

Mechatronics and artificial intelligence: from prototype to product

Giano is the mechatronics project born out of the collaboration between Verona-based Cooperativa Sociale Galileo Onlus and ProM Facility. The tool, already in use by the Moroccan Police, was created with polymer 3D printing, thermal imaging cameras and laser cutting.

A device to be installed on the roof of police cars that can read and analyze through **artificial intelligence** the license plates of cars parked along the side of the road, with the goal of making effective and real-time checks.

We are talking about **Giano**, the innovative project born last year out of the collaboration between Verona-based Cooperativa Sociale Galileo Onlus and **ProM Facility**, the mechatronic prototype laboratory of Trentino Sviluppo, the system company of the Autonomous Province of Trento that deals with territorial development.

This is not a futuristic idea but a **concrete tool** already in use by the Moroccan Police, whose officers, while remaining inside the car, now can check live data on the vehicles they pass by, such as insurance, tax stamps and inspections, allowing them to instantly discover the presence of any violations in progress.

It is a complex and delicate mechatronic device, even in its mechanical parts, for the realization of which cutting-edge technologies such as **polymer 3D printing, thermal imaging cameras and laser cutting** have been exploited.

From Verona to Morocco via Rovereto

The idea was born in Verona within the walls of the non-profit Cooperativa Sociale Galileo Onlus, which works to bring disability and information technology closer together and over the years has increasingly developed professional skills in IT, Ultra Broadband networks and advanced customer care.

The first prototype, which is still in its embryonic stage, was presented at the national conference "*Local Police and Urban Security Days*" held at the Riccione convention center, where it immediately attracted great interest, particularly from the Moroccan police, who ordered six units to be used in three cars (two per car, one per side).

The **electronics** and software developed by the cooperative's engineers was already in place, but the device needed to be redesigned entirely in its structure. There were still many details to be overhauled.

Since this was a **device for outdoor use**, it had to meet specific physical characteristics (particularly heat and weather resistance) that the prototype could not yet meet. The right material had to be found, one that would optimally withstand the stimuli coming from outside.

The design of the structure needed to be improved and compacted and redesigned with a view not only to aesthetics but also to usability. This required design and implementation skills that were difficult to find in the country.

On the advice of Confindustria Verona (already actively present within the ProM Facility network), the **Galileo Cooperative** therefore turned to the only Italian laboratory that, because of its technical capabilities and presence of innovative machinery, could respond quickly and in a timely manner to this particular call for solutions: **ProM Facility**.

This Giano project is indeed perfectly in line with the mission of the laboratory of **Polo Meccatronica** in Rovereto consisting, since its inception, in the design and development of innovative prototypes by deploying all the skills and technologies with which it is equipped, with a view to a continuous and participatory confrontation with customers.

The work took more than two months, from late August 2020, when ProM Facility and Galileo Cooperative technicians first came into contact, to early November, when the prototypes were finally shipped to Morocco for testing.

Giano: the two-faced god Janus

Giano, named after the Roman god Janus who had the gift of being able to read the future and the past and was therefore represented with two faces, consists of a central body on which two cameras are installed. Its operation is, apparently, simple.

When the police car passes another car, the first camera reads the rear license plate, while the second camera, oriented at 90 degrees to its twin, reads the front one.

The license plate **images** are transmitted to a processing unit inside the device that, **thanks to artificial intelligence**, can turn them into text. From there they are sent via a modem to the operations center to be analyzed.

The data can also be read in real time by an operator in the car through a dedicated app that can be used on a PC or smartphone. The system is effective up to a speed of 50 km/h and can analyze cars present on only one side of the roadway.

Therefore, to capture license plates from both sides, it is necessary to use two Giano devices at the same time, just as the Moroccan police force has decided to do.

ProM Facility and development of the prototype

The order made by Galileo's engineers to ProM Facility was immediately clear: to fully re-engineer the prototype's external structure in order to arrive, at a later stage, at the production of the six units requested by the Moroccan Police. There were many challenges to overcome and they needed an in-depth study and a team that could work on it intensively and full-time.

The first problem to overcome was the thermal problem. It was necessary to be able to keep the temperature of the computer inside the facility low because, in situations of excessive heat, it was in danger of shutting down.

The **solution** found in the beginning by the Galileo cooperative was a **fan**, but this did not provide sufficient cooling and had the major flaw of letting in particles of material from the outside, such as dust or sand, which in the long run would impair the operation of the instrument.

ProM Facility engineers then performed a thorough analysis with a **FLIR thermal imaging camera on the device** while in operation to study its heat peaks and thermal dissipation. Having identified the maximum temperature the processing unit could reach while maintaining correct operation (about 40°C), they moved on to the actual design. It was necessary to be able to maintain an acceptable temperature even in full sunshine, but it was first necessary that the body of the device remain airtight so as to prevent the entry of unwanted material.

Therefore, a passive cooling system was developed, consisting of two aluminum tubes (machined with BLM Group's Adige LC5 laser cutter) that provide heat exchange between in and out, while keeping the electronics protected from the elements. Double interspaces were also created in the walls of the structure to further shield it from the heat.

Apart from the electronic instrumentation (AI processing unit, two cameras with fisheye lenses, modem and GPS) and the two aluminum tubes, Giano is made entirely of Nylon PA12, a material that provides high mechanical strength, uniformity, durability and excellent value for money.

This material is perfect for an instrument exposed every day to even extreme weather conditions. The **HP 4200 MJF 3D printer** was used to produce the six units destined for the local Moroccan police. It ran for a full week and managed to produce them in just 3 print sessions.

The details that make the difference

Having resolved the issues related to temperature and weather resistance, which were a key issue in ensuring the device's proper operation in all weather conditions, the engineers moved on to details regarding usability.

The **first step** was to make the head on which the two cameras are installed mobile, so that it could rotate as needed. A system for tilting the entire structure was also developed to enable the instrument to adapt to the road surface according to the varying height of the machines on which, from time to time, it is to be installed.

The **arrangement of internal electronic components** was also simplified. It can now be pulled out easily in case of maintenance, and a handle has been created so that Giano can

be carried around easily. Finally, the way the device is anchored to the car was also rethought. In the initial design, the central body was fixed to a magnetic mount that attached to the roof. To remove the device, it was necessary to detach everything.

ProM Facility designed a system whereby, instead, the stand always remains attached to the car and only the device is removed, via an ad-hoc designed tool, making the operation more practical, faster and safer. Many small touches, which not only changed the face of Giano (it went from the 50 cm length of the first prototype to 34 of the final one), but made it ready to be launched on the market.

ProM facility and the Cooperativa Sociale Galileo Onlus

ProM Facility was established in 2017 as a collaboration between the Autonomous Province of Trento, Trentino Sviluppo, Bruno Kessler Foundation, Confindustria Trento and the University of Trento to offer companies in the mechatronics supply chain an integrated platform for the design, development, implementation, verification and validation of production systems and processes, making use of I4.0 technologies and principles.

Thanks to the commitment of European regional ERDF funds totaling nearly 6 million euros, the Facility has innovative machinery for rapid prototyping of complete mechatronic systems, including metal and polymer 3D printing, laser cutting of tubes and sheets, as well as advanced metrology systems such as X-ray tomography and 3D scanners.

On the other hand, Cooperativa Sociale Galileo Onlus was created in Verona in 1991 with the aim of bringing disability and information technology closer together and to include disadvantaged and disabled people in the world of work.

In addition to the complete customer care management of the Banco Bpm Group, Galileo performs other important activities: the development of niche software with research and development activities aimed at the world of disability, and the development of network activities with the deployment of Internet in areas underserved by Ultra Broadband.