SPARTAN CONTROLS

Experience Industrial Innovation

Process Solutions

Focused on delivering **effective, sustainable advanced solutions** by adhering to three key tenets: combining process & technical expertise, foundation focus, & sustainability by design.

PROCESS SOLUTIONS

For more than 20 years, the Spartan Controls' Process Solutions team has been helping customers leverage advanced process automation tools to optimize their process.

With a team of 20 industry-tested process control professionals, including several at the PhD, Masters and Bachelors level, the Process Solutions team provides highly-specialized skill sets focused on improving operational performance through five main categories of services: Control Loop Tuning, Process Optimization, Procedure Automation, Alarm Management, and Operator Training Systems.

In order to accommodate a wide range of customer needs, timelines and budgets, the Process Solutions team has developed a tiered set of offerings under these categories, as outlined below.

The Process Solutions team is dedicated to delivering sustainable high-value solutions to Spartan customers.

	STUDY	PROJECT	PROGRAM
CONTROL LOOP TUNING	• Regulatory control loop health assessment	• On-demand application tuning • Top-50 loop audit	• Embedded control tuning expert • Top-50 loop program
PROCESS OPTIMIZATION	• Advanced process control opportunity audit • Expert process optimization assessment • Energy efficiency studies	• SpartanPRO™/ SmartProcess™ advanced control • Custom APC application	• Embedded site-wide optimization services • Advanced control sustainability program
PROCEDURE AUTOMATION		• Sequence-based procedure automation • State-based control	• Embedded procedure automation services • Procedure automation sustainability program
ALARM MANAGEMENT	• Alarm management assessment	• Alarm philosophy development/refresh • Alarm management training • Bad actor Management • Alarm Rationalization	• Alarm rationalization continuous improvement program
OPERATOR TRAINING SYSTEM		• OTS Philosophy • OTS Functional Design Specification • OTS and dynamic simulation	• OTS-DCS continuous alignment program

By working cohesively and collaboratively with customers, they have delivered over **$700 million in realized customer benefits** over the past decade.

