Nexus Controls
a Baker Hughes business

The power of simplification in Safety and Distributed Control Systems (DCS)

Intelligent control that drives productivity, automation and protection

“Genius is making complex ideas simple, not making simple ideas complex.”

— Albert Einstein

Executive summary

Mastery is achieved when we can make the complex simple. It is harnessing the sophistication of innovative design and groundbreaking capabilities in simple, intuitive, easy-to-use ways. In the case of next generation Distributed Control Systems (DCS) and Safety Systems, the tremendous power of simplification is bringing intelligent control to high stakes manufacturing and production environments. Used together, DCS and Safety Systems are helping to boost safety, improve productivity and increase reliability, thus paving the way for 4IR (fourth industrial revolution) competencies. Said another way: DCS and Safety Systems are mitigating the looming risks and devastating costs (see specifics on page 3) of unplanned downtime.

Unplanned downtime is the bane of all business operations. In continuous process production, it carries very steep costs, can compromise safety and will often spur escalating delays and disruptions throughout the entire business operation. When unplanned downtime occurs, the challenges of returning to normal operations are magnified by reactive urgency together with a dearth of operational information and insight and easy access to application logic. These challenges can further heighten risks and related costs – such as operational, regulatory, financial, environmental impact, and safety – and they do so unnecessarily.

The opposite of unplanned downtime, however, is not simply uptime – it is intelligent uptime. Next generation Distributed Control Systems (DCS) and Safety Systems help to automate control, collect data, analyze that data into actionable insights and provide quick access to customizable application logic with intuitive user interfaces. In the case of unplanned downtime, the ability to make critical, data-driven decisions enables accuracy and speed in returning to normal operations.

Next generation DCS and Safety Systems are transforming industrial manufacturing and preparing it for 4IR. Smart business operations properly mitigate the production, regulatory, financial and safety risks that can quickly escalate and stem from unplanned downtime. Read more to learn how industry-leading manufacturers do this through adoption of next generation DCS and Safety systems – to protect people, the environment and optimize productivity all while sustaining profits.

1. The unvarnished truth about unplanned downtime

"Being effective is about doing the right things, while being efficient is about doing things right."

— Insightsquared

Efficiency does not equal effectiveness. In the area of cost savings – a key tenet in business operations that helps to maximize productivity and profitability – it's ironic that avoiding some costs you may actually incur even more financial burden. Nothing demonstrates this as persuasively as unplanned downtime.

Vulnerabilities introduced by unplanned downtime span functional areas, such as operations (including health/safety/environment, quality, productivity, plant management), finance, legal, and marketing. As a result, vulnerabilities that can cause unplanned downtime can skyrocket in magnitude over a very short period of time, initiating a domino effect of consequences that can escalate far and wide. This elevates the inherent risks of a single unplanned downtime event, making it potentially catastrophic to business operations.

How costly is unplanned downtime?

While estimating the true cost of unplanned downtime varies greatly as it is tricky to accurately assess, one universal truth is pervasive: The costs of unplanned downtime are extraordinarily high, and the consequences often irreversible. As such, unplanned downtime is the bane of every business operation.

"Unplanned downtime is the bane of every business operation."

On average, in industrial production and manufacturing environments, unplanned downtime costs $260,000 per hour, spiking higher in the automotive industry where estimates range between $1.3 million and $3 million an hour. One contributing factor is that unplanned maintenance costs 2-5 times more than planned maintenance. These staggering estimates make each and every second count.

Unplanned downtime, however, impacts multiple business operations areas simultaneously with the potential for long-term, chain-reaction consequences. Complications such as these also exacerbate the accurate assessment of precise financial impacts of unplanned downtime. For example, in a recent survey, 82% of companies experienced unplanned downtime event with each event's estimated cost at $2 million. The financial impacts of unplanned downtime are comprised of tangible costs, intangible costs and higher order factors that may emerge slowly after the unplanned downtime event.

Cost components of unplanned downtime

The cost components of unplanned downtime are bucketed into three categories and described briefly below, illustrating the challenges of pinpointing precise costs.

