Digital Business

A Human-Centric Approach to Oil & Gas Industry Safety

Wearables and other digital hardware can help minimize safety incidents. Monitoring biometrics and alerting workers before they become dangerously mentally or physically fatigued mitigates tiredness as a significant contributing factor in workplace accidents. Applying big data techniques to human behavior enables causal analysis to find the root causes of accidents.

Executive summary

In today's oil and gas industry, employee safety remains the biggest area of concern. As the industry begins a long-awaited recovery, recent research outlines two key challenges in the area of health and safety. The first is managing operations with a less experienced workforce, as younger workers are twice as likely to be injured on the job as experienced workers.[1] The second is effectively operating complex processes with aging infrastructure. More than half of global oil and gas production comes from assets beyond the midpoint in their lifecycles.

The use of digital advancements to prevent loss of containment[2] by detecting telltale anomalies, prevent personal injury and root out systemic safety hazards plays a crucial role in improving safety performance and avoiding major accidents (see Figure 1, next page). This white paper focuses on how a human-centric approach and a risk-mitigation framework can help mitigate health and safety risks through digital work processes that proactively change the way people work.

Industrial safety philosophy, as depicted in Figure 2, is based on managing hazards through prevention and, when that fails to contain a danger, mitigating the consequences.

The inverted triangle's hierarchy of controls illustrates the relative effectiveness of different classes of mitigation. The preferred approach is to implement proactive barriers to threats, particularly when the consequences can be loss of life or a life-changing injury. The main threats discussed in this paper deal with fatigue management and other hazards induced by human behavior.