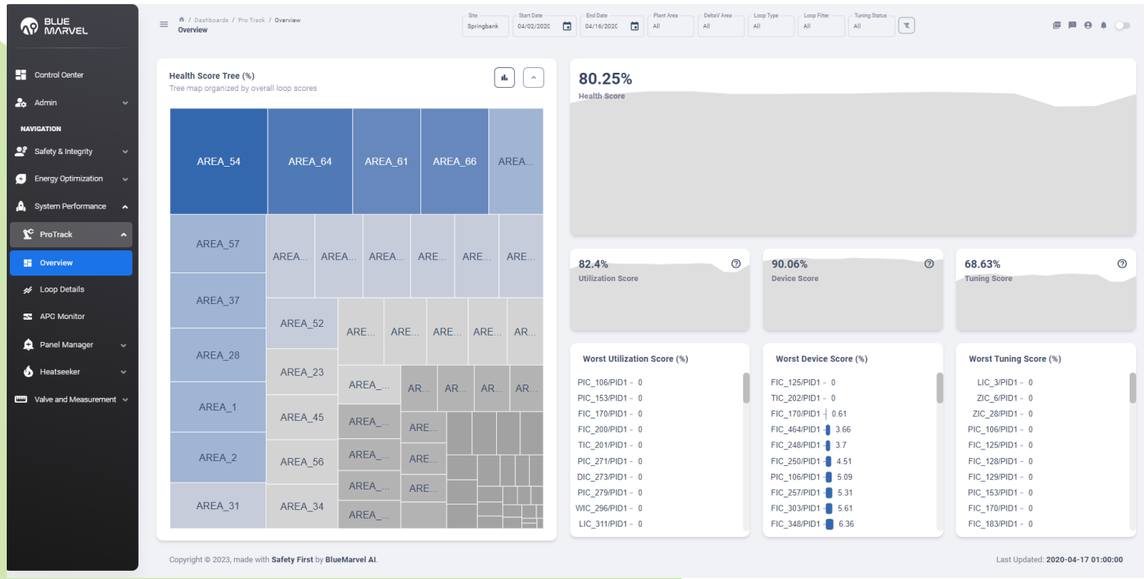
CONTROL LOOP TUNING

STABILITY OF OPERATIONS

The stability of operations can have a profound impact on efficiency, reliability, throughput capacity, and safety. By ensuring that control loops are tuned to be responsive and stable, operators can quickly achieve and maintain operation at ideal design conditions. On the other hand, unstable control loops add unnecessary risk and force operators to run conservatively and less profitably with a greater level of manual intervention. Unfortunately, control loop tuning is often overlooked in favour of immediate concerns and left neglected. Unless the loop is extremely critical, operators will often leave poorly-tuned control loops in a manual state. In some instances, the expertise to effectively tune control loops may not be available on site.

Spartan Controls' Process Solutions team specializes in process control applications, including maintenance of regulatory control loops. In order to serve a wide range of customer requirements, the Process Solutions team can provide a variety of control loop services, including:

- On-demand regulatory loop tuning of critical applications
- On-demand regulatory control strategy (re)design
- Regulatory control loop health assessments and prioritization
- "Top 50" control loop program to strategically maintain high performance on the most important loops
- Embedded control specialist to support instrumentation and operations by prioritizing, tuning, documenting, and/or designing a high-performance regulatory control network



STUDY - Regulatory Control Loop Health Assessment
Typical Duration: 1 Week

A broad survey of area- or plant-wide regulatory loop health. This brief study highlights high- priority design and tuning issues and lays out a plan for improving overall regulatory control health.

PROJECT – On-Demand Application Tuning
Typical Duration: 1 Day – 2 Weeks

A highly-focused project that provides expert tuning service to a high-value piece of equipment or process. The scope of this work is highly flexible and may include strategy modification and redesign, if desired. Ideal for re-tuning a specific problematic area.

PROJECT – Top-50 Loop Audit
Typical Duration: 2-3 Months

A one-time project for an entire site or large process area that strategically prioritizes control loops in terms of current performance and net impact on overall operation, and re-tuning those loops to achieve a meaningful improvement in overall plant stability.

PROGRAM – Embedded Control Tuning Expert
Typical Duration: Any

Embedded site services from a specialized control tuning expert to work side-by-side with operations, instrumentation, and engineering personnel to provide well-documented continuous improvement to overall plant stability through regulatory control loop tuning, strategy design, and sequence automation.

PROGRAM – Top-50 Loop Audit
Typical Duration: Any

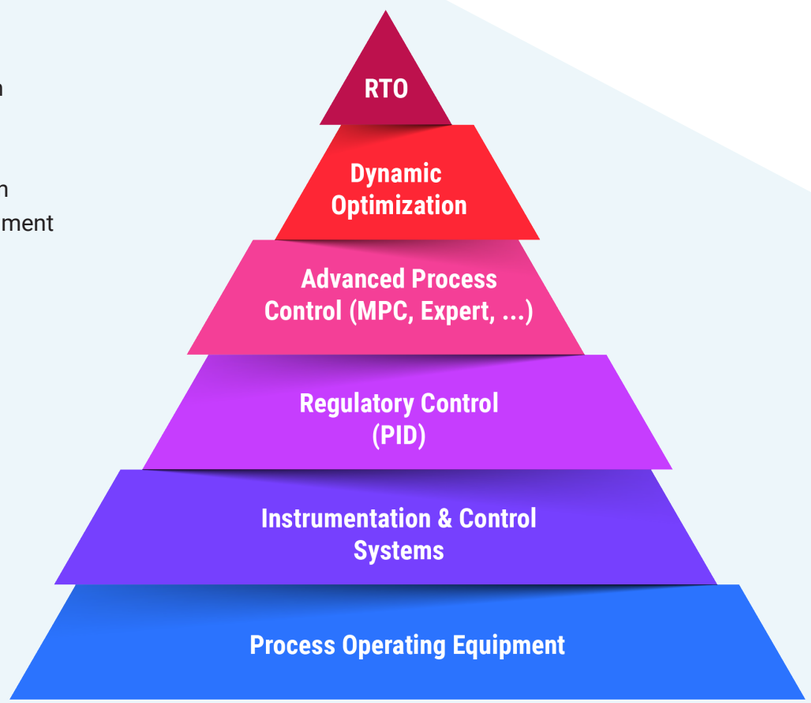
A continuous improvement program that begins with a Top-50 loop audit project. Following completion of the initial audit improvements, the program includes regular refinement, tracking and tuning of a Top-50 database.

