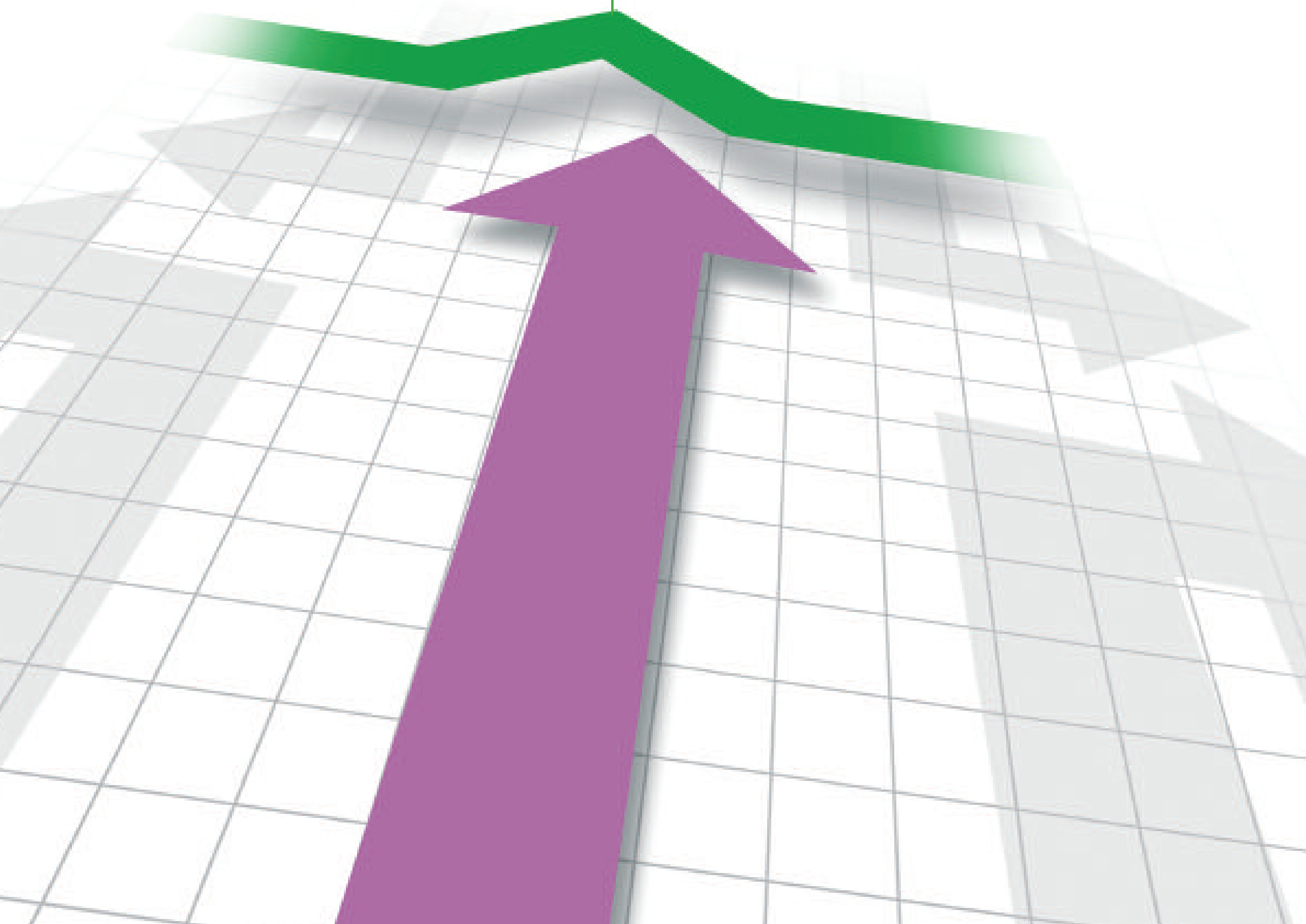
1 chapter

Automation solution guide

From the needs,
choose an architecture,
then a technology
to lead to a product



1. Automation solution guide

Summary

1. Automation solution guide

1.1 Introduction

Progress in industrial automation has helped industry to increase its productivity and lower its costs. Widespread use of electronics and powerful, flexible software have given rise to more efficient modular designs and new maintenance tools.

Customer demands have also evolved substantially; competition, productivity and quality requirements compel them to adopt a process-based approach.

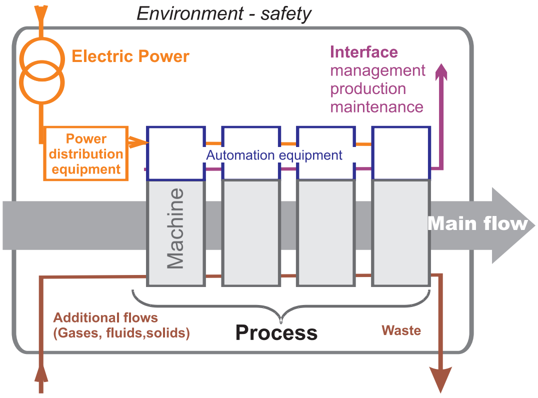


Fig. 1 Customer value creation process

Customer value creation process

The customer value creation process is based on the main flow (⇨ *Fig. 1*), i.e. core business, such as product manufacturing, transport of persons or conveyance of a load.

This process requires equipment in the form of machines and automated devices. This equipment can be confined to a single place, such as a factory, or else spread over extensive areas, as is the case for a water treatment and distribution plant.

To work smoothly, the process requires additional flows such as electricity, air, water, gas and packaging.

The process engenders waste which must be collected, transported, treated and discarded.

1.2 The automation equipment

Automation equipment features five basic functions linked by power and control systems (⇨ *Fig. 2*).

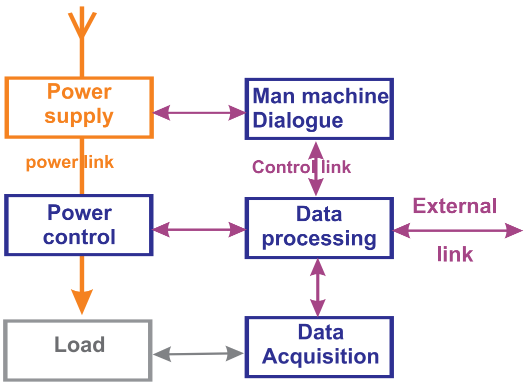


Fig. 2 Five basic functions

Five basic functions

Electrical power supply

Ensures the distribution of power to the power devicescapacity and control parts.
It must be uninterrupted and protected in compliance with electrical installation and machines standards. This function is usually ensured by a circuit-breaker or fuse holder switch.

Power control

Controls loads driven by the automatic device, either a contactor is used as a direct on line starter or an electronic controller is used to graduate the power supply of a motor or heater.

Dialogue

Commonly named man-machine interface, it is the link between the operator and the machine. It is function is to give orders and monitor the status of the process Control is made by push buttons, keyboards and touch screens and viewed through indicator lights, illuminated indicator banks and screens.

