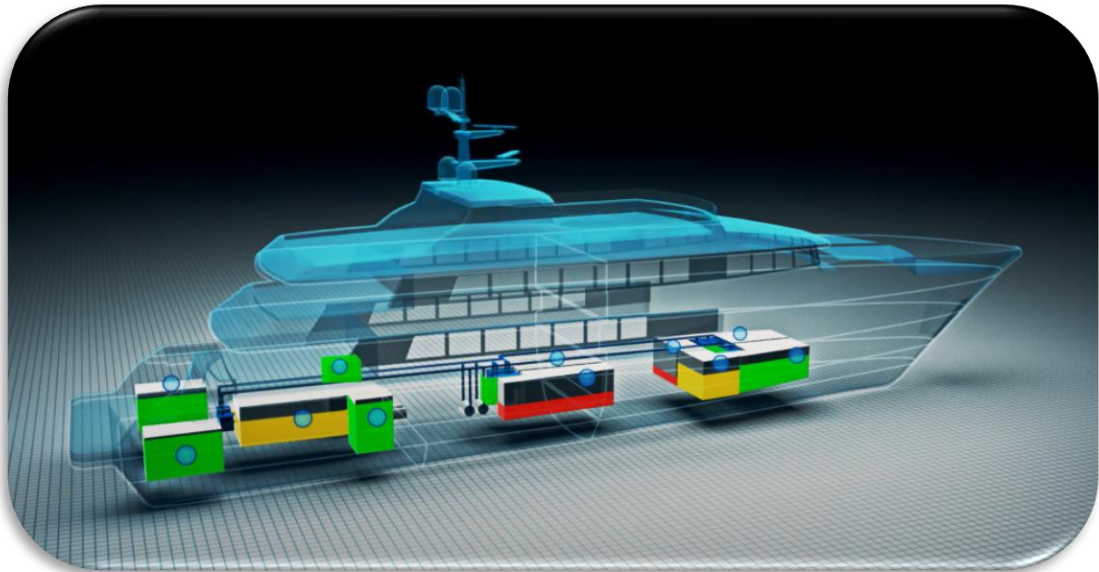


Socio-economic benefits from ESA Technology Transfers (Pilot)



Case Study 3

EATOPS: Automatic code generation

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Automating complex systems: Space-style control rooms for terrestrial industries

The design and manufacture of a control system is a delicate and fastidious task. It requires a lot of engineering time to assemble software and hardware components before an intensive commissioning phase. **Automatic code generation has been at the top of the energy industry's wish list for many years.** The NOROK (Norwegian industry standards body) has been asking for automatic code generation for years and now, **with the help of ESA and the space sector, their wish may finally be fulfilled.**



A tradition of fragmented, linear and manual control systems

Past generations of control systems had been set-up on a manual basis in a very simple and linear way, which opens the door to many potential mistakes. **Existing automation processes are not being deployed at full throttle**, with concerns (rightfully so) of the risk of automating processes without full understanding and human control. The result is that, in many cases, the performance of the systems is suboptimal, and **the real benefits of software automation are not being realised.**

EATOPS were driven by the belief that the energy sector could really lean their production if they **installed centralised control rooms onshore** that would support their integrated operations instead of letting every offshore vessel operate individually, like an island. For this real transformative change to occur, **the Energy industry had to go through a digital transformation** and complete rethink of their control systems design. Instead of making use of a stand-alone control system which would remain as rigid as possible throughout the 20-year cycle of those offshore installations, this control system architecture is now dynamic, and provides elastic services, allowing for changes to the envelop of operations. Such a tremendous step could not be taken with the previous static programming methods. **Automatic code generators**, or elastic scripts services, came as an obvious solution to the equation. This shift has taken great inspiration from the Space industry (ESA).

Space technology brought down to Earth ...

Automatic coding has been adopted in the Space industry for over a decade. It's essential for the handling one or more satellites and enables continuous monitoring of hundreds of thousands of different variables. **With the help and support of ESA, EATOPS are applying these same techniques** developed to control constellations of satellites to enable a centralised oversight of multiple offshore installations for energy providers in offshore wind farms, natural gas production and crude oil extraction.

"ESA first made use of autocoding for our experimental Proba-1 Earth-observing satellite. It served as an efficient way of speeding up mission development to fit the available timeframe. The adopted solution was **automatic code generation**, allowing the use of modelling methods to generate better software by construction, ultimately accelerating the verification process also."