Unplanned downtime

Tangible costs include:	
Category	**Examples**
Lost revenue	Halting production of goods means less to sell
Unexpected costs	Engineering complications, regulatory penalties, and fines
Fixed costs	Labor and factory overhead
Lost productivity	Increased cost per unit (fixed + variable costs, lost capacity)
Equipment repair/ replacement + recovery	Unplanned maintenance is 2-5X planned maintenance costs

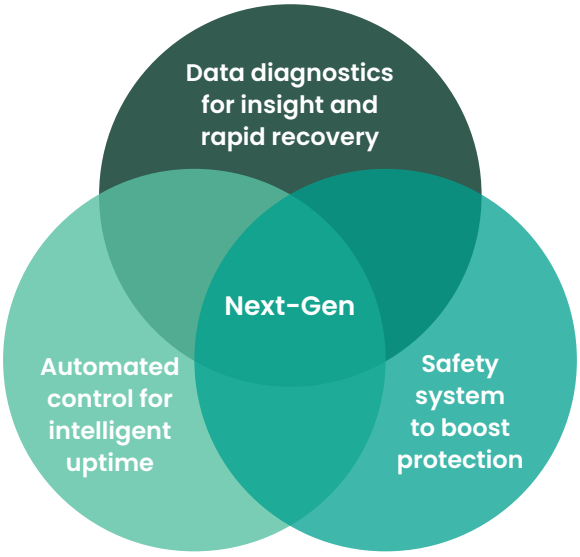
Intangible costs include:	
Category	**Examples**
Brand damage	Negative experiences linger, damaging brand
Customer experience	Less focus on customer support + missed promises
Industry exclusions	Regulatory issues + supply chain interdependence
Legal ramifications	Prison sentences for Executives

Higher order costs:	
Category	**Examples**
Human safety	Injuries to personnel, staff, public, communities
Environmental impact	Emissions, leaks, catastrophic events
Damage to facilities, plants	Impact on equipment, plants, catastrophic events

2. The opposite of unplanned downtime

When unplanned downtime does occur, the challenges of returning to normal operations are magnified by reactive urgency paired with a dearth of operational information and insights, and ready access to application logic. As a result, risks can heighten even more, such as vulnerabilities in operational, regulatory, financial, environmental impact, and safety — and they do so unnecessarily.

To effectively counter the risks of unplanned downtime and enable rapid recovery, three manufacturing capabilities are essential:



As business operations journey from Reactive > Predictive > Proactive processes, the opposite of unplanned downtime is not simply uptime. Rather, it is "intelligent uptime" or smart manufacturing that connects, diagnoses and alerts of issues before they can become failures or higher-order events. Today, the three competencies – automated control, data diagnostics, safety system – are essential, providing proactive, automated protection and smart manufacturing to enable safer operations, increased reliability, rapid recovery and maximized uptime. As industrial production and manufacturing enters the fourth industrial revolution (4IR), these competencies will become an increasingly vital foundational prerequisite or "minimum requirement for entry" across various production & manufacturing operations, and enterprises.

"The opposite of unplanned downtime is not simply uptime – it is intelligent uptime."

At AL-BAHA Company for Caustic Chlorine Industries, the control system was designed as the central hub of operations – akin to the brains of an operation or central nervous system. Their previously used legacy control system had become obsolete, expensive to maintain, a security concern, and overly complex to use. By updating to a next generation DCS solution that overcame these deficiencies and provided additional capabilities, AL-BAHA was able to achieve rapid operational improvements with impressive results such as:

Up to

60%

reduction in after-hours engineering call-outs > **this can be expensive, similar to double time pay**

Up to

85K

cost avoidance over 3 years of support services > **a cost factor typically overlooked**

Up to

66%

fewer spare parts required to have on-hand > **a significant cost burden, often overlooked**

3. An antidote to unplanned downtime

So, what are leading industrial operations organizations doing to achieve intelligent uptime today and simultaneously prepare for 4IR? It is next generation distributed control systems (DCS) and automated safety systems, the nexus of all operations, which are answering this need.

Distributed Control Systems (DCS)

As evidenced by the AL-BAHA Company example and results, DCS's are industrial manufacturing and operations game-changers, making companies better able to compete while protecting profitability. Distributed control systems leverage multiple controllers – or nodes – throughout an operation that integrates their data together via a software platform. This builds in redundancy and reliability by mitigating the vulnerabilities of a single point of failure. While control functions are localized in close proximity to the processing facility and its' control room, the DCS also provides centralized, remote management and monitoring capabilities for maximum operational visibility, data-driven decision making, and application logic changes.

Comprehensive DCS platforms integrate a host of capabilities, including hardware, software and services into one complete solution. Features such as distributed control and monitoring, control logic, operator interface (HMI), a data historian, process simulation, and diagnostics for trends & reporting, and alarm management – comprise a complete and total solution for robust management, control, and protection.

Safety Systems

Continuous process manufacturing and production environments, which are inherently higher risk operations, require advanced reliability and security measures, making them ideal DCS applications. Because safety is also an elevated priority in continuous process operations, DCS's complementary ally is an automated Safety System. These programmable electronic safety systems provide industrial protection with capabilities such as emergency trip systems, emergency shut down devices, as well as, compressor and burner management protection systems. Safety systems must be customized to a plant's unique equipment and configuration to effectively prevent and mitigate unsafe events – which can lead to enormously catastrophic consequences if left unprotected.