PROCESS OPTIMIZATION

Modern operational technology (OT) systems are capable of performing advanced operational functions such as real-time optimization and multivariable process control. These advanced features can bring substantial benefits to stability, reliability, and profitability of operations, but require expertise to use. Therefore, most industrial facilities do not leverage these high-value tools, and the OT system simply serves as a digital interface between operators and the process.

For more than 20 years, Spartan Controls Process Solutions team has focused on building industry-specific expertise in the application of advanced process control and real-time optimization. Additionally, Spartan can leverage Emerson's team of process control professionals to augment in-house capabilities for specialized applications, providing further experienced resources to our customers. By continuously optimizing challenging and complex processes in real-time, the Spartan/ Emerson team has helped customers realize proven benefits that include:

- Improved product quality
- Improved energy efficiency
- Reduced chemical consumption
- Improved process stability
- Reduced risk of trip/failure
- Greater consistency of operation
- Reduced risk to safety & environment



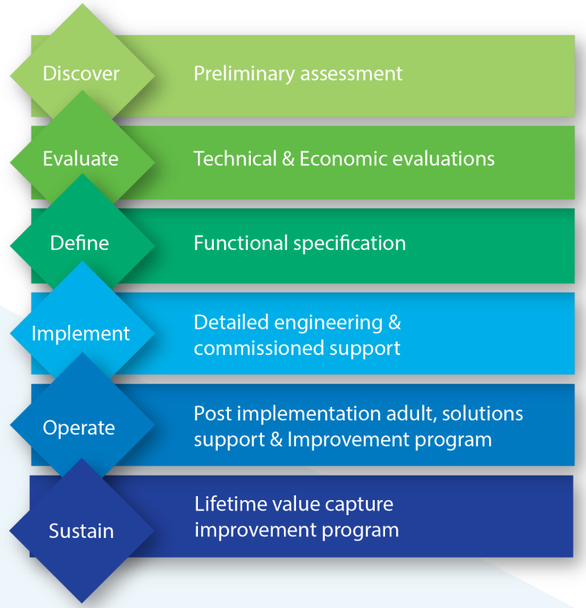
Spartan Process Solutions proven process control hierarchy model

Spartan's approach to process optimization is focused on achieving meaningful and sustainable results to improve operational performance by adhering to three key tenets:

- Process and technical expertise – all solutions are designed by experienced industry controls specialists that understand the process operational requirements and objectives
- Focus on the foundation – solutions are not simply dropped on top of existing controls; implementation includes a thorough review of the foundational instrumentation, regulatory controls, control system, and process
- Sustainability by design – solutions are sustained by tracking performance benefits, effectivelytraining & documenting, empowering site personnel to understand and perform basic troubleshooting, and providing local support

Spartan has developed optimization applications that cover a wide range of Western Canadian industries including oil sands (in-situ), oil and gas, pulp and paper, mining, potash, water and wastewater treatment, chemical, and refining. Spartan also specializes in the development customized applications that address unique challenges for individual operating facilities. All of Spartan's solutions are designed to be deployed within a DeltaV™ DCS, but can also be deployed in AspenTech™'s powerful advanced automation software suite for non-DeltaV™ sites.

For customers who are unsure of which applications are most beneficial to them, or who are simply curious about how advanced controls can help their operations, Spartan provides a structured opportunity mapping process. This consultative short-term study is conducted by an industry-specific advanced control specialist.



Spartan Process Solutions implementation methodology

Studies

STUDY – Advanced Control Opportunity Audit
Typical Duration: 2 Weeks/1-2 Months

A plant or area-wide study to identify and prioritize opportunities for advanced process control and optimization, including calculated paybacks. Tiered offerings available based on level of detail desired.