Joachim FUCHS, Head of ESA's Software Systems Division

Proposed by European company EATOPS as a tech transfer project four years ago, **ESA**, via the Technology Transfer and Patent Office (TTPO), **have played an essential role in transferring the space technology to a commercial terrestrial application.** Since then, EATOPS have grown from strength to strength.

... introducing AUTOGEN

Getting an accurate picture of the offshore installation requires hundreds of sensor read-outs to be collected and brought back to shore in near real-time, in some cases every second. These sensor read-outs can be consumed by software logic and computers are able to process a line of automatic action or response to any foreseeable scenario. **EATOPS designed a software platform called 'drawing code' to automatically convert an engineering specification such as a CAD electrical drawing into an automatic sequence**, or low-level PLC logic.

Just as ESA achieved with autocoding, short for automatic code generation, **EATOPS employ software to write software**. The design platform 'drawing code' developed at EATOPS gives the computer the role of writing logic for the control system. This strategic decision allows the scope of the control system to gradually grow in time. The management of these lines of code remain under the control of a script rather than a human hand which would eventually reach its limits over time.

AUTOGEN takes control rooms to the next level by generating a **control panel in full 3D**. EATOPS calls this the overview panel.




Equipment List



 **EATOPS**

How DRAWING CODE works

The automatic code generation starts with the definition of an equipment list, the drawing of an SCD (shape control diagram), and sequence drawings. Once the model contains all the different pieces of equipment involved in the assembly of the control system, including parameter names, alarm list, OPC configuration AE, 2D symbols, a consistent io list, and the PLC logic (scenarios, cause and effect, etc), **the DRAWING CODE software is able to generate the logic to run on the industrial computers** installed onboard the offshore vessels.

Enabling EATOPS to automate control systems for the Energy industry

Drawing Code

At first, AUTOGENs were purely Excel-based, however recent developments have enabled the use of electronic drawings as an input source. With the introduction of industry standardised drawings (SCDs), AUTOGENs are no longer going from Excel to code but directly from drawing to code (skipping Excel), **enabling customers to draw their processes using the DRAWING CODE native software and sit back as the scripts write the source code straight from their drawing.**

This innovation is transformative and enables a process of continuous integration. New for 2021, SCD technical drawings are now the main input document, replacing the need to use Excel as an intermediary. A digital export of those technical specifications is now available in AML (automation modelling language) to share with services in need of a definition.

Growth for EATOPS

EATOPS have multiplied their turnover fivefold as a result of the **DRAWING CODE** innovation and demand in the Energy industry for what is a very novel solution, allowing the digitalisation transformation to happen.

New market segments

EATOPS are now in the process of increasing the scope beyond oil and gas to, for example, wind farms infrastructures, large transportation vessels, power grid managements, and smart cities.

Customers can deploy better systems, faster

Improved performance

Providing a more intelligent control system, resilient to changes and future evolution for the same amount of money.

Today's complexity of systems forces companies to take less risk to ensure system robustness. However, thanks to DRAWING CODE control services, companies can dynamically scale-up the logic and create more advanced, intelligent systems with the security that these systems will remain robust and coherent. Because DRAWING CODE uses the same scripting philosophies for different systems, when a bug is identified and corrected, then the same correction is implemented across all control systems. The control systems rapidly converge towards a stable tested configuration.

"We were able to say that if you make use of our DRAWING CODE software tools you will improve your safety and work more efficiently, and this is exactly what has happened."

Corentin PANE, control system engineer at EATOPS

Cost savings

"We have a script that with a simple level of abstraction is able to read a specification drawing such as a Line Diagram, and SCD, or sequence drawing, and convert it into control system logic. Our engineers are able to draw and deliver their pretested results overnight compared to the hundreds of back-and-forth cycles required in the past. It means we can perform what would otherwise be 10,000 hours of programming within a few hundred hours."

Vidar DAHL, automation department at APPLY

Energy companies see the benefits of the DRAWING CODE solution as a way forward, enabling them to safely complete their digital transition without losing information along the way.

“In fact, these tools were among the missing cornerstones required to build another bridge towards our digital twin strategies. **Moving from engineering to testing the code directly, removing a lot of waste and reducing risk of errors**, by skipping many steps through automation. This **enables and accelerates development to a speed and scale currently unprecedented**. A new range of possibilities building on digital twin concepts opens up, **without associated explosion of the cost**.”