The International Electrotechnical Commission (IEC) has published an international safety standard, IEC 61508, applicable across industry types. The basic premise of IEC 61508 is that safety systems must operate properly or predictably fail in a safe manner. The Safety Integrity Level (SIL) indicates the reliability of safety system functions or probability to fail on-demand as shown in the table below.

Safety Integrity Level (SIL)	Probability of Failure on Demand (PFD avg)	Target Risk Reduction (RRF)
4	$\geq 10^{-5}$ to $< 10^{-4}$	> 10,000 to ≤ 100,000
3	$\geq 10^{-4}$ to $< 10^{-3}$	> 1,000 to ≤ 10,000
2	$\geq 10^{-3}$ to $< 10^{-2}$	> 100 to ≤ 1,000
1	$\geq 10^{-2}$ to $< 10^{-1}$	> 10 to ≤ 100

When it comes to process control and safety, the stakes can be extremely high. Safeguarding personnel, the environment and equipment, as well as, operations, reliability and profitability are critically important requirements. The role of domain knowledge, proven experience and service expertise in DCS and Safety Systems is crucial to properly and proactively mitigate the various levels of ever-present risks.

Tri-State Generation and Transmission Association upgraded to a next generation DCS at two locations in Brighton and Limon, Colorado. Motivating this decision were waning confidence in their controller solution, as it could be down for extended periods of time, and the older operating system for their HMI, presenting security concerns. It was time for an upgrade. Due to the intuitive, easy-to-learn nature of the new DCS interface, the Tri-State operations staff quickly came up to speed and operations became more productive rapidly. Their DCS installation was designed around:

450

I/O points distributed across 5 control system cabinets in Brighton and 4 control system cabinets in Limon

72 MW

of peak output per generator

4. Next generation DCS and safety systems

Next generation DCS and Safety Systems are manufacturing and production "game changers". Outdated legacy systems have been far surpassed with today's modern, new system designs and capabilities, providing significant upticks in reliability and results. Most notably, next generation system designs have increased in their sophistication, while simultaneously increasing in their simplicity – making them easier to use and learn while delivering enhanced performance and providing unparalleled insights for plant operations. Next generation DCS and Safety Systems, however, are not all created equal. Understanding some of the important criteria helps to differentiate between them.

Key characteristics of comprehensive next generation DCS and Safety Systems include:

- ☑ Full automation
- ☑ Simple and easy-to-learn-and-use interfaces (HMIs)
- ☑ Redundant architecture and remote monitoring together with advanced diagnostic and troubleshooting tools
- ☑ Software integration, intelligence and interfaces include a data historian for data trends and analysis
- ☑ Real-time logic changes via simplified programming
- ☑ Intuitive designs for aging workforce and workforce turnover
- ☑ Dynamic online and "hot-swap" changes to configurations

Experienced technical and support services are an oft over-looked key differentiator to successful DCS and Safety System operation. Altogether, comprehensive next generation DCS and Safety System designs help to increase asset and operations longevity, visibility, improve troubleshooting and reduce operational risks.

Summary

As business operations adopt solutions that facilitate intelligent uptime, the specter of unplanned downtime is diminished. Next generation Distributed Control Systems (DCS) and Safety Systems do just that. As a result, they are transforming what is possible in industrial production and manufacturing, helping to automate control, collect data, help to analyze data into actionable insights and provide quick access to application logic with simple user interfaces. In the case of unplanned downtime, the ability to make critical, data-driven decisions enables accuracy and speed in returning to normal operations. All this sophistication is now realized in 4IR-readiness via next generation, powerfully simple systems that protect people, the environment, company assets, optimize productivity and ultimately, help to sustain profits.

About Nexus Controls

Nexus Controls has a wealth of knowledge and experience due to its rich 150-year history, dating back to the founding of the Woodward Governor company. Nexus Controls, a Baker Hughes business, was officially founded over 62 years ago and has proudly been providing the control and safety systems you can trust - from experts you can trust.

Nexus Controls supplies control and safety systems for heavy duty and aeroderivative gas turbines, steam turbines, hydro turbines, generators, compressors, turboexpanders, excitation, balance of plant equipment, DCS and manufacturing operations. Many legacy systems are limited by the technology of their era and require an upgrade to deliver optimal turbine performance, operability, manufacturing performance, safety, and availability improvements; to modernize them consistent with the fourth industrial revolution (4IR).to deliver turbine performance, operability, and availability improvements.

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