Data processing

The software, part of the automation equipment, fusing the orders given by the operator and the process status measurements is the brain of the equipment. It controls the preactuators and sends information when and where required. The automation engineer has a wide range of options, from the simplest (as a set of push buttons directly controlling a contactor), through programmable logic systems to a collaborative link between the automated devices and computers. Today as simple low-cost automated devices are available, relay diagrams have practically disappeared.

- **Data acquisition**

Data acquisition is mandatory to send feedback is to the controller or the PLC. Due to technological progress most of all physical value can now be detected or measured.

The equipment must satisfy the external constraints

- to ensure the safety of the people and the production tools,
- to respect the requirements of the environment such as the temperature, the shock protection, dust or environments aggressive.

Power links

These are the connections between parts and include cables, busbars, connectors and mechanical protection such as ducts and shields. Current values range from a few to several thousand amperes. They must be tailored to cover electrodynamic and mechanical stress as well as heat stress.

Control links

These are used to drive and control the automated devices. Conventional cabling systems with separate wires are gradually being replaced by ready-made connections with connectors and communication buses.

Lifecycle of an automated equipment

An equipment is designed, then used and maintained throughout its lifecycle. This lifecycle depends on the users and their needs, the customer's requirements and external obligations (laws, standards, etc.). The steps are as follows:

- definition of the machine or process by the customer,
- choice of automation equipment,
- component supply,
- commissioning, tests,
- operation,
- maintenance,
- dismantling, recycling, destruction.

Cost of an equipment

Cost reduction is an issue at every level during the choice and decision-making process. It's tightly bound with the customer needs. Though this guide only describes the technical aspects, it has been written with cost-effectiveness in mind.

Evolution of user needs and market pressure

Over the last few years, the automated device market has been subject to great economic and technological pressure. The main customer priorities are now:

- shorten time to market,
- expand the offer through flexible design so that new products can be marketed without having to overhaul the entire offer,
- expand the offer through customisation,
- cost reduction.

This situation has created new needs:

- reduction of development time,
- reduction of complexity,
- greater flexibility in particular when manufacturers have to change series,
- gathering information for production management and maintenance (cost reduction, down times, etc.).

To meet these requirements, an offer for reliable and powerful products must include "ready-to-use" architectures enabling intermediate players such as systems integrators and OEMs to specify and build the perfect solution for any end user. The *figure 3* illustrates the relationship between market players and Schneider Electric offer.

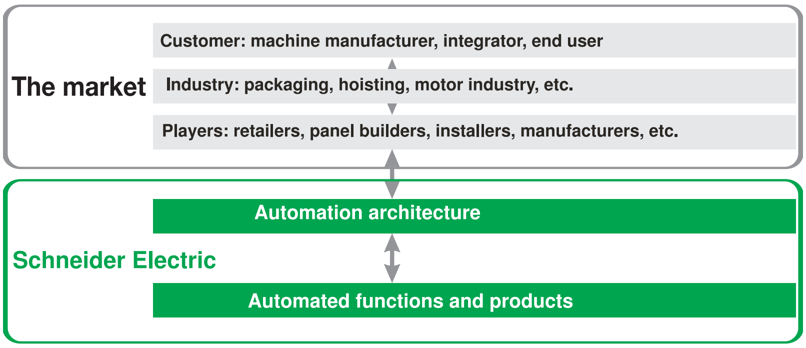


Fig. 3 *Automatism market players*

Architectures add value to the intermediate players, starting with the retailer or wholesaler, panel builder, machine installer or manufacturer. It is a global approach that enables them to respond more reliably, exactly and faster to end customers in different industries such as food, infrastructure or building.

1.3 Automation architectures

In the late 1990s, the conventional prioritised approach both in manufacturing processes (CIM: Computer Integrated Manufacturing) and in continuous processes (PWS: Plant Wide Systems) gave way to a decentralised approach. Automated functions were implemented as close as possible to the process (see the definition of these terms in the software section.)

The development of web processes based on Ethernet and the TCP/IP protocol began to penetrate complex automated systems. These gradually split up and were integrated into other functions, thus giving rise to smart devices.

This architecture made it possible to have transparent interconnection between the control systems and IT management tools (MES, ERP).

At the same time, the components (actuators, speed controllers, sensors, input/output devices, etc.) gradually evolved into smart devices by integrating programming and communication features.

Smart devices

These include nano-automated devices, automated cells (such as Power Logic, Sepam, Dialpact, etc.) and components with a regulating function, such as speed controllers. These products are smart enough to manage process functions locally and to interact with each other. Transparent communication means that tasks can be reconfigured and diagnoses made – these possibilities are perfectly in line with the web process (individual addressing, information formatted to be ready to use, information provider management).

The product line of smart devices products are systematically plug and play for power controllers, control bus and sensors. This approach means equipment can be replaced quickly and easily in the event of failure.

The integration of browsers into keyboard and screen systems, radio controls and other MMIs has accelerated deployment of web technologies right up to the component level *(see chapter 9 for explanations of connection and classes)*.

The integration of control functions into smart devices has reduced the data flow on networks, thereby lowering costs, reducing the power of the automated devices and speeding up response times. There is less need for synchronisation because the smart devices process locally.

Networks

At the same time, networks have been widely accepted and have converged on a limited number of standards which cover 80% of applications. There are many options open to designers (CANopen, AS-Interface, Profibus, DeviceNet, etc.) but the trend is towards a standard single network. In this framework, Ethernet, which has already won over the industrial computerisation sector, can also address needs for ground buses.

A great many elements are now directly network-connectable. This is the result of the combined effects of web-technology distribution, rationalisation of communication standards, the sharp drop in the price of information technology and the integration of electronics into electro-mechanical components.

These developments have led to the definition of field buses adapted to communication between components and automated devices such as Modbus, CANopen, AS-Interface, Device Net, Interbus S, Profibus, Fip, etc.

The increasing need for exchange prompts customers to give priority to the choice of network ahead of automated equipment.

Software and development tools

Programming tools have greatly expanded, from software dependent on hardware platforms to purely functional software downloaded onto a variety of hardware configurations. Communication between components is generated automatically. The information the programs produce is accessed by a unifying tool and shares a common distributed database, which considerably cuts down on the time taken to capture information (parameters, variables, etc.).

So far, industrial automated device programming language concepts have not changed, with practically all suppliers promoting offers based on the IEC 61131-3 standard, sometimes enhanced by tools supporting collaborative control.

Future improvements mainly concern the information generated by products designed to:

- automatically generate the automated device configuration and input/output naming,
- import and export functions to and from the automated device's software and the components' software,
- integrate electrical diagrams into diagnostics tools,
- generate a common database, even for a simple configuration,
- offer total transparency,
- offer a single ergonomics which can be learnt once and for all for several uses.

