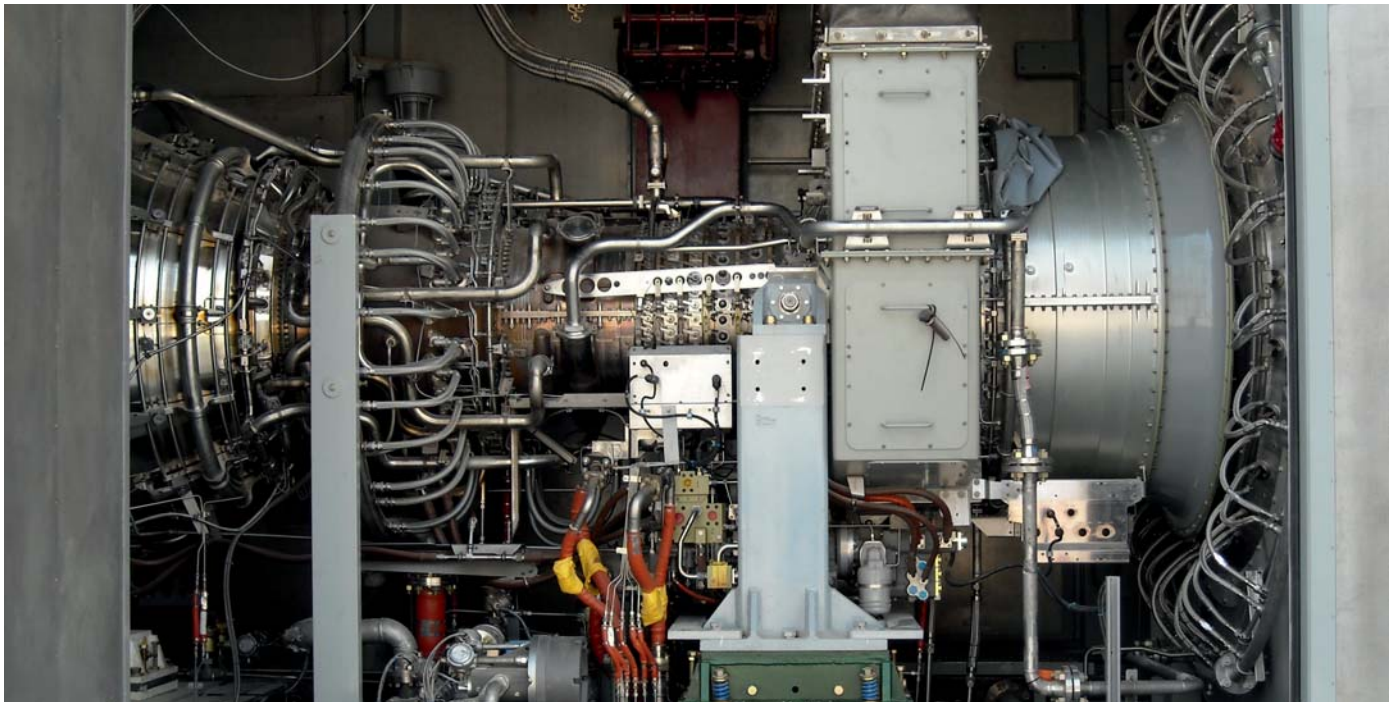

The benefits of using process automation systems for turbomachinery controls

When replacing or upgrading (obsolete) turbomachinery control systems, integrating turbomachinery controls with process controls has many benefits.
It increases the reliability of customer's machinery and process. Single hardware platform provides smaller footprint (e.g. off-shore space limits), knowledge, training – focus on one system and integrated architecture. Integrating all machines and sensors on one screen and remote access which allows you to view the same information from every control screen around the plant. Alarming and sequence of events are supported by common time stamp.
Other advantages of TMC system integration to DCS are improved obsolescence management and life cycle management, cyber security (less points of entry for cyber-attacks), reduced number of investments. Total Cost of Ownership (TCO) is lower than the 3rd party vendor / black box solution.