Severity ranking pyramid

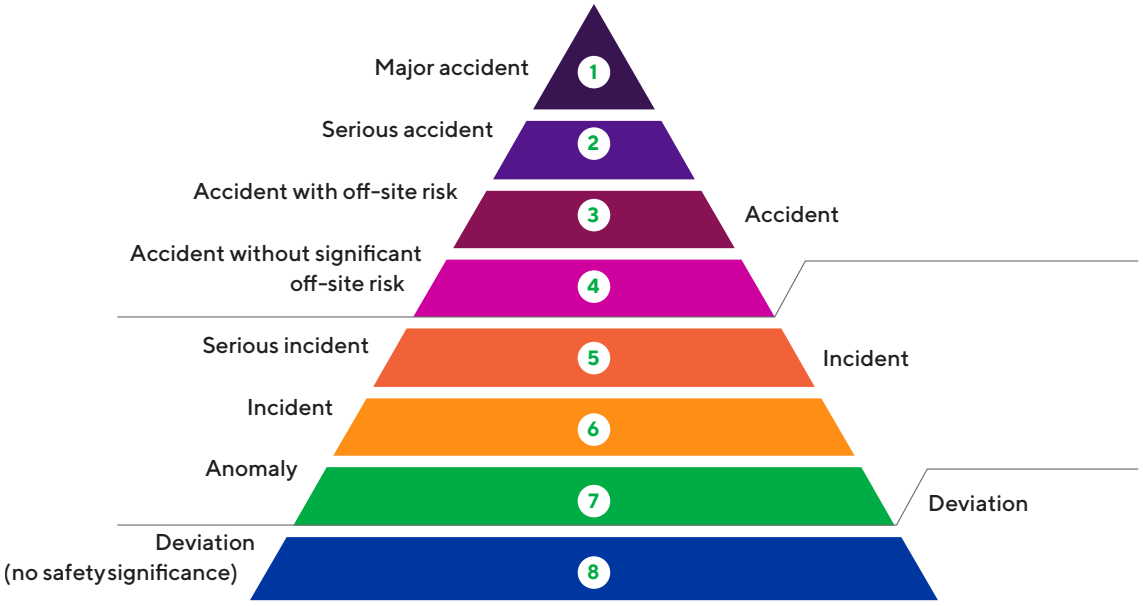


Figure 1

The safety bow tie

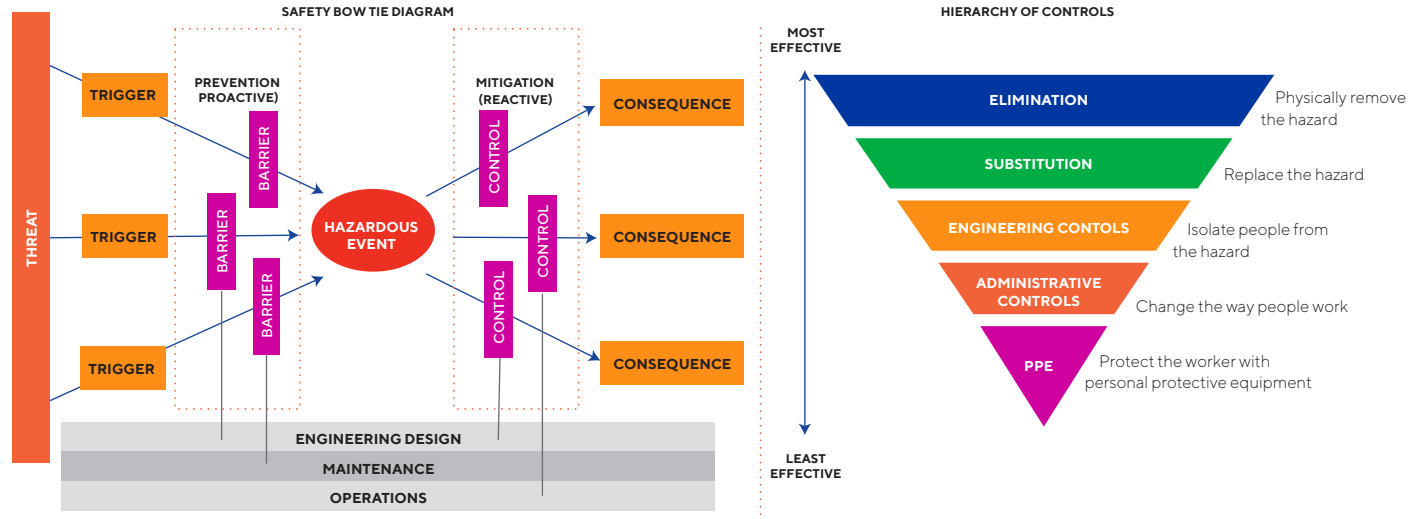
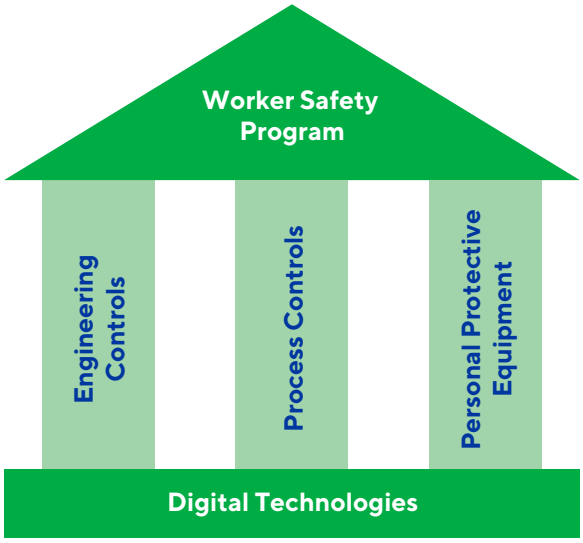


Figure 2

Today's worker safety programs

Today's worker safety programs are designed to adhere to safety standards that are practiced globally and based on learning from incidents. For example, companies now need to have well-defined processes in place for airborne hazard detection and assessment and for alerts associated with hot work in the field. The U.S. Occupational Safety and Health Administration (OSHA) recently updated the guidelines for safety and health programs it first released 30 years ago to reflect changes in the economy, workplaces, and evolving safety and health issues.