Software is an obligatory ingredient of widely different products and is used not only for programming, but also for configuration, parameter setting and diagnosis. These separate features can be included in the same program.

1.4 Architecture definition

An architecture is designed to integrate, interface and coordinate the automated functions required for a machine or process with the object of productivity and environmental safety.
A limited number of architectures can meet most automation requirements. To keep matters simple, Schneider Electric proposes to classify architectures on the basis of two structure levels *(⇨ Fig. 4)*:
- functional integration based on the number of automation panels or enclosures,
- the number of automated control functions, i.e. the number of control units in e.g. an automated device.

Automation architecture	Number of panels	Number of control units
All in one device All functions in a single device	0	1
All in one panel All functions in a single panel	1	1
Distributed peripheral Functions distributed over several panels	Several	1
Collaborative control Several collaborative control functions	Several	Several

Fig. 4 Type of architectures

These architectures are explained and illustrated in the following paragraphs.

All in one device

The most compact structure, with all the functions in a single product, this architecture can range from the simplest to the most complex as illustrated in the two examples below.

Remote controlled sliding door *(⇨ Fig. 6)*

This only has a few functions *(⇨ Fig. 5)*, the control being limited to direct command of the power controller by the sensor and the dialogue to two buttons. The power controller also includes the power supply and the protection of the power circuit.

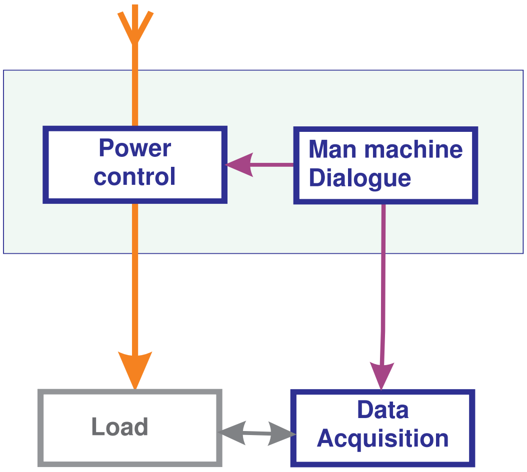


Fig. 5 Simple architecture "All in on device"

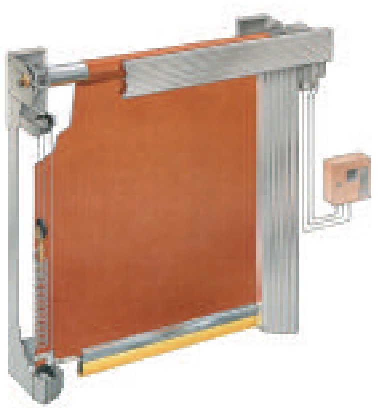


Fig. 6 Remote controlled sliding door

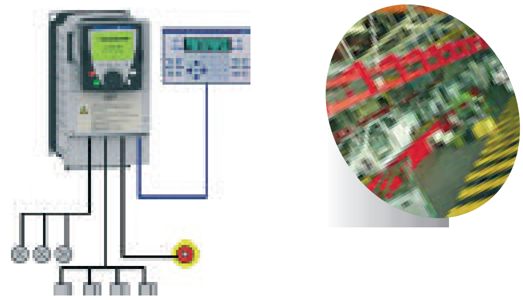


Fig. 8 Section of a conveyor system driven by an ATV71 with an integrated controller card

Fig. 10 LGP pump

Fig. 11 Textile inspection machine

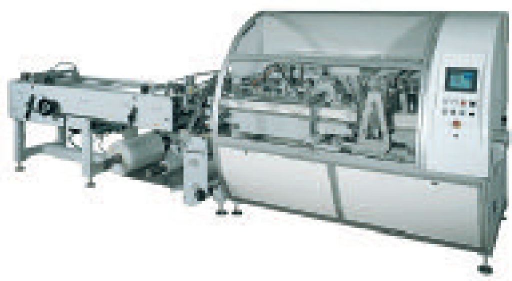


Fig. 12 Packaging machine

Conveyor system section (⇨ Fig. 8)

Power control dialog, processing and detection are integrated into the speed controller (⇨ Fig. 7). The other automated parts are linked via a communication bus. The power supply requires an electrical distribution panel covering all the automated equipment in the system.

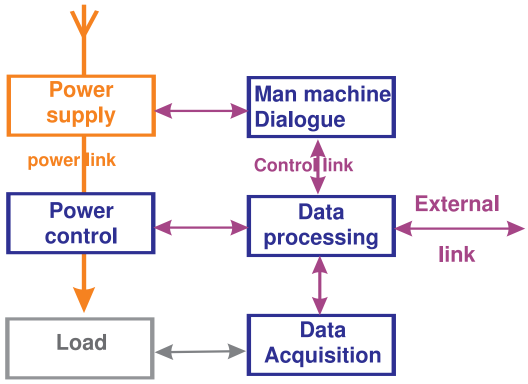


Fig. 7 "All in One device" complex architecture

All in one panel

This is the most common architecture (⇨ Fig. 9), with the automated functions centralised in a single place which, depending on the case, is a single enclosure or built into the machine and has a single control function *(application examples fig. 10,11,12)*.

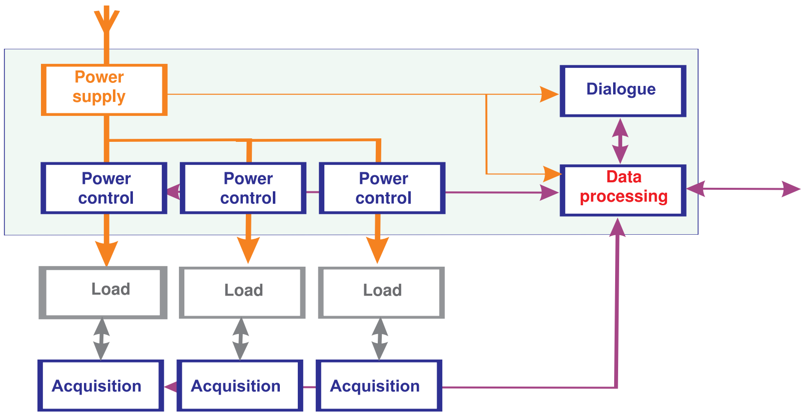
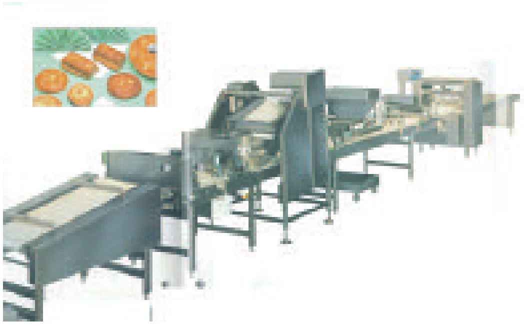