STUDY – Expert Process Optimization Assessment
Typical Duration: 2-4 Weeks

A study on the control and operation of a specific application or process by an experienced process expert, with a focus on control strategy design and optimal operating practices. Not available for all processes.

STUDY – Energy Efficiency Study
Typical Duration: 1-2 Months

A study of energy-saving and/or emission-reducing opportunities across an entire plant or large process area. Findings include a list of opportunities along with estimated cost and savings potential.

Projects

PROJECT – SpartanPRO™/SmartProcess™ Advanced Control
Typical Duration: 2-6 Months

A well-tested, established advanced process control solution for a high-value industry process. Includes strategy customization based on site-specific requirements, configuration, testing, graphic modifications, commissioning, training and documentation. Open, unlocked configuration in DeltaV™ DCS.

PROJECT – Customized Advanced Control Applications
Typical Duration: 2-6 Months

Advanced control solution design, configuration, testing, graphic modifications, commissioning, training and documentation for a customized high-value application using DeltaV™ DCS APC tools and techniques.

Programs

PROGRAM – Embedded Site-Wide Optimization Services
Typical Duration: Any

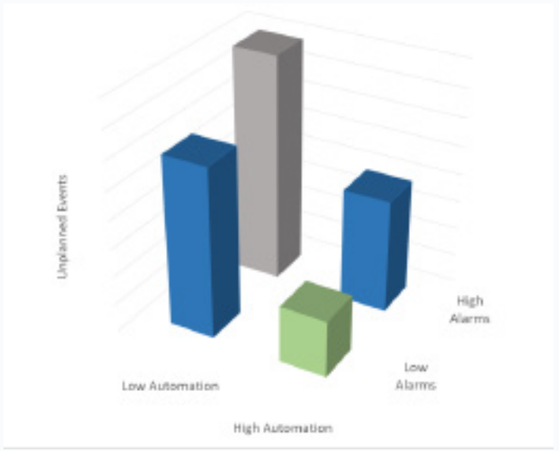
Embedded site services from a specialized advanced control expert to work side-by-side with operations, instrumentation, and engineering personnel on the development, commissioning, and long-term sustainability of advanced process control applications.

PROGRAM – Advanced Control Sustainability Program
Typical Duration: Any

A program for existing advanced control applications to maximize lifespan and provide continuous improvement with a cost-effective combination of on-site maintenance and remote monitoring services.

PROCEDURE AUTOMATION

Operator error accounts for 42% of the unscheduled plant shutdowns (O'Brien, 2010) with the average dollar loss per major incident at over $80 million USD (J. H. Marsh & McLennan, 2010). This is expected to get worse with retirement of the aging but experienced workforce; and along with the arrival of younger and more mobile workers, this will lead to skill/knowledege gaps in the workforce placing a large burden and expense for training. With companies under the constant pressure to reduce operating costs, more board operators will be demanded to run the process safely and efficiently with larger spans of control.

