ALESSANDRO PRIOGLIO

TEQ SA of Switzerland pioneered the application of the CAN protocol to multiplex electronic and electrical networks in industrial vehicles and buses. Today, its technology leadership extends to onboard and remote diagnostics, fleet management, and intelligent transportation systems, its managing director told **Eliot Lobo**.

Where did it all begin? Please tell us the story of TEQ's origins.

My father Francesco Prioglio was a member and president of Cometto Corporation SA, the Swiss branch of Industrie Cometto SpA of Italy, a leading manufacturer of self-propelled vehicles. Cometto Corporation SA developed the first electronic system for a self-propelled vehicle used in a steel factory. The vehicle, designed to carry a 40-tonne basket, automatically followed the overhead travelling crane that picked up and weighed scrap based on a recipe set in a customised application software and sent by radio to the crane operator's display. At the end of the loading operation, the self-propelled vehicle automatically transported the basket to the blast furnace.

The suspension and steering of vehicles of that kind were normally controlled hydraulically, but the aforementioned experience demonstrated the advantages of electronics — greater functionality, lower costs, and the ability to diagnose faults, etc. At that time the Italian Cometto wasn't interested in developing and investing in electronics, so my father founded his own electronics company with the aim of developing and supplying electronics customised for each vehicle manufacturer.

For what applications did TEQ develop its first multiplex system?

We developed a full CAN-based multiplex application for Ammann Verdichtung of Switzerland for its pivot-steering vibrating asphalt compactor models. This system had one dashboard with integrated display, one electronic keyboard, and three I/O modules — for the engine compartment, front roller, and rear roller. We developed an electronic crab steering function, controlled with a joystick, that allowed the machine to be operated close to a guard rail and steered away with no damage to the guard rail. Another main request was redundancy: the roller must not in any case stay blocked on the hot asphalt laid by the paver should any of the electronic modules fail, because if the asphalt cooled below the compaction temperature of 100–130degC it would be useless and would have to be removed and a fresh mat laid. For this reason it was necessary to be able to move the faulty machine off the mat. Our solution for the multiplex system was to develop three identical units

that could be interchanged without the need to reprogram input parameters. These had to be plug-and-play. We applied the same technology to all our multiplex systems, even those for buses, which in Europe can have up to eight modules. This idea was immediately copied by the others…

What was the true benefit of the multiplex in this application?

For one, the wiring harness was simpler. But what's really important was the reliability of the machine, because relays are electromechanical devices that can break down. To design a logic circuit with relays you have to have very complex wiring and many relays, and the possibility that something will go wrong is very high. It's simpler with electronics, because once you set up the software you can check the functions easily and you're sure that if you put the same software in another machine it will behave the same. The main advantage of the multiplex is that you take away the electronic board with the complexity of relays, and replace it with a module. In reality, electronics is more complex than relays, so the workshop doesn't understand it. But if you have a problem, all you do is take away the module, put in a new one, and see if it works. Diagnosing a fault actually takes very little time, and so the repair time is very short. We were the first to have identical modules that you could switch. Normally our competitors had one specific module for every position — even if the hardware was the same, the software was different. And that was a problem, because if one module broke down, you needed to have the same spare part. For one bus with five modules,

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When did your competitors come out with multiplex systems?

A couple of years later. We were first in buses, starting with Mauri in 1989. As you know, CAN is widely used in cars. But cars are produced in their millions, and so the big companies were naturally more interested in cars than in buses. So first car, then truck, then bus, simply because of the volumes. We work in low volumes, so for us buses were very important. That's really why we are pushing so much in that field.

Being the pioneer, TEQ is presumably more advanced in the technology as well. What else did you introduce along the way?

Another thing we developed was integrated diagnostics. At that time all the OEMs that had electronics in their vehicles were selling tools to the workshops, but these were all very expensive. Mercedes had its Star Diagnosis System, Iveco called its system Modus 2000, and Bosch had its own too. These weren't handheld devices at that time but computers on wheels that cost a minimum of 10,000 euros. The workshops could not afford this expense, so we thought, why not put all the diagnostics on board, so that you could check the whole vehicle on the display? We introduced the self-diagnostic feature in our multiplex in 1997 — this idea too was copied by the others, because the market wanted it.

What kind of multiplex system are you planning to introduce in India?