Tom Langezaal, Sales & Applications, and Shamoe Lakhisaran, Business Development, Control-Care, Amsterdam, The Netherlands

The history of turbomachinery control can be traced back to the initial development of steam engines, which required effective speed control. Watt's governor (also known as the flyball governor) of 1788 was the first centrifugal and fully automatic speed control which utilized a system of levers and gravity to control the opening of the aperture on throttle valves in steam engines. The mechanical set up became more advanced over time, with hydraulic systems replacing the flyball.
Prior to the computerization of turbomachinery systems, the control of valves was firmly based in mechanical engineering, via a set of hydro-mechanical governors, with each responsible for some aspect of control or limiting. These systems continued to improve and develop along with the increased use of turbomachinery for gas transportation and power generation, until the 1970s when the governors were replaced with I/O modules and control philosophies were firmly planted within controllers. Instead of relying on the aforementioned system of mechanical governors as the "brain" of turbo-machinery controls, these actions soon shifted into controllers sending out rapid signal outputs to electro-hydraulic actuators.
With the rapid advancement of microprocessor technology, a shift in process control and turbomachinery control toward software-based solutions is noticed. And the emergence of fast and flexible Distributed Control Systems (DCS) means that firms specializing in turbomachinery control will gradually move away from proprietary hardware and instead focus on software and know-how.
Turbomachinery equipment, such as centrifugal compressors operating at

the border of their surge lines, require proprietary controllers. Measuring a compressor's behavior as it approaches its surge line not only requires speed, but also advanced algorithms. This is mainly due to the nonlinearity of a compressor's performance curve for any given speed where the operating point accelerates along the curve towards the surge limit. Poor control is a major risk to the safe and reliable operation of turbomachinery. The economic consequences of non-availability of turbomachinery is large and capable support services are critical to the successful application of turbomachinery controls (TMC).

Suppliers often differ on the best way to control turbomachinery. Some advocate plant-wide controls operated by Programmable Logic Controllers (PLC) and Distributed Control Systems (DCS), while others opt for proprietary black box or software-based solutions. In any case, choosing a controller is a challenge for users because the applications are becoming more demanding as the technology races to keep up.

For years, DCSs were used primarily in continuous process operations where precise sequences of control were necessary, for example, to optimize a petroleum refinery or a pulp and paper plant. PLCs on the other hand, tended to be employed more often in discrete manufacturing, where variable control based on temperature or pressure was usually not an issue. Recently the lines have blurred. Both DCSs and PLCs are now found in turbomachinery controls applications.

End user issues often are that the energy consumed by turbomachinery is a major cost of operation in process plants and (oil) production operations. As such, today's requirements to decrease energy costs and to boost efficiency of industrial processes requires a different and advanced approach to control; one which protects turbomachinery from excessive speeds, flawless starts and stops and allow it to operate continuously while also taking into account the driven process.

Many plants have turbomachinery control hardware that is decades old as upgrading or replacing a control system is a costly investment. Traditional reasons to replace or (partial) upgrade control systems are when, the control systems are obsolete and software versions are no longer supported or when hardware

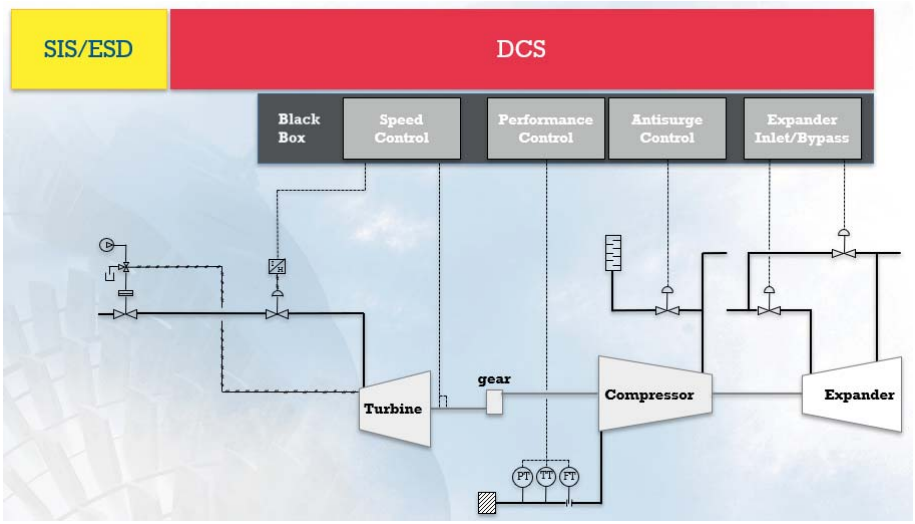

Fig. 1a *TMC separate from an Integrated Control & Safety System (ICSS), DCS and/or SIS.*