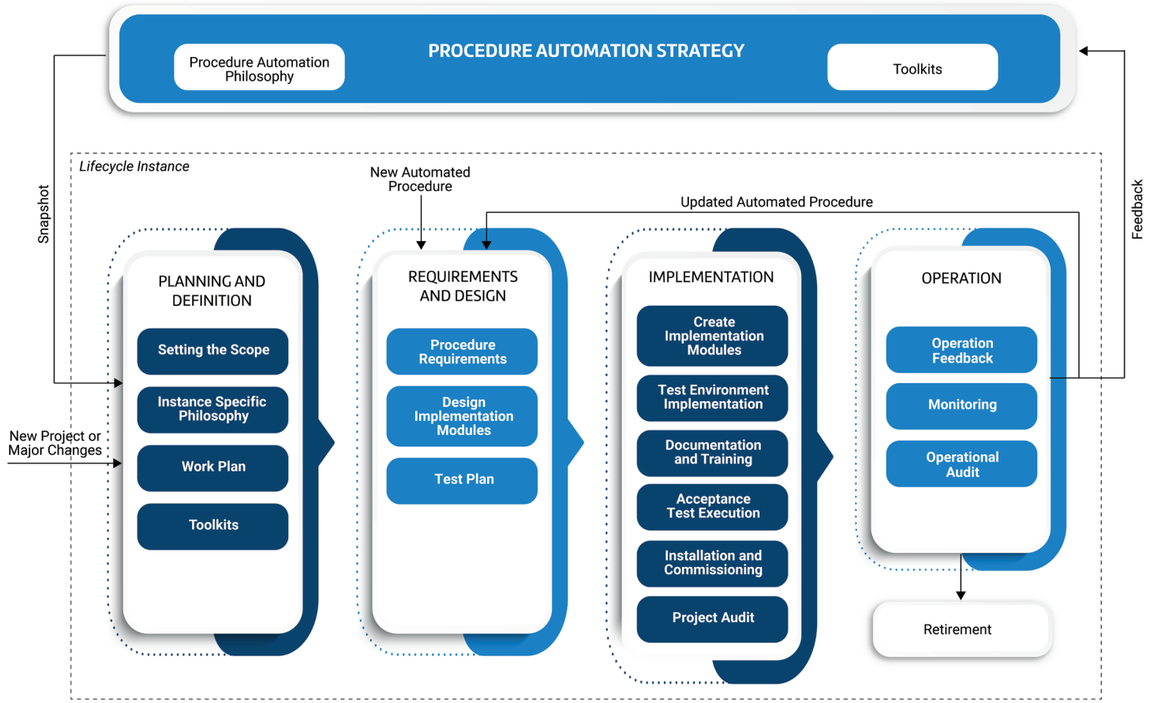


In order to reduce human error, improve operational efficiency, and ensure consistent execution of critical tasks, operators will need to transform from "valve turners" to "process managers". Capturing the knowledge through procedure automation gives a means of retaining the built-up operating expertise of startup, normal run conditions, shutdown and abnormal conditions. The process of developing procedure automation naturally leads into alarm justification and operator responses to those alarms. High level of automation and low alarms has shown to lead to a reduction in unplanned events.

Industrial Procedure Automation refers to embedding operating procedures in digital operations platforms, like the DCS, to guide operators through the execution of sequential tasks or procedures. Procedures for continuous process operations include situations of startup, shutdown, abnormal situations, hold steps, and transitions of process feed/output. These procedures might exist in manual form, probably written prior to automation, and can range from equipment control to enterprise level control. ISA-106 standard on procedure automation for continuous process operations defines models, styles, strategies, philosophies, and the lifecycle for automation of procedures in the continuous process industries.

Spartan Controls' Process Solutions group has years of field experience designing, programming, and commissioning effective Procedure Automation solutions in the DeltaV DCS based on ISA-106 guidelines. Our process isn't just designed to code procedures efficiently; it focuses on ensuring that the end result is intuitive, delivers payback on investment, and meets all of the needs of operations. Several key deliverables from a SpartanPRO™ Procedure Automation solution include:

- Thorough review and alignment with operations teams to document current process modes
- Functional specification document of the operating procedure in the various process modes and how to transition safely and efficiently between those modes
- Flexibility for manual, semi-automated, or fully automated tasks
- A standard "Command-Perform-Verify" process for execution of each task within a procedure
- Efficient DeltaV programming to facilitate easy updates and troubleshooting
- Intuitive, modern DeltaV Operate/Live user interface based on ISA-101 best practices and site standards
- Dynamic state-based alarming for easy exception catching
- Simulation for function testing and operator training



ISA 106 Lifecycle

ALARM MANAGEMENT

Poorly designed alarm systems are common in the process industry and can add significant costs for an operating facility. These costs are usually hidden under inefficiencies and operator frustrations, but they can impose serious financial, environmental, and safety implications if critical alarms get overlooked during process upsets. An investment in a sound alarm management system is an effective risk mitigation tool and a key step toward safe operations.