Industry players are aware that digital technology has an important role in improving work safety. Many organizations are looking to redefine their work processes and augment their current safety methods through innovative ways of working. Careful selection of technology-based strategies allows companies to leverage a safety-first approach to gain better control of workplace hazards, ramp-up communication, enhance training, and improve workforce and business asset protection. As illustrated below, digitization is now considered a foundation to improve upon the traditional levers for workplace safety.



Careful selection of technology-based strategies allows companies to leverage a safety-first approach to gain better control of workplace hazards, ramp-up communication, enhance training, and improve workforce and business asset protection.

Fatigue can be caused by a combination of long work hours and intense physical work, extensive periods of wakefulness, monotony and work shifts that are not aligned with circadian rhythms.

- **Engineering controls:** These include safe equipment design and installation, robust basic safety control systems, continuous monitoring, fire suppression and gas containment systems, and analytical models to predict and prevent adverse events.
- **Work process controls**: These are enabled by safe work practices and training, situational awareness, training in proper procedures, and periodic inspection and maintenance of equipment driven by predictive maintenance algorithms.
- **Personal protective equipment**: This category includes standard hard hats, flame-retardant clothing, hearing and eye protection, gloves, steel-toed boots and extra protective equipment as needed such as fall protection harnesses and lanyards, full face masks, clip-on monitors for H2S, CO, NH3, or low O2, or portable lower and upper explosive limit monitors in hydrocarbon gas environments.

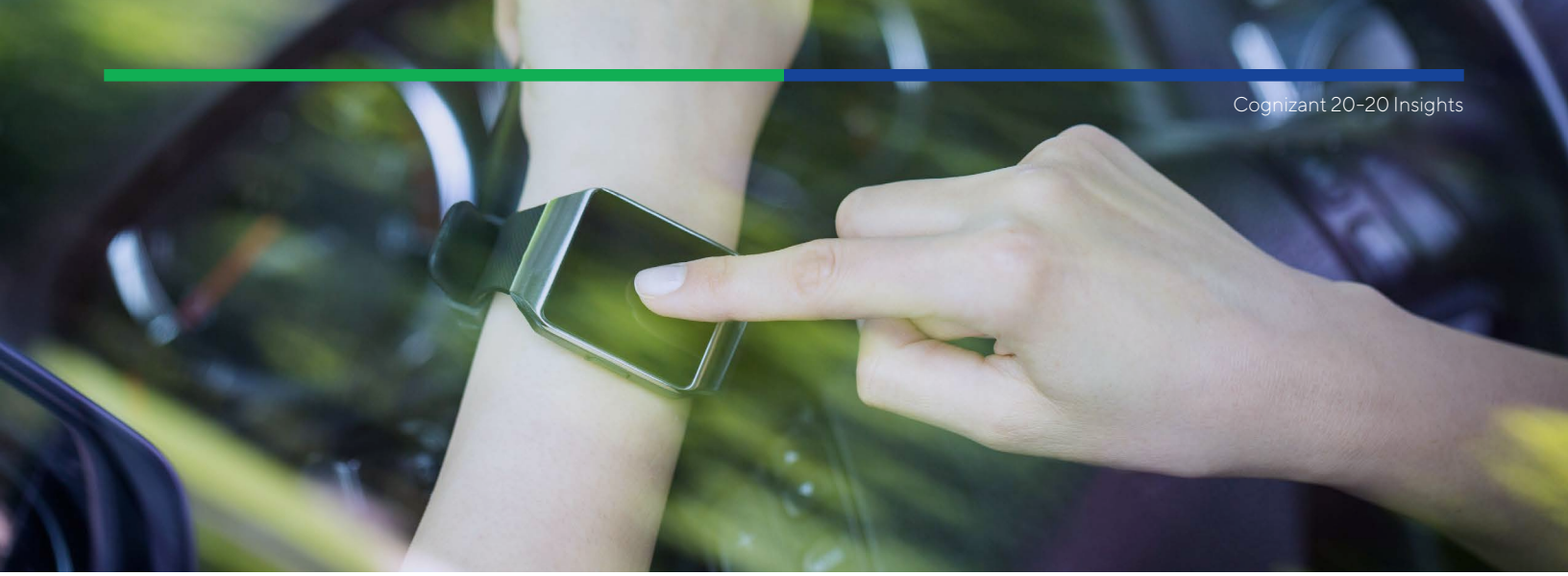
What follows is a day in the life of an oil and gas worker, depicting how digitization can transform offshore operations in conjunction with traditional industry approaches to safety standards and guidelines.