Our company's main features are quality and support, so we planned to invest initially in the bus sector, where we are building up a technical basis that will enable us to deliver high-quality support. We want to provide solutions, not problems! For this reason we've designed a bus multiplex especially for India that we presented at the Busworld exhibition in Mumbai this January. Technicians from our Indian representative Integra have been trained in Switzerland on this system, and are already working with Corona Bus to integrate it into a new city bus model the manufacturer plans to introduce later this year.

The specifications of the system meet the requirements of many Indian manufacturers I visited and associations and committees I

interacted with last August. It consists of a dashboard including a switch panel with CAN, a front I/O, and a rear I/O, and it manages the engine, gearbox, external lights, internal lights, wipers, horn, pneumatic doors, gas leakage sensor, fans, and electronic signs. Like our full-blown systems for the European market, this one has GPS, onboard and remote diagnostics with a GSM module, and an interface to our Bus Sapiens ITS.

It also has important safety functions. One example has to do with the external lights. In many cases Indian vehicles travel with broken bulbs. The Adicom multiplex not only warns the driver about the failure via a telltale light on the dashboard, but also switches the function to another light, i.e. a broken rear position light will be simulated by stoplights with reduced power, or a direction light by stop lights, or a stop light by direction lights. Which means that the function still works. And when you repair the wire or the bulb the function is transferred back automatically. We've also provided a gas leakage sensor due to the frequent fires on buses (one BEST bus during the Mumbai exhibition!).

The driver just needs to push a button to see at a glance the state of all the functions in the vehicle. For the workshop there is more detailed information. And with GSM they can have this information in real time.

Where would you say your Adicom system has an advantage compared to an open system based on CANopen?
We have CANopen for a specific customer, for a one-off tracklaying machine for the railway. But the fact is that, for the Indian market, the J1939-standard interface is adequate because it allows you to multiplex engine, electronic suspension, brake system, and gearbox. In western Europe, we are now supplying manufacturers of doors and air-conditioning with CAN modules. You buy a door for a city bus that already has CAN, and this allows you to simply plug it into the system.

You specialise in bespoke solutions for manufacturers with small volumes. Surely your system would be more expensive than the standard ones, to begin with. What's the value proposition you engage them on?
There isn't a great difference in cost between our system and the other systems. It may be a little bit higher for the service we give, but it's always paid back very soon. For example, a big customer LAZ in the Ukraine decided to use electronics from China because of the cost. But soon after they tried the Chinese system they came back to us, because they understood that it's not only a matter of how much you pay for the electronics — if you produce a vehicle you aren't able to sell because it's not reliable, you're not going to earn money. LAZ recently won an order to build more than 2,000 buses for the European Soccer Championships. They were in a hurry, and with our system they could afford to develop a multiplex bus in a short period. Now

they are very happy with our system. Cost may be an issue when you talk of a consumer product, but when you buy a technical product it's not only a matter of cost but a matter of what you really need.

In India cost is the first question. You've probably heard that one...
Yes absolutely. But when you get a product that doesn't work? My system is just one part of the bus. The bus builder is putting a lot of money into the vehicle. And if one component like the multiplex doesn't work, the whole bus doesn't work. This means it's a total failure. So people have to understand that they have to invest and the money will be paid back, absolutely.

Apart from simplifying the electrical plant and enhancing safety, as you describe above, what other significant benefits does a multiplex promise?
The multiplex is important for the warranty of the vehicle. Quality vehicles need warranty. And our Adicom system has a black box. We store data of whatever's going on in the vehicle, monitor the vital functions, so to speak, which is important for maintenance. We are going in a direction where more and more the final customer will ask for total service. Now the practice is you buy the vehicle and you carry out the maintenance following the directives of the manufacturer. I think in the world of the future, people won't buy vehicles but performance per kilometre. We are moving from buying a vehicle to buying a global service, which actually means you don't buy the vehicle but you buy performance. And in order to do that, the manufacturer needs to know his vehicle well over its lifecycle. Normally, the manufacturer 'knows' his vehicle only while it is under warranty, but after that it's out of his system and he only sells spare parts. In the future for sure things will change.

In this way the OEMs also stand to make more money from their vehicles over their lifecycles.
Yes, but this means they have to know their vehicles very well. This is why, for example, they are very interested in our ITS (intelligent transportation system).

