Industrial Control Solutions in Research Laboratories

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Abstract

During the 1970's, while computer technology was developing under the thrust of the ever increasing need for data processing, large projects in the fields of astronomy and physics were launched. They provided an incentive for the development of advanced architecture in control engineering. More than twenty years later, industry is producing very efficient generic control solutions in response to the present competitive situation. Our machines are supplied with electricity, water, air, helium, vacuum, etc., for which the production and/or the distribution are industrial processes. Let us use industrial solutions to bring savings in terms of both money and human resources.

There is a natural tendency to be conservative and the progress towards the "don't make but buy" approach is slowed down by arguments ranging from misunderstanding in the best of cases to unwillingness in the worst. Let us explain to those who are confused.

INTRODUCTION

Particle physics relies totally on statistics, as the precision of experimental results is primarily driven by the number of collected events. This explains why the ever increasing need for number crunching has been one of the major incentives for the development of computer technology during the 1960's. Mainframes sizes were continuously growing to cope with all aspects of scientific work. The need to shorten the time between the production of events and their analysis prompted the development of on-line connections, creating the first mesh of today's communication networks.

Similarly, computer-based control systems started with a centralized architecture, the equipment being connected by simple communication lines. During the 1970's, the large size of the machines being built compelled control engineers to install computers near the equipment in order to address the cabling problem. Consequently, computer communication protocols were developed and gave the main control rooms the means of getting the data from and sending the commands to the equipment, via the distributed computers. These developments, originating from our research laboratories, constitute one of their technological spin-offs. Industrial action in this field, driven in the early days by our pioneering engineers, is today guided by the strength of the consumer market. Very satisfactory solutions have been developed in response to the present industrial competitive situation. They can be used for our needs and bring savings in terms of both money and human resources.

THE MEANING OF INDUSTRIAL CONTROLS

The engineers' attitude

The debates concerning industrial control systems show a discrepancy in the different meanings given to this phrase in the scientific community. Engineers and technicians are influenced by two factors: experience and conservatism. Those living in isolation as recluses do not follow the external evolution and may or may not understand its true meaning. Others defending their position and/or their work, in other words their motivation, resist their introduction with questionable arguments.

The confusion

The word industrial when associated with controls systems can be interpreted in two ways, depending on whether it qualifies controls manufactured for, or by, industry. The first meaning describes control equipment currently available on the market and used by the industrial community; the word industrial then bears a connotation of wide acceptance, optimum design, good quality, extensive tests, large quantities, competitive price, support, long life time, turnkey solutions, etc.. The second meaning suggests an alternative to the traditional home-made approach and conveys the ideas of outside manufacturing, subcontracting, outside procurement, etc.. This last meaning creates some confusion. Unlike Mr. Jourdain who was ignorant of the fact he was talking in prose in Moliere's "Le Bourgeois

Gentilhomme”, many control engineers are convinced they are, and have always been, industrial control users since they are buying industrial components and since industry is building what they design.

Structure and phases of a technical project

Any technical project has a tree structure. At the top level we find the global project. Breaking it into parts provides a set of objects that may also be regarded as technical projects but of a smaller size, they in turn may be broken down and so forth. Different factors influence the level at which the decomposition stops: complexity, feasibility, modularity, availability, homogeneity. The smallest objects are elementary projects. The best fit with industry is obtained whenever the elementary projects match its capability at the highest possible level in the tree structure.

The development of a technical project has six phases: specifications, design, prototyping, production, installation and commissioning. The first phase obviously needs the participation of the client at least to define the project, but its execution is a process with which industry can be entrusted. The specification document contains all the requirements that have to be fulfilled and which will govern the implementation of all the other phases. If the customer only provides functional specifications, this results in handing over full responsibility of a project to industry and thus lead to the “industrial” label, which means based on the manufacturer’s ideas, methods, tools and standards.