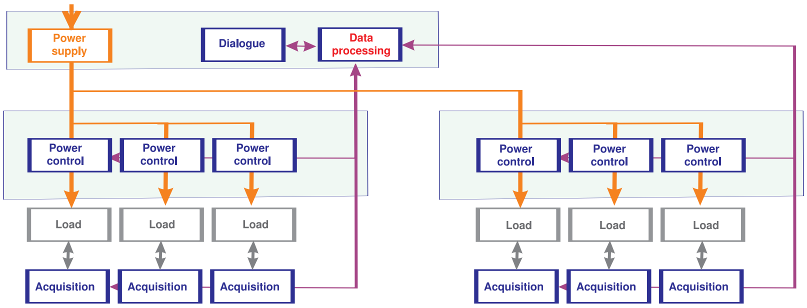
Fig. 9 "All in one panel" architecture



↑ *Fig. 14* *Industrial bakery machine*

Distributed peripheral *(⇨ Fig. 13)*

This architecture has a single central automated device to drive several automated distribution panels. It is suited to plant-wide machines and procedures and modular machines *(⇨ Fig. 14)*. The link is controlled by a ground bus. The power supply is centralised and often includes the parts for controlling and operating the safety system.

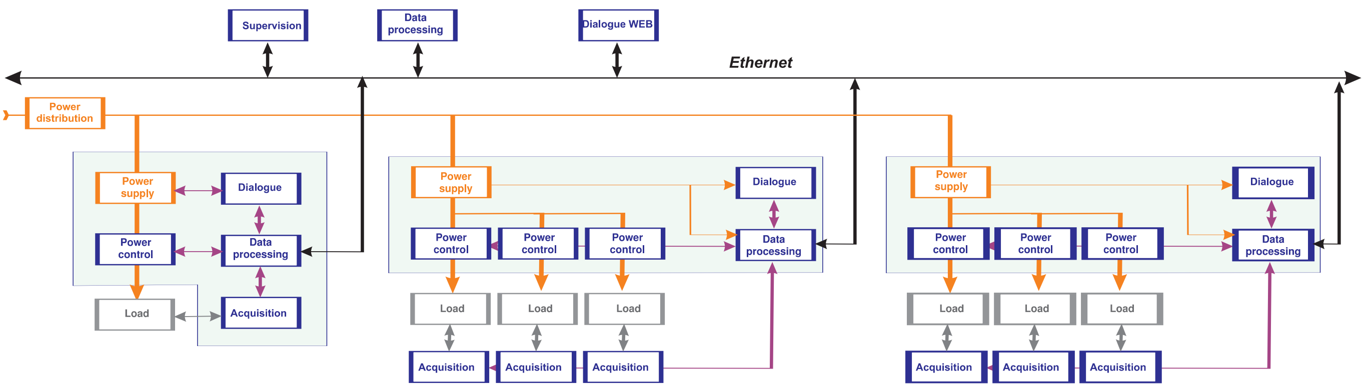


↑ *Fig. 13* *"Distributed peripheral" architecture*

Collaborative control

Several machines or parts of a procedure have their own controllers *(⇨ Fig. 15)*. They are linked together and collaborate in operating the system. This architecture is designed for large procedures such as in the petrochemical and steel industries or for infrastructures such as airports or water treatment plants *(⇨ Fig.16)*.

↑ *Fig. 16* *Water treatment*



↑ *Fig. 15* *"Collaborative control" architecture*

1.5 Choice of automated equipment

Architecture implementation

We propose to help the customer by addressing their problem to guide them and optimise their choice of architecture and the products and services it will include. This process starts by ascertaining the customer's needs and structuring questions as we shall describe.

To make it easier to choose, Schneider Electric has optimised a number of variants based on the most common architectures.

The first involves compact applications where the automated devices are grouped into an all-in-one panel.

The second relates to procedure-distributed applications. The automated devices are divided up into several panels known as distributed peripherals.

The other two (All in One Device and Collaborative Control) are not left out, but are presented differently. The all-in-one device is comparable to a single device and is treated as such. The collaborative control structure mainly involves data exchange between devices and is described in the section on links and exchanges. Its details are in the sections on automated devices and software.

Choices offered by Schneider Electric

Both architecture concepts above can be implemented in many ways. To make it easier for the customer to choose, Schneider Electric has opted for a total of 10 possible implementations to offer optimal combinations.

To prevent any confusion between the architecture concepts described above and the practical solutions Schneider Electric proposes, the latter will be referred to as ***preferred implementations***.

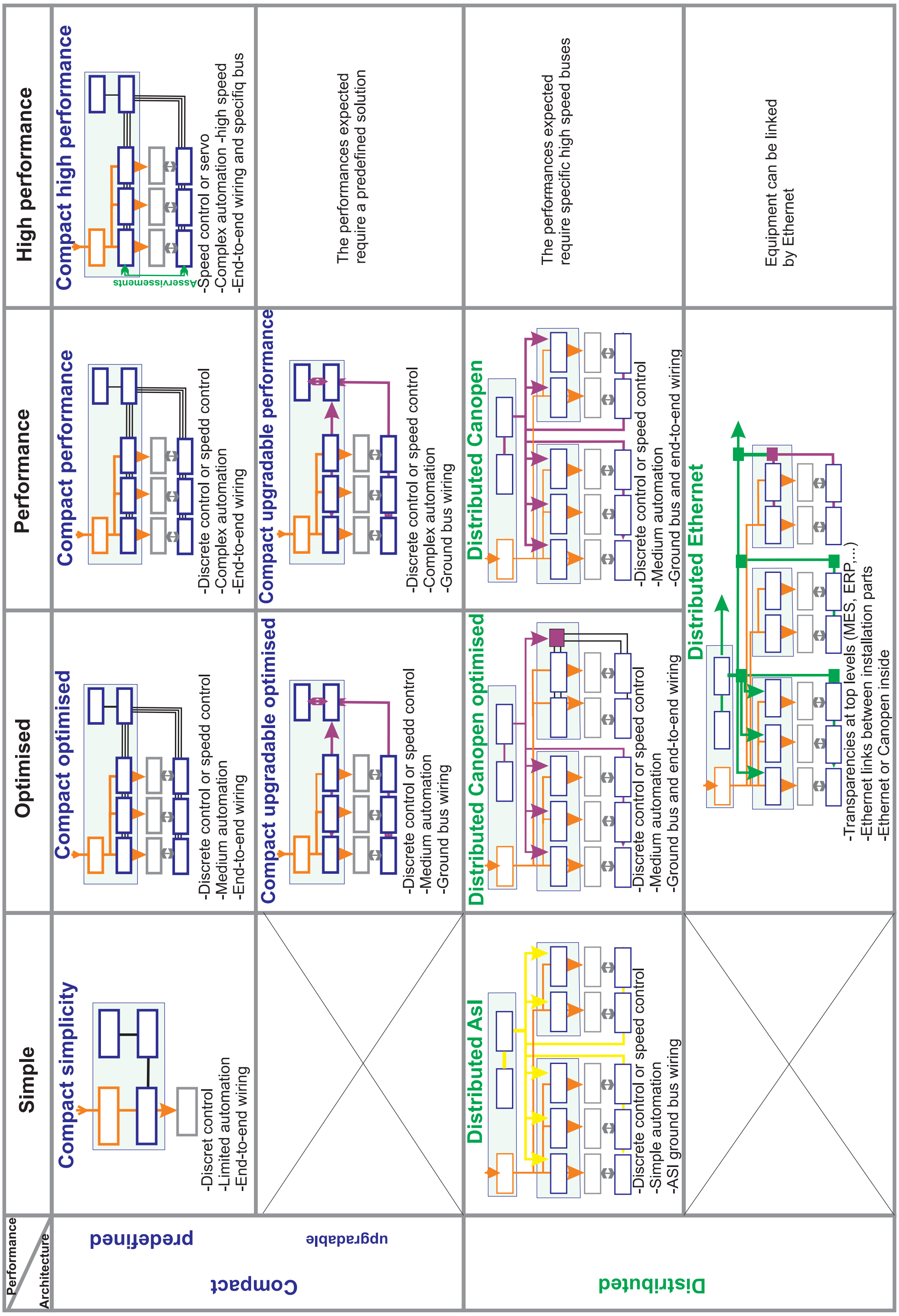
The table *(⇨ Fig. 17)* below shows a summary of this approach.