Our company believes the old standalone application approach is fading out and is being replaced by ecosystems that are more microservice based and open, and this **enables us to consume and use solutions from smart startups** and other software **with very specific services**. Somewhat similar to what Amazon Web Services is to a consumer market, AkerBP is investing in dedicated services that benefit the Energy Industry. Naturally, we end up discussing the same needs and attitudes towards DEVOPS and automatic scripting to manage our clusters of services.”

Arnfinn GRØTTE, Digitalisation Lead for Well Construction at AkerBP

EATOPS are also making it possible to add new elements to any given control system during the twenty-year lifecycle of an offshore installation or vessel. Because oil reservoirs evolve, with changing levels of pressure, water being injected to help liberate further capacity of the reservoir, and so on, **the industry is able to optimise the use of the reservoir to its full potential**. These resources exist in limited quantity on Earth, and we must therefore harvest them in the most sustainable manner until the transition to green energy is complete.

Warning system

“Via our smart control system, EATOPS are pushing for **automatic fault scenario recognition features that can foresee issues ahead of time**. In other words, before the upset scenario has occurred. **This brings a considerable amount of additional logic for the same price in an ultra-inter-connected world**. We are making it hard for another Deep Water Horizon disaster to occur by bringing every single bit of warning back to shore. If a safety system is not responding or is not performing according to standard anymore, the head office will be notified. Its replacement will be scheduled, averting a great deal of risk. **This digitalisation transition is also a transition towards safety and environmental policies** which have improved a great deal in the past decade.”

Alexandre VAN DAMME, director at EATOPS

Offshore to onshore

Bringing data back to shore for analysis and problem detection is helping prevent disasters.

Automatic code generation can automatically connect data between the offshore installations and the shore, providing a clear understanding of the system’s integrity in real-time. Bringing all of the data from the vessels back to a central source on shore enables the implementation of a system of full transparency. Visual Remote Operations also enable the fluid accessibility of data.

AUTOMATIC CODE GENERATION for Offshore Floating Production Facilities

In the oil and gas industry, **automatic code generation technology is novel and has the potential to have a significant impact**. The price of oil is falling, leaving oil and gas companies looking at new ways to optimise their costs. EATOPS are working with a large energy provider to apply the same approach from Space R&D to provide continuous upgrades to offshore installations, which is of considerable benefit given that a 2021 floating production facility costs in the order of \$2bn and is built to last for at least 30 years. Via their smart control systems and DRAWING CODE, EATOPS are working to enable optimisations throughout the entire lifecycle.

Spin back into space sector

EATOPS recently completed a major project for a “New Space” customer, **supporting NASA’s Artemis programme** that will send humans back to the surface of the Moon. The scope of the contract included **the design & development of seven control panels for an automatic mission to the surface of the Moon**, with launch scheduled for April 2022.

The example above shows that **the benefits of technology transfer are not purely one way**. EATOPS are providing technology, developed and honed for terrestrial use, for the benefit of space applications. The contract is also a significant statement for a European company to be contributing to the United States’ Artemis programme.

Would these benefits have been realised without ESA?



ESA, through the TTPO, played a significant role in enabling a relatively young firm such as EATOPS to develop and commercialise its AUTOMATIC CODE GENERATION technology. Whilst EATOPS rewrote every line of the software (code) from scratch, the ESA methodology and ICSS standards in space industry **played a significant role in showing the art of the possible and providing the approach from which AUTOGEN was created**. ESA also played a big role in **financing and de-risking the investment**.

“ESA gave us [EATOPS] the absolute confidence that it was going to work. It’s like jumping over a 5m gap with the confidence that you are going to make it and land on your feet. As engineers, EATOPS were excited about doing it, but **ESA provided the assurance that the investment would be worthwhile**. We cannot thank ESA enough for **part-financing** [the project], but also **showing how they used the technology for their PROBA mission** (2006).

Alexandre Van Damme, director at EATOPS

... with further development and benefits to come

EATOPS are also looking at **applying their computer logic to retro-fit old ships**, in an effort to upgrade their energy consumption. This requires the ability to turn old system drawings of ships (tankers, ship containers, and any other assets running a control system from an electrical system) into software logic. The trend of the industry is moving towards fully autonomous automation and artificial intelligence (AI). Whilst EATOPS are content with framing their current technology as ‘computer logic’, they are **exploring the potential of self-learning control systems**. Training machines to read and understand old drawings is currently part of the company’s technical roadmap. **EATOPS is also evolving to provide systems for renewables**, e.g. offshore windfarms, which have the same instrumentation standards.