, the development of a method to produce vitamin C from glucose and research into the processing of bulbs into edible products.
Shell expanded significantly after the Second World War, investment in research increased enormously and technological developments occurred at lightning speed. The growth of the lab in Amsterdam in the following decades coincided with organisational changes, further professionalisation and expansion and consolidation of research topics. Shell increasingly integrated research into its strategy in the last decades of the twentieth century.

TREASURES OF TECHNOLOGY: MORE THAN 100 YEARS OF TECHNOLOGICAL ACHIEVEMENTS

Tapping into the best and brightest minds has resulted in novel technology development in Amsterdam for more than a century. The creativity and expertise of STCA employees have led to a variety of technological achievements.

For example, the Shell OMEGA process; a more efficient process for producing the raw material used for a number of everyday products such as polyester for clothing and PET for bottles.
Another example is gas-to-liquids (GTL) technology; a technology for converting natural gas into more environmentally friendly transport fuels such as GTL Fuel technology can also produce raw materials for soap, plastics and lube oils.

Research methods and standards were also developed to make such innovations possible. For example, the Van Deemter-curve, named after the Dutch Shell employee, Jan van Deemter. Almost every user of gas chromatography knows his name.

PARTNERS IN SCIENCE: ART AND INNOVATION

Analysing an oil sample for sulphur content or developing catalysts, it is all in a day's work for STCA employees. But, since the 1990s, Shell researchers have also studied tiny paint samples from paintings. Currently they have researched more than 160 paintings.

As *Partners in Science,* Shell employees – together with the Van Gogh Museum in Amsterdam and the Cultural Heritage Agency of the Netherlands – have researched the work method of Vincent van Gogh and the technical condition of his paintings for more than 15 years. The results appeared in various exhibitions – including a major international exhibition in 2013 of "Van Gogh at work" – scientific publications and the collection catalogue of the Van Gogh Museum.

In 2012, Shell began a *Partners in Science* collaboration with the Mauritshuis in The Hague. The wall and ceiling paintings by Pellegrini in the Golden Room were jointly studied. In the coming years the collaboration will continue with research on the work of Jan Steen and his contemporaries.

Shell also works together with the National Gallery in London. Scientists from STCA and the National Gallery conduct research focused on the degradation of a red pigment, which was used by Rembrandt van Rijn and other 17th century artists.

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