Are you seeing this move to per-km pricing happen in Europe already?
Absolutely. The transportation companies aren't hiring new people in the workshops, because they are transferring responsibility for maintenance to the OEMs. This is why we got into ITS. We started working with some manufacturers who told us they needed to know what was happening in their vehicles. So we started putting GSM modules into the vehicles that collect the vehicle operating data and upload all this information to the manufacturers.

Is this telemetry?
Yes, it's telemetry — part of the analysis is done

With TEQ's Adicom multiplex, a single LCD display serves as the diagnostic and ITS interface in addition to delivering comprehensive dashboard functionality.

on board and part on software that runs on a PC. And about four years ago we put in a GPS that allowed us to develop our ITS. We've combined the dashboard, the video monitor for the ITS, and the monitor for the rear-view camera into one display. But a lot of companies do not have vehicles with our multiplex, in which case we put in an extra display.

Are you then the only company that offers an integrated multiplex and ITS?
Yes.

Let's imagine a fleet in which all the buses have TEQ Adicom and Bus Sapiens, your ITS. Compared to what's available now, bits and pieces from various manufacturers, what's the advantage? Both in the bus, and for the operator?

"A big benefit of real-time information is that it enables the workshop to turn the vehicle around in the shortest possible time."

A transport company that has vehicles with Adicom and Bus Sapiens can diagnose vehicle faults in real time in the control room. If a vehicle breaks down, the company has two problems — one, what to do with the vehicle. Do mechanics have to be sent out to fix it on the road? Does it have to be brought back, or can it return on its own? And then, there's the problem of a lost schedule. What to do with the passengers? Should a replacement vehicle be introduced on that route? With Bus Sapiens, when something goes wrong with the vehicle,

information immediately and automatically goes to one person who can take those two decisions.

At present the driver has to make a number of phone calls. He has to communicate with the person who schedules the service, and with the workshop superintendent for the repair. Another thing that normally happens is that when a warning lamp lights up in the dashboard, the driver often ignores it and keeps going — simply because, with all the electronically monitored equipment on his vehicle, he really doesn't know

what's going on. Or maybe he is driving a vehicle he's not familiar with. But if the vehicle has ITS in conjunction with multiplex, this information goes to somebody who knows, or if he doesn't know, the system tells him. This is one of the big advantages of having both together. It's a complete solution.

Do you have a customer for this integrated solution?
Yes. We started with the companies responsible for suburban transport in Bologna and Verona. They were the first two that really wanted the diagnostic system. Azienda Trasporti Verona (ATV) Srl has our fleet management and diagnostic system already integrated, and three-quarters of its fleet has our multiplex as well. We worked a lot with this company, and now they are very happy with the system because it's saving them money. In western Europe, where the cost of labour is really high, it's important that the vehicles are out of service for the least possible time. And the fewer spare vehicles you need, the lower your costs — not only the cost of the vehicles, but also the insurance, the tax you have to pay on them even if you don't use them. A big benefit of real-time information is that it enables the workshop to turn the vehicle around in the shortest possible time by alerting it to what action needs to be taken so that it is fully prepared when the vehicle comes in. With ATV, we succeeded with real-time information in cutting down the number of spare vehicles they needed.

Could you quantify this?
They reduced the number of spare vehicles by half. Normally spare vehicles make up less than 10 percent of the fleet; now they're less than five percent, and this number continues to shrink. We like to say we are the brain of the vehicle — in Verona we also interfaced the ticketing system, consisting of machines that sell tickets on board. Earlier they had staff that had to empty the machines every night and report the day's earnings; now every day's collection is automatically accounted for on the ITS and automatically relayed to the ERP system.

There are a lot of tenders in India for ITS. Are you looking at that here too?
ITS requires many more technical people on the ground for training, assistance, and maintenance. This is why the Japanese systems they've tried out in some cities don't work. The fact is, when you try to sell something, you have to do it in the best way you can. So we've started with multiplex, because it was the first request we got from the market.

However, we also have an ITS solution that could be good for BRTs, and will shortly kick off a project with Chartered Motors of Ahmedabad, the operator of around 200 buses in that city's BRT. This will involve a demo vehicle fitted with our ITS and monitored via a remote server at our headquarters in Lugano. ∎