Automation architecture	Schneider Electric orientations	proposed implementations
All in one device All functions in a single device	Same as one produit	Products such as Tesys U ATV71 Controller Inside
All in one panel All functions in a single panel	Compact architecture	6 implementations
Distributed peripheral Functions distributed over several panels	Distributed architecture	4 implementations
Collaborative control Several collaborative control functions	Same as data exchange between automated devices	Combinaison of the implementations above

↑ Fig. 17 *Choice of Schneider Electric implementations*

Preferred implementations

These implementations are the result of an optimization between the expressed needs and technologies available. The table *(⇨ Fig. 18)* below shows a summary of them; they are described in greater detail in the documents provided by Schneider Electric.



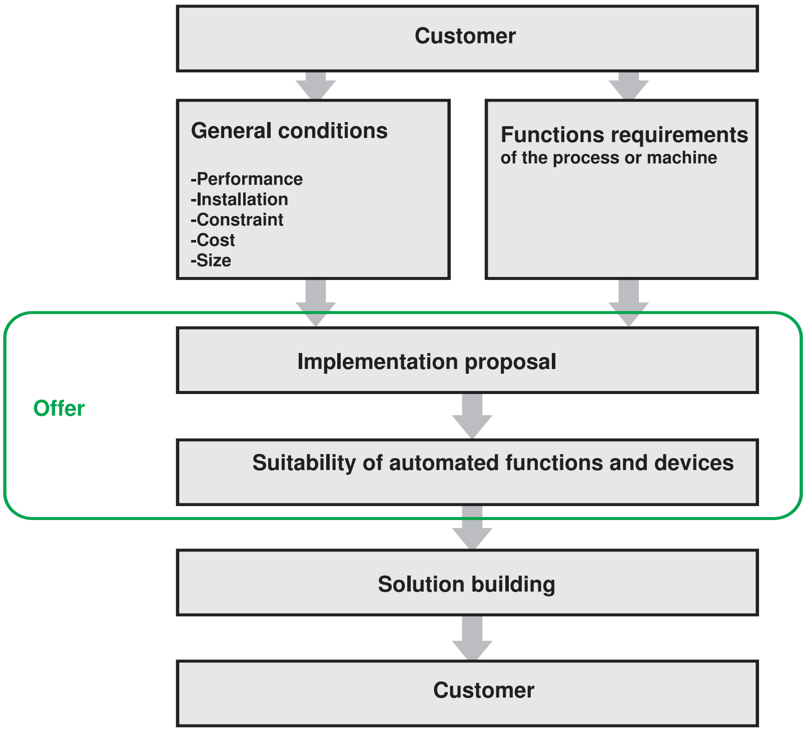
↑ *Fig. 18* *Preferred implementations characteristics (refer to fig 5 to 11)*

Choice of a preferred implementation

The solution approach to these implementations, which includes all the customer's requirements, has many advantages:

- simplified choice of automation systems,
- peace of mind and confidence for the user because the devices are interoperable and performance levels are guaranteed,
- once the implementation is chosen, the customer will have an adequately precise framework, alongside the catalogue and specific guides, to select the requisite automated functions and devices,
- commissioning is facilitated by the work completed upstream.

The table *(⇨ Fig. 19)* below summarises the proposed approach:



↑ Fig. 19 *Step by step approach for automatism choice*

To assist customers choice, Schneider Electric has drawn up a complete guide with questions divided into four themes given the mnemonic of PICCS (Performance, Installation, Constraints, Cost, Size). An example is given *(⇨ Fig. 20 and 21)* below. For all the implementations available, please refer to the catalogues. Here we are just illustrating the approach with examples.

Type of implemenation		Compact					
Name of implementation		*Simple*	*optimised*	*optimised upgradeable*	*performance*	*high performance*	*upgradeable performance*
General conditions							
Performance	Installed capacity	low	low to high	low to medium	low to medium	low to medium	low to medium
	Precision, rate	none	medium	medium	medium	high	medium
	number of motors	1 to 4	1 to 10	1 to 50	1 to 10	1 to 10	1 to 50
	types of motor	Asynchronous Direct	Asynchronous Speed Control	Asynchronous Speed Control	Asynchronous FVC / servosystem	Synchronous servosystem	Asynchronous FVC Synchronous servosystem
	Data exchange	no	no	yes	no	possible	yes
	Number of inputs/outputs	<20	<100	<100	<100	>100	>100
	Dialogue types and functions	buttons lights	buttons lights displays	buttons keyboard displays	buttons keyboard displays	buttons keyboard displays	buttons keyboard displays
	Processing system	wired or preset	preset	basic programmable functions	advanced workshop software functions	advanced workshop software functions+ application	advanced workshop software functions
	Remote services (diagnosis, update, etc.)	no	no	possible	no	no	possible
Installation	Number of panels	1	1	1	1	1	1
	Constant or upgradeable	constant	constant	upgradeable	constant	constant	upgradeable
Environment **C**onditions	Atmosphere (temperature, dust, etc.)	limited	yes	yes	yes	yes	yes
	Safety (people, equipment)	Emergency stop	Emergency stop	automated functions	simple functions	automated functions	automated functions
Cost	cost of machine or installation	equipment	equipment	update maintenance	equipment	machine	update maintenance
	design costs	no	no	yes	no	yes	yes
	operating cost	no	yes	yes	no	yes	yes
Surface area and size	size of installation	small	medium	medium	medium	medium	medium
	Inhouse network	none	none	yes	none	none or specific bus	yes
	Length of external network						