A digital day in the life of an offshore platform worker

In a typical workday environment in the field, many disciplines are subject to occupational hazards. Field work involves collaboration from disciplines such as construction, maintenance, extraction operations, facility management and other special services. Crews can be challenged by harsh weather conditions, extreme physical work conditions and exposure to hazardous chemical processes. Despite the presence of well-laid-out safety standards and guidelines, the process carries high risks at all time during daily routine operations.

An operator's daily tasks includes positioning heavy equipment, climbing on scaffolds, conducting physical inspections, carrying out scheduled and unplanned maintenance, and general servicing of rig platform components. While performing these tasks, there are occasions where a worker might be prone to mental and physical fatigue. Fatigue can be caused by a combination of long work hours and intense physical work, extensive periods of wakefulness, monotony and work shifts that are not aligned with circadian rhythms.

The following human-centric design approach identifies activities associated with human behavior or response, namely fatigue, and further identifies potential digitization interventions that can reduce risks. This is an administrative control that proactively changes the way people work.



Using smart wearables and advanced analytics to proactively predict fatigue risk

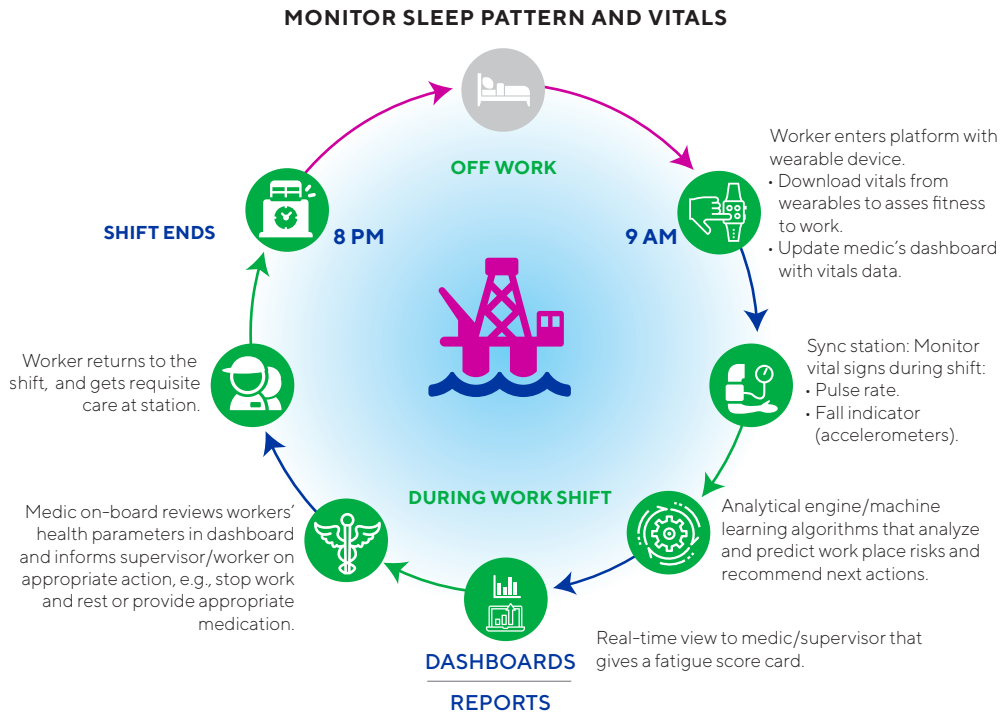


Figure 3

Collecting data about the worker's fatigue creates a history that can be used to improve existing control mechanisms and establish new proactive controls that establish worker health and safety (see figure 4, see next page).