With the modernization of control systems, the addition and communication of process alarms has become easy. In a genuine effort to protect against unsafe conditions, the default alarm strategy has shifted toward alarming for every possible undesirable scenario. As a consequence, operators are overwhelmed with nuisance alarms that they cannot act on, already know about, or that have no impact based on current operation. Once alarms become a nuisance rather than a tool to support operators, they gradually become ignored. Major consequences can arise when critical alarms are hidden within the flood of overlooked alarms.

As a result of this growing problem, multiple guidelines regarding alarm rates and frequency have been developed. However, the majority of industrial facilities have alarm rates that are significantly higher than these recommended levels.

	Oil & Gas	PetroChem	Power	Other	Best Practice	Standard
Average Alarms/ day	1200	1500	2000	900	~150-300	~150-300
Average alarms per 10 Minute Interval	6	9	8	5	~1-2	~1-2
Peak alarms per 10 Minutes	220	180	350	180	≤10	≤10
Average Standing Alarms	50	100	65	35	<10	<5
Distribution % (low/medium/ high)	25/40/35	25/40/35	25/40/35	25/40/35	80/15/5	80/15/5

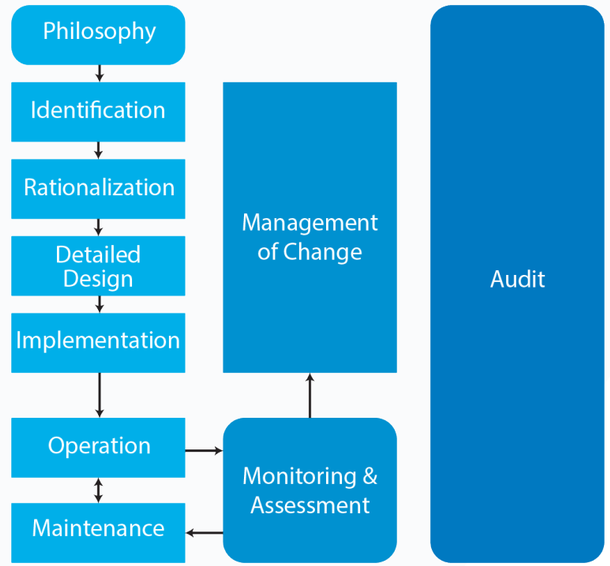
Source - I. Izadi, S.L. Shah, D.S. Shook, and T. Chen "An introduction to alarm analysis and design", Proceedings of the 7th IFAC SAFEPROCESS, pp. 645-650, Barcelona, Spain, 2009

Creation of an alarm philosophy document, based on ISA 18.2 or IEC 62682, is the cornerstone for development and sustainability of an effective alarm management program. The alarm philosophy document establishes the standards for how to address all aspects of alarm management — including design, operations, maintenance, testing, training and management of change. It also documents the rules that will be used for alarm rationalization.

Once an alarm philosophy is defined, an alarm rationalization program can begin to work toward compliance with established industry best practices. This is a rigorous process that:

- Prioritizes alarms based on consequence of inaction and urgency of response
- Refines appropriate alarm limits
- Minimizes alarm flooding causes such as redundant, chattering and unactionable alarms
- Couples alarms based on first-outs to prevent overloading
- Implements sustainable practices around alarm shelving and suppression
- Reviews operator graphic visualization of alarming
- Establishes criteria for future alarm addition
- Tracks performance and benchmarks against industry standards

By properly rationalizing alarms, they can once again become a useful and reliable tool for process operators. Significant cost savings from shutdown prevention can be quickly realized by having alarms that accurately highlight situations requiring immediate attention to prevent lost production, equipment damage, or worse.



ANSI/ISA 18.2-2016 Standard

Studies

STUDY – Alarm Management Assessment
Typical Duration: 1-4 Weeks

A plant or area-wide benchmarking study to assess current state of alarming against industry standards, and to identify the biggest potential opportunities for quick improvement.

STUDY – Alarm Philosophy and Training Workshop
Typical Duration: ?

The workshop covers the design principles of alarm management and the requirements/recommendations of the ISA-18.2 standard. The intent is to create a common understanding across the team to support the development of the site-specific alarm philosophy document.