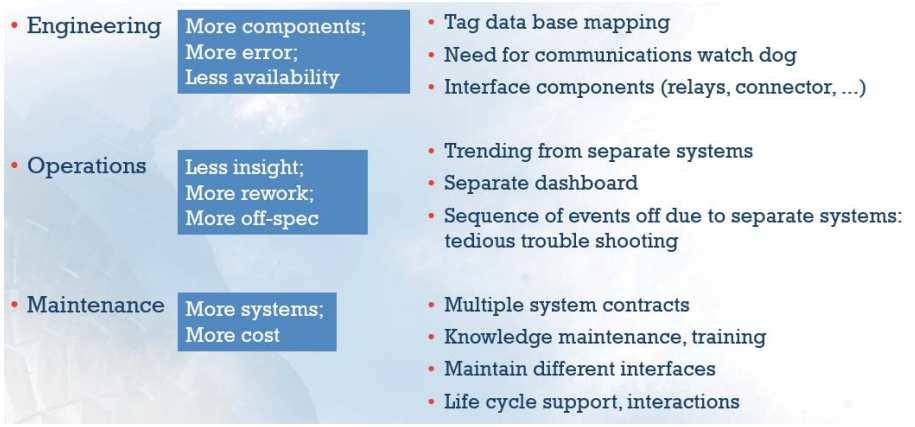

Fig. 1b *Issues when TMC is separate from ICSS, DCS or SIS.*

spare parts are no longer available. In the past these type of systems have been supplied as stand-alone Unit Control Panels (UCPs) with a data exchange interface to the plant's control and supervisory system also called Distributed Control System (DCS), Process Control System (PCS) or Process Automation System (PAS) see fig. 1a & 1b. Other benefits to lookout for when upgrading are energy efficiency, integration of all machines and sensors on one screen and remote access which allows you to view the same information from every control screen around the plant or even remotely from another location.

Plant operators need an efficient operational management system that would enable them to quickly address system upsets, and the facility needs to generate regulatory reports from historical trend data. To achieve these goals, it is important to design a system offering seamless control while providing operators with centrally located operator consoles. As with most upgrades, it is also critical to minimize downtime during system cutover and to provide the operations staff with an automation system that they can maintain with existing internal resources. The complexity of turbomachinery control and protection algorithms has not decreased with the development of appropriate programs. However, start-up, commissioning and debugging should be done by experts specializing in control, not necessarily in hardware.

The original Distributed Control System (DCS), began a revolution in industrial process control. What had previously been the realm of operators and pneumatic control systems slowly began to migrate into a microprocessor-based control chassis. The history and evolution of turbomachinery control was linked to this progression, but it also took its own course, with specialists emerging who focused solely on control, regulation and protection of turbomachinery.