↑ Fig. 20 *Guide for compact architectures*

Type of implemenation		**Distributed**			
	Name of implementation	***As-Interface***	***optimised CANopen***	***CANopen***	***Ethernet***
General conditions					***Transparent Factory***
Performance	Installed capacity	low to medium	low to high	low to high	low to high
	Precision, rate	low to medium	medium	medium	depending on ground bus
	number of motors	1 to 10	1 to 10	<20	>20
	types of motor	Asynchronous Direct	Asynchronous Speed Control	Asynchronous Speed Control	all types contingent on ground bus
	Data exchange	no	possible	possible	yes
	Number of inputs/outputs	<100	<100	>100	>100
	Dialogue types and functions	keyboards displays	keyboards displays	keyboards displays	keyboards PC displays
	Processing system	basic programmable functions	advanced workshop software functions	advanced workshop software functions	software workshop + collaboration other systems
	Remote services (diagnosis, update, etc.)	no	possible	possible	yes
Installation	Number of panels	<5	<10	<10	n
	Constant or upgradeable	upgradeable	upgradeable	upgradeable	upgradeable
Environment Conditions	Atmosphere (temperature, dust, etc.)	yes	yes	yes	yes
	Safety (people, equipment)	automated functions	automated functions	automated functions	automated functions
Cost	cost of machine or installation	update maintenance	update maintenance	update maintenance	global
	design costs	yes	yes	yes	yes
	operating cost	yes	yes	yes	yes
Surface area and size	size of installation	medium	medium	medium	large
	Inhouse network	ASI	CANopen	CANopen	ground network
	Length of external network	100m	250m	250m	>250m

Fig. 21 *Guide for distributed architectures*

1.5 Choice of automated equipment

We shall take three different applications and ascertain the most suitable architecture(s) for each of them.

Tower crane

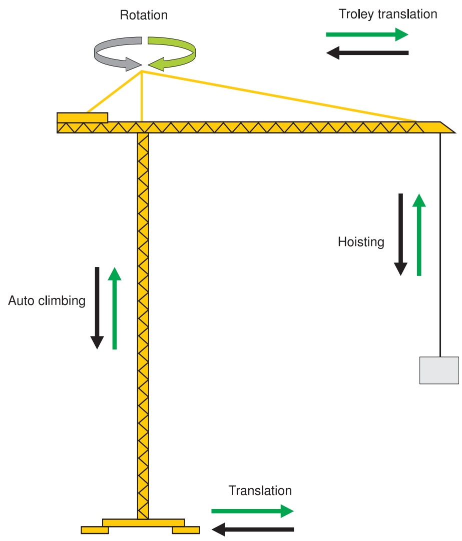
Notwithstanding its apparent simplicity, this machine (⇨ *Fig. 22*) has to comply with stringent safety and environmental standards. Market competition forces manufacturers to consider the cost of every element.

The features of this type of crane are:

- power of the installation from 10 kW to 115 kW depending on the load to hoist (2 to 350 metric tons),
- hoisting, rotation, trolleying and translation are driven by three-phase AC motors with two or three gears or AC drives. Braking is mechanical or electric,
- the system requires about a dozen of sensors and the man-machine interface can be in the cabin or remote-controlled.

The choice of implementation naturally focuses on an ***optimised compact*** system in a single panel at the basement of the crane.

The highlighted colour coding in the selection table above shows the options at a glance (⇨ *Fig. 23*).



↑ *Fig. 22* *Tower crane*

Type of implemenation / ***Name of implementatic***		**Compact** *Simple*	*optimised*	*optimised upgradeable*
General conditions				
Performance	Installed capacity	low	low to high	low to medium
	Precision, rate	none	medium	medium
	number of motors	1 to 4	1 to 10	1 to 50
	types of motor	Asynchronous Direct	Asynchronous Speed Control	Asynchronous Speed Control
	Data exchange	no	no	yes
	Number of inputs/outputs	<20	<100	<100
	Dialogue types and functions	buttons lights	buttons lights displays	buttons keyboard displays
	Processing system	wired or preset	preset	basic programmable functions
	Remote services (diagnosis, update, etc.)	no	no	possible
Installation	Number of panels	1	1	1
	Constant or upgradeable	constant	constant	upgradeable
Environment Conditions	Atmosphere (temperature, dust, etc.)	limited	yes	yes
	Safety (people, equipment)	Emergency stop	Emergency stop	automated functions
Cost	cost of machine or installation	equipment	equipment	update maintenance
	design costs	no	no	yes
	operating cost	no	yes	yes
Surface area and size	size of installation	small	medium	medium
	Inhouse network	none	none	yes
	Length of external network			
colour codes	***suitable***			
	unsuitable			

↑ *Fig. 23* *Implementation choice for a tower crane*

The ***Simple Compact*** is eliminated because its options are too limited. Both ***Optimised Compact*** and ***Evolutive Optimised Compact*** are suitable (⇨ *Fig. 24 and 25*). The latter is even more suitable if the machine is a modular design or if remote maintenance is required.

1.5 Choice of automated equipment

The choice of components naturally depends on the customer's constraints and those of the chosen implementation. The figures below illustrate both possible implementations:

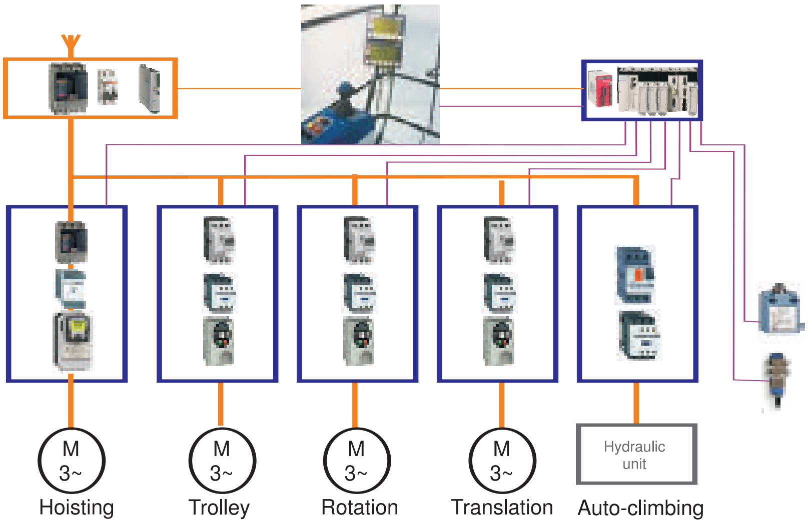


Fig. 24 *Compact optimised solution*

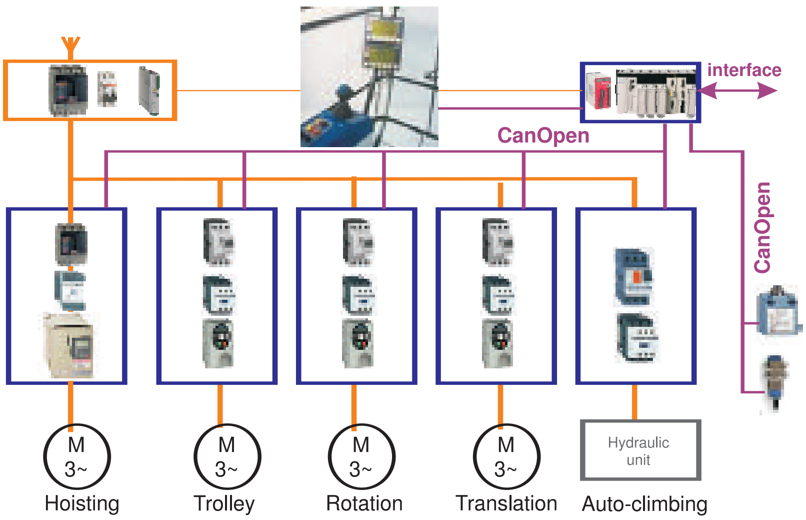
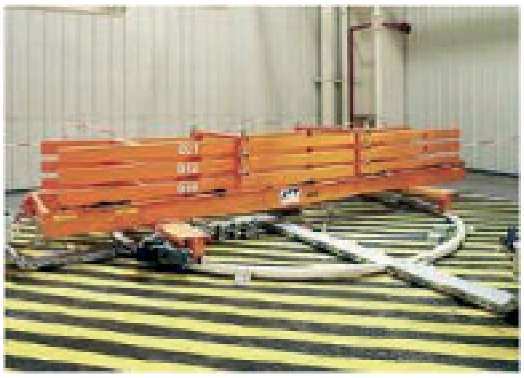


Fig. 25 *Evolutive optimised compact solution*

The components are described in detail in the following sections.



↑ *Fig. 26* *Revolving table*

◻ Conveyors and revolving tables

This kind of unit is very common in the manufacturing industry *(⇨ Fig. 26 and 27)*. The type of machine greatly depends on the surroundings. Its output has to be adjusted to the product and it is controlled by upstream and downstream automation. One automated device will control several sections in a conveyor and each element will have one or more panels.

The main features are:

- low power installation,
- medium performance requirements,
- per section, 2 to 10 three-phase AC motors with AC drives,
- 10 to 50 inputs/outputs,
- interface by keyboard and display,
- real-time knowledge of the type and number of products conveyed.

Since there are several linked equipments, the choice should focus on a distributed architecture.

The selection table highlights the best solutions *(⇨ Fig. 28)*. The ASI bus one is a bit restricted because of the difficulties in speed control and the Ethernet one, except in some specific cases, is likely to be too expensive.

↑ *Fig. 27* *Conveyor*

Type of implementation		**Distributed**			
	Name of implementation	***As-Interface***	***optimised CANopen***	***CANopen***	***Ethernet***
General conditions					***Transparent Factory***
Performance	Installed capacity	low to medium	low to high	low to high	low to high
	Precision, rate	low to medium	medium	medium	depending on ground bus
	number of motors	1 to 10	1 to 10	<20	>20
	types of motor	Asynchronous Direct	Asynchronous Speed Control	Asynchronous Speed Control	all types contingent on ground bus
	Data exchange	no	possible	possible	yes
	Number of inputs/outputs	<100	<100	>100	>100
	Dialogue types and functions	keyboards displays	keyboards displays	keyboards displays	keyboards PC displays
	Processing system	basic programmable functions	advanced workshop software functions	advanced workshop software functions	software workshop + collaboration other systems
	Remote services (diagnosis, update, etc.)	no	possible	possible	yes
Installation	Number of panels	<5	<10	<10	n
	Constant or upgradeable	upgradeable	upgradeable	upgradeable	upgradeable
Environment Conditions	Atmosphere (temperature, dust, etc.)	yes	yes	yes	yes
	Safety (people, equipment)	automated functions	automated functions	automated functions	automated functions
Cost	cost of machine or installation	update maintenance	update maintenance	update maintenance	global
	design costs	yes	yes	yes	yes
	operating cost	yes	yes	yes	yes
Surface area and size	size of installation	medium	medium	medium	large
	Inhouse network	ASI	CANopen	CANopen	ground network
	Length of external network	100m	250m	250m	>250m
colour codes	***suitable*** ***unsuitable***				

↑ *Fig. 28* *Conveying system choice*

This leaves the two CANopen field bus solutions. The first, which is more economical *(⇨ Fig. 29)*, ensures the basic requisite functions and the second *(⇨ Fig. 30)* ensures transparency and synchronisation with automated devices outside the section involved. It is also easy to upgrade: a new configuration can be downloaded whenever a series is changed and so forth.

Electrical diagram

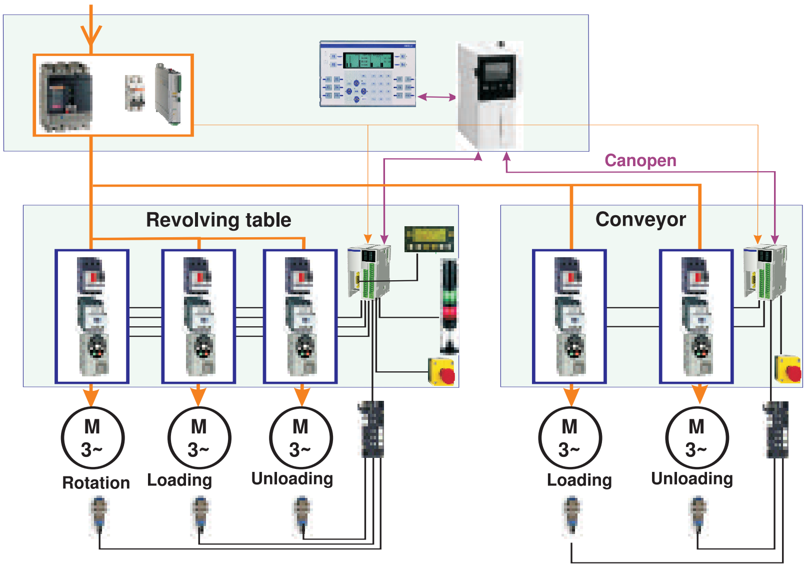


Fig. 29 *Optimised CANopen solution*

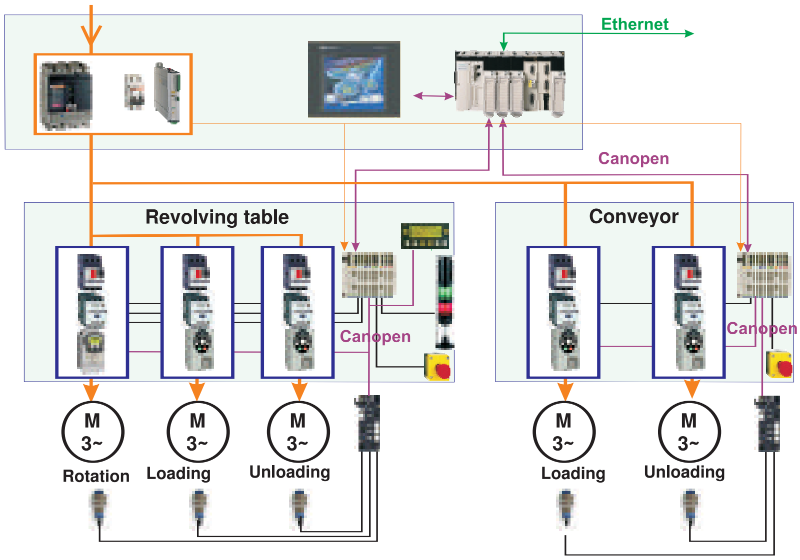


Fig. 30 *CANopen solution*

Fig. 31 *Water treatment pumping station*

Drinking water supply

This example *(⇨ Fig. 31)* illustrates part of an infrastructure for water treatment and distribution. It consists of a set of units spread over a territorial area.