Project

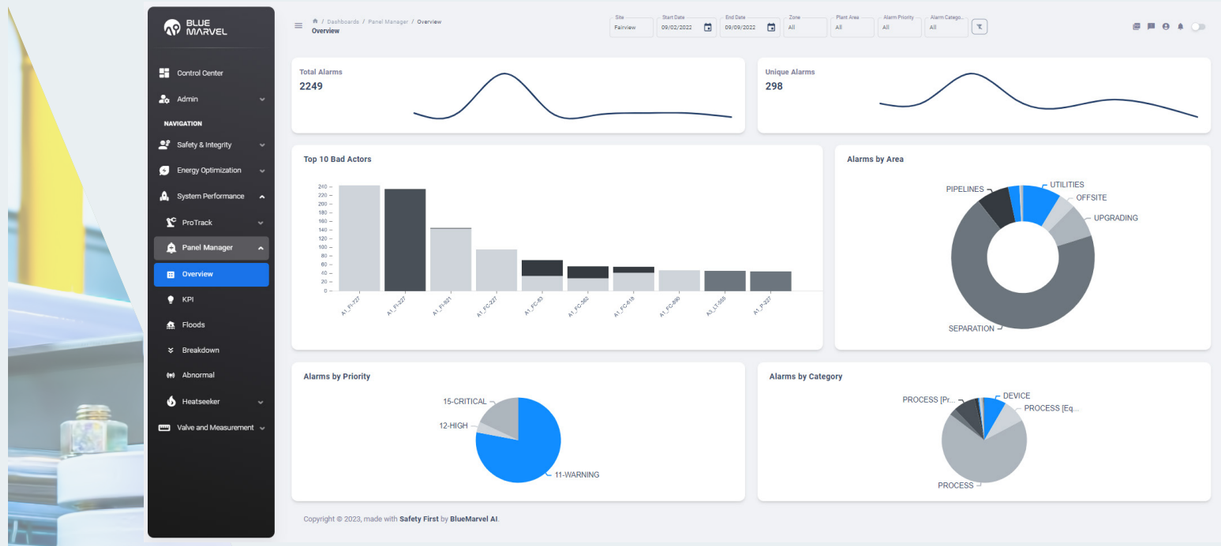
PROJECT – Alarm Management Blitz
Typical Duration: 3-6 Months

A prioritized project to strategically reduce operator alarm frequency. Project methodology uses proven tools and techniques to prioritize alerts and achieve the biggest impact over a short period, bringing site operations in line with or significantly closer to industry benchmarks. Implementation methodologies focus on sustainable solutions centered around site safety priorities.

Program

PROGRAM – Alarm Rationalization Continuous Improvement Program Typical
Duration: Any

Embedded or remote services from an alarm management specialist to work side-by-side with operations and provide continuous rationalization of process alarms following industry best practices. Typically preceded by an Alarm Management Blitz project.



DATA ANALYTICS

Spartan Controls' data scientists and engineers have focused on applying the latest technologies in the realm of data science to process industry problems and challenges. We combine our process knowledge, engineering backgrounds and process control expertise, with modern data science tools like reinforcement and deep learning, to uncover process optimization, process and equipment reliability, and safety opportunities.

OPERATOR TRAINING SYSTEM

The ability of an operator to respond to critical but infrequent events can have profound implications on production, the environment, process equipment, and most importantly, worker safety. These rare scenarios are difficult to prepare for; it takes years of experience to gain the confidence to respond properly in a timely manner. Classroom training and paper manuals are poor substitutes for hands-on experience during a high-stress situation. The lack of preparation of new operators is a major risk to overall plant profitability, reliability, and safety.