Programmable Logic Control (PLC) and DCS companies are hardware specialists

that are used to addressing an entire plant control system. They are generally less expert in turbomachinery and software applications for turbomachinery, which is a small portion of the whole package. PLC and DCS type systems are often distinguished by speed. The PLC is traditionally used generally for startup and shut down activities, especially in safety applications because of the faster response. Dedicated turbomachinery controllers, designed as a unified hardware and software package to address the specific needs of a given turbine or compressor. Most dedicated turbomachinery controllers are expensive and tie the user to the vendor for service. At end of life, the user then has to buy another black box using proprietary hardware.
Turbomachinery controls development is done by two types of providers: Turbomachinery Original Equipment Manufacturers (OEMs) and independent industrial control and automation companies. OEMs offer turn-key solutions that includes turbine and compressor anti-surge control. However, OEMs often are not concerned with protection or control of the entire process. Independent solution providers are specialized in turbomachinery control and protection as well as the process technology with custom designed controllers.
Processes vary and require control solutions tailored to meet specific requirements. An open platform is the best match for a turbomachinery controller. Independent TMC solution specialists offer software-based applications, designed as custom function blocks that contain proprietary algorithms, and are implemented on any hardware platform capable of handling fast processes.
The (end) user will be able to select both DCS suppliers and various turbomachinery applications suppliers. DCSs will not capture the entire market of turbomachinery control. But technological trends and end users who have become increasingly sensitive to costs and black box/PLC solutions will be more inclined to standard DCS solutions and this trend will progress just as rapidly as the development of the technologies themselves. Competition of algorithmic and software solutions, both in terms of control quality, completeness and depth will only intensify. Turbomachinery controls can be deployed and integrated on renowned DCS platforms for example ABB,

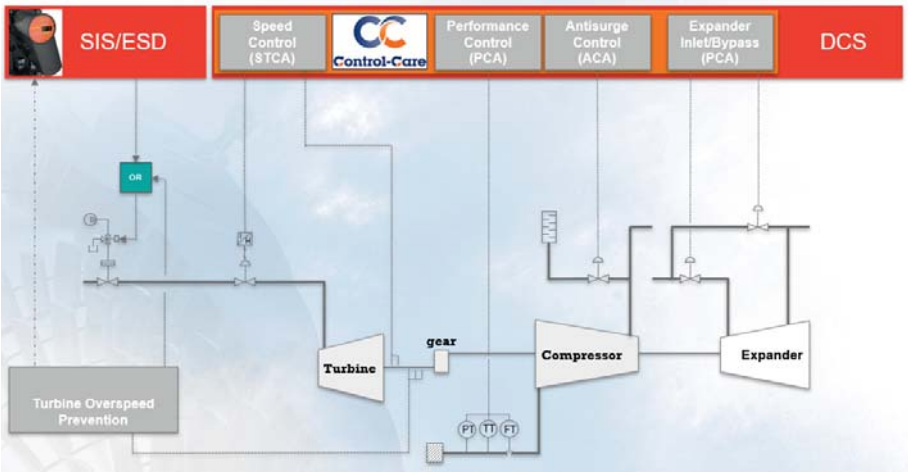

Fig. 2a *TMC implemented in an Integrated Control & Safety System (ICSS), DCS and/or SIS.*

Fig. 2b *TMC included in ICSS, DCS and/or SIS; benefits of integration.*

Honeywell, Emerson, Valmet, Yokogawa and others.
TMC included in DCS/BOP (Balance of Plant) Integration benefits engineering in terms of less error and better availability (smaller footprint, integrated tag data base, no interface footprints), operations (trending from one system, integrated dashboard, integration on the screen) and maintenance (single system service contract, knowledge, training-focus on one stem, no interfaces and consistent and future proof life cycle support) see Fig. 2a & 2b.
Other advantages of TMC system integration to DCS are improved obsolescence management and life cycle management, cyber security (less points of entry for cyber-attacks), reduced number of investments and nonetheless the Total Cost of Ownership (TCO) is lower than the 3rd party vendor / black box solution.

About Control-Care

Control-Care is a global turbomachinery control solution & independent engineering services provider, based in Amsterdam, the Netherlands with experienced turbomachinery controls and software engineers. Main focus of the company is turbomachinery controls and instrumentation systems, machine protection systems, machine monitoring systems.
Control-Care, specialized in industrial turbomachinery control challenges has implemented and integrated its turbomachinery controls suite of applications at several plants globally. Integration of turbomachinery with process controls has many benefits: It increases the reliability of end user's machinery and process, prevention of unnecessary process trips and downtime, surge, overspeed, minimizes process disturbances and associated damage.
Control-Care has completed more than 220 unique projects globally for end users and OEMs since 2008 and acts as a Consultant, Solution Provider and Service Provider for virtually any kind of turbomachinery challenge!
info@control-care.com, www.control-care.com