This kind of application must be standalone and ensure a continuous supply. Customers give great attention to supervision and maintenance of the installation.

The features of the station are:

- 4 pumps of 7.5 kW with AC drives,
- a dozen of sensors (pressure, output, etc.),
- an automated device to control pump sequencing and communication,
- remote supervision of the installation.

1.5 Choice of automated equipment

The choice will focus on a distributed implementation. The table *(⇨ Fig. 32)* below shows the best one.

The most suitable implementation is the Ethernet one *(⇨ Fig. 33 and 34)*, ensuring total transparency in the installation. The ASI bus is limited by its low data exchange capacity. The CANopen ones can be used with a modem but their possibilities are still restricted.

Type of implementation		**Distributed**			
	Name of implementation	***As-Interface***	***optimised CANopen***	***CANopen***	***Ethernet Transparent Factory***
General conditions					
Performance	Installed capacity	low to medium	low to high	low to high	low to high
	Precision, rate	low to medium	medium	medium	depending on ground bus
	number of motors	1 to 10	1 to 10	<20	>20
	types of motor	Asynchronous Direct	Asynchronous Speed Control	Asynchronous Speed Control	all types contingent on ground bus
	Data exchange	no	possible	possible	yes
	Number of inputs/outputs	<100	<100	>100	>100
	Dialogue types and functions	keyboards displays	keyboards displays	keyboards displays	keyboards PC displays
	Processing system	basic programmable functions	advanced workshop software functions	advanced workshop software functions	software workshop + collaboration other systems
	Remote services (diagnosis, update, etc.)	no	possible	possible	yes
Installation	Number of panels	<5	<10	<10	n
	Constant or upgradeable	upgradeable	upgradeable	upgradeable	upgradeable
Environment Conditions	Atmosphere (temperature, dust, etc.)	yes	yes	yes	yes
	Safety (people, equipment)	automated functions	automated functions	automated functions	automated functions
Cost	cost of machine or installation	update maintenance	update maintenance	update maintenance	global
	design costs	yes	yes	yes	yes
	operating cost	yes	yes	yes	yes
Surface area and size	size of installation	medium	medium	medium	large
	Inhouse network	ASI	CANopen	CANopen	ground network
	Length of external network	100m	250m	250m	>250m
colour codes	***suitable*** ***unsuitable***				

↑ Fig. 32 *Water treatment pumping station architeture choice*

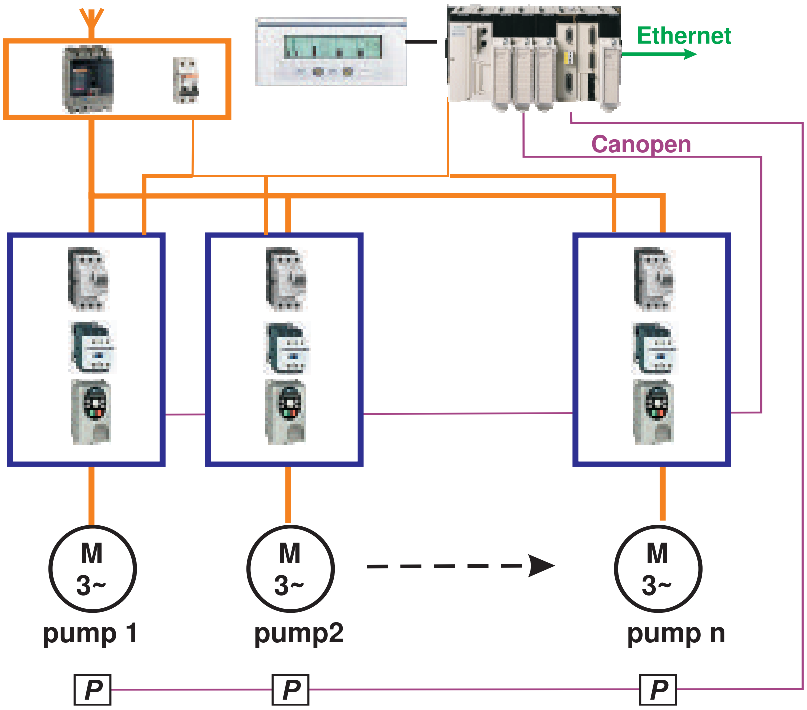


Fig. 33 Solution 1 from a PLC

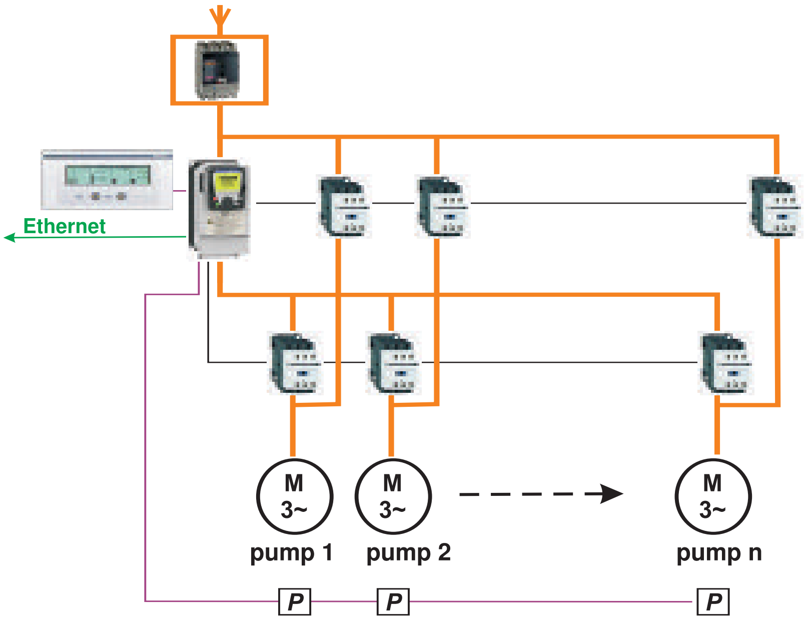


Fig. 34 Solution 2 from a speed drive