The case for Industrial Control Systems

Industrial control systems are nothing more than technical projects and meet the same criteria as those stated above. Therefore, industrial controls result from functional specifications. In fact, industrial solutions have been generated by industry in response to the needs of the market. Control engineers may develop their project in different ways:

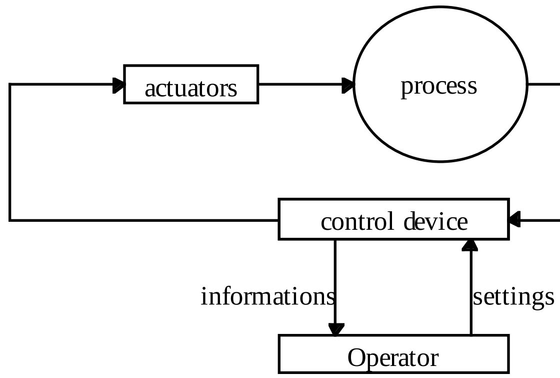
1. specify the system functionally and physically, design the system, build a prototype in the laboratory, test, produce, install and commission: a fully home-made approach.
2. specify the system functionally and physically, design the system, build a prototype in the laboratory, test, subcontract the production, install and commission: still a home-made approach.
3. specify the system functionally and physically, design the system; ask industry for a prototype, production, eventually for installation and commissioning: a partially industrial approach.
4. specify the system functionally with the description of the environment; ask industry for the design of the complete system, production, installation and commissioning: an industrial approach.

system specific.	***system design***	***protot.***	***product.***	***install.***	***commis.***	***nature of controls***
client	client	client	client	client	client	**~~industrial~~**
client	client	client	industry	client or industry	client or industry	**~~industrial~~**
client	client	industry	industry	client or industry	client or industry	**industrial?**
client	industry	industry	industry	client	client	**industrial**
client	industry	industry	industry	industry	industry	**fully industrial**

To qualify as being “industrial”, the controls should have been designed by industry. The solutions should either come from collecting systems and components that are currently available, or to generate new systems or components which will be produced for industrial needs.

THE MANUFACTURERS OF INDUSTRIAL CONTROL SYSTEMS

The automation of a process, i.e., a machine, a set of machines or more generally industrial equipment, consists of ensuring its correct control by the use of technological devices [1]. The system is intelligent and so knows how to proceed in all operating conditions. An operator is often necessary to provide the global operation and supervision of the process. An automatic device has the following typical structure:



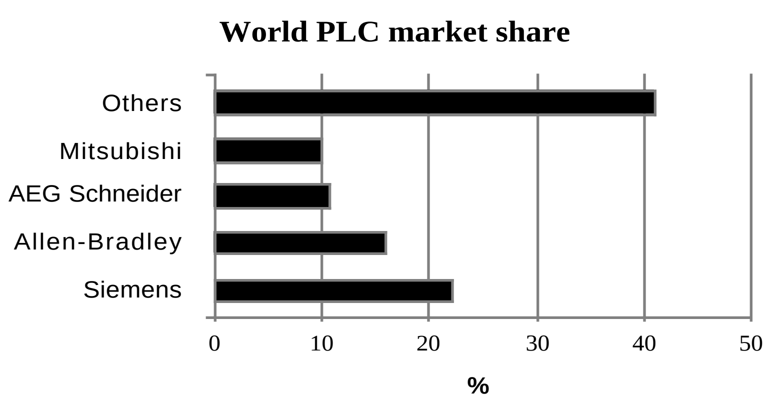
Programmable Logic Controllers were born in the United States in about the year 1969, in response to the demands of the automotive industry. The goal was to develop automated production lines able to follow the evolution of the manufactured models. The PLCs were substituted for relay cabinets, not only because of their easy implementation and flexibility, but because the costs of cabling were becoming too high. PLCs are built around processors executing dedicated programs which control actuators according to the values of sensors. Their environment includes:

- inputs and outputs which connect to sensors and actuators
- programming stations
- operating stations
- peripherals such as printers, hard disks, etc....

To coordinate different processes, buses and communication networking between the different PLCs are required A few manufacturers are offering Distributed Control Systems to attach these to their PLCs thus allowing technicians to operate, supervise, archive, log events, analyze data, display variable trends, manage data, etc. from a central location. Independent vendors offer the same features in generic supervision systems that may connect to PLCs from different manufacturers. Mixing different PLCs in the same application is not easy however, as the protocols at that level are still mostly proprietary.