Dynamic simulation is a proven technology used to reduce risk and improve plant profitability by providing a safe and efficient environment to train new and veteran operators alike. Using this technology, a new operator can be quickly trained to veteran levels on critical high-pressure scenarios that occur once per year, in a matter of days with no risk to the live process. In addition to providing a reliable platform for operator training, simulation systems have numerous other benefits that include:

- Testing of new processes, technologies, control strategies, and graphics
- Expedited start-up commissioning
- Operator training ahead of new process startup, shortening schedules and decreasing costs
- Design and comparison of potential process or system enhancements with minimal investment or risk to production
- Easily facilitating knowledge transfer from senior to junior operators
- Providing a platform for operator qualification programs

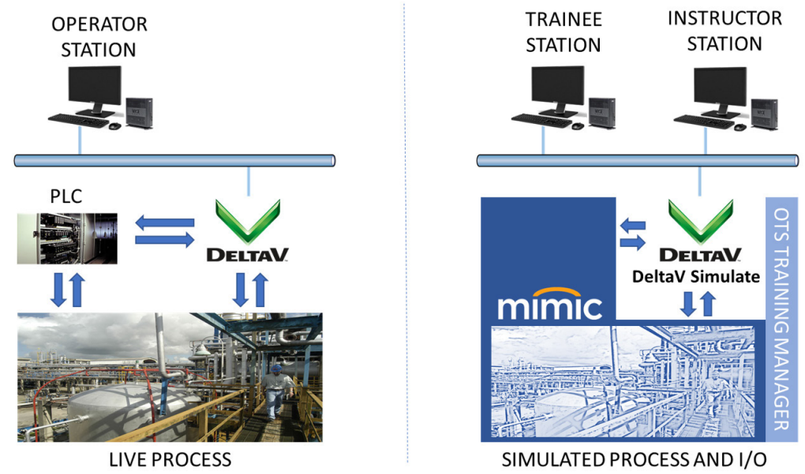
Spartan's approach to dynamic simulation is to create a virtual plant that replicates both the operator experience and process response of a live system. Emerson's MiMiC™ dynamic simulation software is used to simulate the process, measurement, and actuation of the live system. At the same time, a DeltaV™ Simulate virtual control system (or other DCS vendor's simulated control system software) provides an exact replication of the real control system including graphics, configuration, and alarms, which can be updated from a quick and easy export from the live DeltaV™ graphics library and configuration database. This allows for testing and training on the actual control strategies used to run the plant while minimizing simulation system maintenance.

The MiMiC™ Dynamic Process Simulation is fully integrated with the DeltaV™ Virtual Control system, and provides real-time IO and model updates so that the Virtual Control System thinks it is working with the real process.

Some of the key features include:

- Easy setup - bulk entry of Simulated I/O (SIO) definition
- Advanced modeling objects for common process equipment
- Thermodynamic property database for 1,700 compounds
- Advanced modeling execution faster than 1 sec
- MiMiC Train's Operator Training Software includes scenarios, process snapshot restoration, adjustable dynamics, and advanced failure behaviours

MiMiC™ dynamic process simulation can also be integrated with non-DeltaV™ systems with no loss of features or functionality.



Emerson OTS system setup model

The Emerson approach of “selective” fidelity to meet customer requirements, is a key competitive advantage.

mimic Capabilities	Process Model Fidelity: Tiebacks	Low	Dynamic Core	High
Static Values for Uncontrolled I/O	✓	✓	✓	✓
Directionally Correct Process Response for Loop I/O	✓	✓	✓	✓
Directionally Correct Process Response for Dynamic I/O		✓	✓	✓
Simple I/O Interactions		✓	✓	✓
Material and Energy Balance			✓	✓
Pressure-Flow Network			✓	✓
Equipment Modeled per Plant Design Specifications			✓	✓
First-Principles Based Process Interactions			✓	✓
Component, Phase, and Size Tracking				✓
Vapor-Liquid Equilibrium				✓
Reaction Kinetics				✓
Realistic Transitions over Full Operating Range				✓

Project

PROJECT – OTS and Dynamic Simulation
Typical Duration: 4-12 Months

A well-tested, established advanced process control solution for a high-value industry process. Includes OTS Philosophy development (optional), system design with strategy customization based on site-specific requirements, configuration, testing, graphic modifications, commissioning, training and documentation. Open, unlocked configuration in DeltaV™ DCS.

Program

PROGRAM – OTS-DCS Continuous Alignment Program
Typical Duration: Any

Refresh service provides expert assessment and alignment services to maintain the relevancy of the OTS system year over year. Our simulation specialists will first assess the current status of the system and then provide a core set of updates to bring the system to a functioning state.

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