From an economic point of view, the world-wide market for PLCs was estimated at $2.5 billion in 1987 and is approximately $5.5 billion today. The growth rate for revenue is around 10% per year, Europe and the United States being the largest PLC markets. Siemens, Allen-Bradley and Schneider are manufacturers number one, two and three for sales respectively. The Distributed Control System (DCS) was invented by Honeywell in 1975, but ABB and Bailey have today joined the DCS heading team. The supervision market is led by the United States with Intellution, US. Data, Wonderware and Iconics at the forefront.

Their share of the market is given in the chart below.



source: Control Engineering, January 1995

THE USERS OF INDUSTRIAL CONTROLS

Industrial controls are mostly concerned with automation in the domains of production, processing and distribution. The sectors that are concerned are:

manufacturing industries: metallurgy, machines-tools, motor industry, etc..
PLCs are highly involved in production and on assembly lines, test benches, machines for milling, pressing, grinding, welding, etc.. More than 95% of the most modern machine-tools are under PLC control.

processing industries: chemicals, petroleum, agro-food, etc..
PLCs are used for the proportioning and the mixing of ingredients, purification of effluents, oil-pumping station control and supervision and the distribution of gas and liquids.

services: energy supply, water supply, gas supply, etc..
Today, domestic and industrial supplies are under the control of PLCs for production and distribution. Nuclear energy requires safe and secure industrial control systems which are now available.

others: textile, transportation, handling, building, etc..
Warehousing, parking management and building supervision are typical applications for PLCs. Even some ski resorts use PLCs in the production of artificial snow.

INDUSTRIAL CONTROL SYSTEMS IN RESEARCH LABORATORIES

The needs

Cabling or programming technologies were the alternatives given to the control engineers of the last decade. Programmable Logic Controllers are today gaining ground because they are simple, reliable, very flexible and are becoming steadily cheaper. Industrial processes are typically characterized by the rather slow evolution of the variables that have to be controlled. This is also the case for the services in our research laboratories, which are unquestionable candidates for industrial controls. These services may be either general needs for the laboratory or equipment utilities for the machines. They concern: water, electricity, gas, heating, cooling, ventilation, vacuum, cryogenics, access, etc.. Apart from these services, production test benches and laboratory prototyping are activities where industrial controls may be useful.

The diversity of these services poses problems of coherence and integration in the domain of controls. The problem of coherence stems from the functional need for a single operating centre from which all the services may be supervised. This coherence is difficult to implement at the level of the PLCs as at that level the standards are non-existent and the products proprietary. Restricting the supply of PLCs to a single source may not be commercially viable for large installations, although this restriction might be desirable at the elementary level of the project, and even more so for small installations. The integration of industrial control systems supporting the operation of one machine needs a functional control architecture [2], organized around service-specific centres which are the vantage-points and the nerve centres for each type of service.

Research laboratories facing industrial controls

Research laboratories should definitely lean towards using industrial control systems for their services:

- technically, the services make use of industrial processes for which industrial controls have been developed. Using industrial systems gives the advantage of tried and tested solutions, as they are used a number of times in similar applications. The different phases being shorter, the development of the project requires much less time.

- financially, the design cost is shared by the whole community of customers, and the prime cost decreases rapidly with the increase of production. The regulating mechanism of the market makes it likely that the price will be competitive.

- politically, fundamental research is suffering from the current economic situation in many countries. The approval process for the Large Hadron Collider [3] at CERN has been a lengthy and painful one. Support from the Member States is not as strong as it was fifteen years ago. We now have to cope with new boundary conditions which have a direct impact on the way the project can be developed. The squeeze on human resources poses a question on some of the laboratory activities and the need to make savings by limiting them to those that are vital. In this context, the use of industrial controls is undoubtedly one of the rational answers. Our States would like their investment in fundamental research to give rise to new technologies that generate employment and positive returns. [4].

The first use by CERN of an industrial control system for equipment in an accelerator was made for LEP in the domain of cooling and ventilation [5]. The decision in 1990 to control the refrigeration system for the LEP upgrade with an industrial control system launched an increasing interest which is today supported by a large community [6] [7].

CONCLUSION

Given the present climate, our Member States' politicians must find economical justification for the support they give to our research laboratories. The financial investment must generate an appreciable increase in industrial activity. The political support we can expect from manufacturers as process control system consumers is certainly better than as control system designers. To defend our scientific interests it is vital to present our sponsors with good arguments. It is vital to use industrial controls.

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