Care should be taken to comply with local privacy laws regarding the worker's medical history. Also, wearable biometric devices such as pedometers, heart-rate monitors, etc. are not designed to be intrinsically safe, and may not be allowed in environments where flammable material could be present due to loss of containment or under

Fatigue risk prediction using advanced analytics

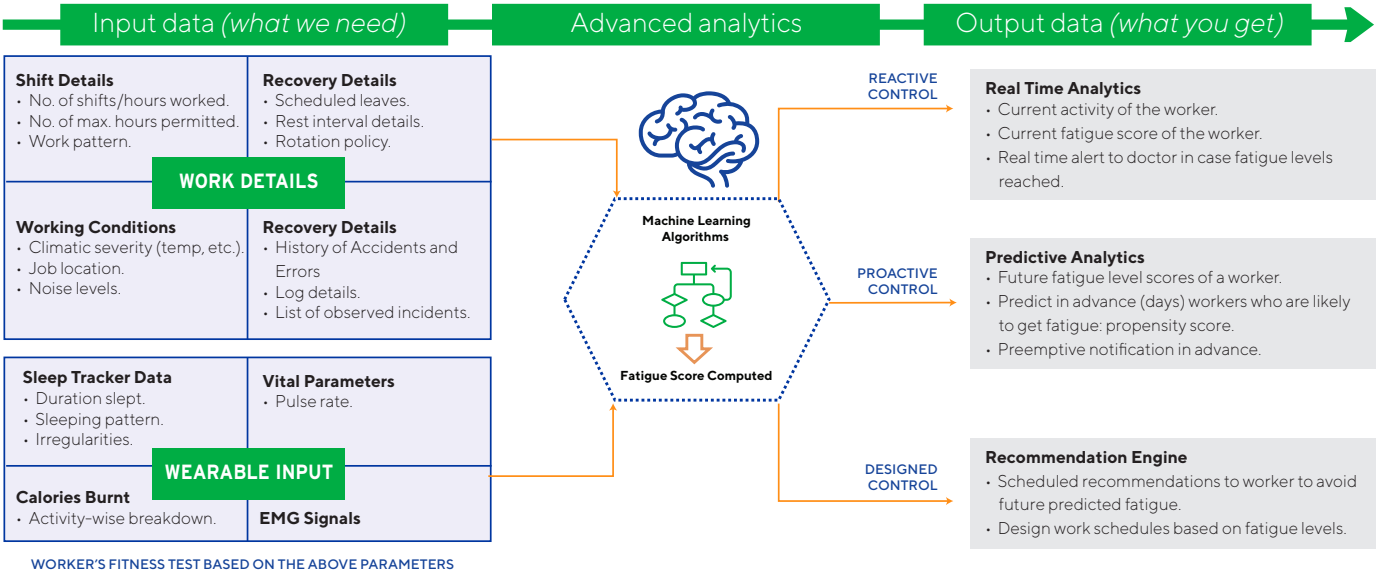


Figure 4

A fatigue-predicting dashboard: An illustrative view

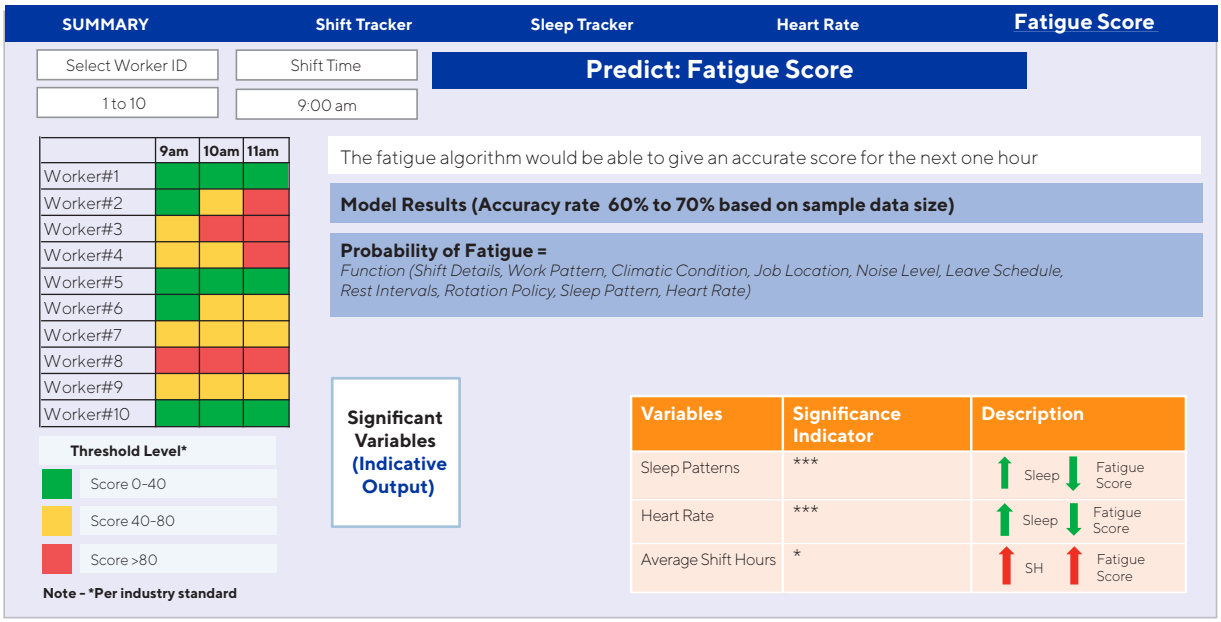


Figure 5

normal circumstances. Wearable biometrics are not recommended for use in such environments.

A dashboard allows a medic to track real-time fatigue scores for workers working on platforms and when indicated suggest a process to proactively avoid potential incidents (see Figure 5).

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Some other digital use cases that can transform ways of working:

- **Augmented reality for training** field engineers/workers for unfamiliar tasks on new equipment or hazardous environments. This administrative control changes how people learn.
- "**Digital twins" of assets** to model and simulate complex design, process and equipment modifications in the virtual world to ensure they are safe before applying them in the real world. (To learn more about the concept of digital twins, read: "Is Your Organization Ready to Embrace a Digital Twin?")
- **Remote monitoring using drones to survey or enter inaccessible or dangerous places.** This eliminates hazards to humans by putting drones in place of workers.
- **Determine whether systemic conditions cause certain accidents.** For example, you might learn from data concerning incidents collected over time that slips and falls consistently occur in a certain hallway. It turns out, you find, that the floor is sloped and worn smooth and is now very slippery. The data indicated that these particular slips and falls were not random acts of clumsiness, but rather resulted from a systemic condition created by the work environment. So instead of advising employees to step carefully, you recommend that the flooring be replaced with material that has enhanced traction.
- **Find patterns of operations anomalies** that coincide with past personal safety incidents or equipment failures. Once the mechanism between anomalies and the incidents or failures is understood, the anomalies then become a set of early warning signs that trigger a personal safety intervention or preventative maintenance. Collections of operations anomalies that could pertain to working environments or equipment in other workplaces can be shared to the benefit of the entire enterprise.
- **Embed an accelerometer in hard hats to detect falls.** Accelerometers can detect sudden changes in elevation (e.g., a fall). When a worker falls or collapses, the accelerometer can send out a signal for help in the control room.

Recommended digital framework to identify, prioritize & implement solutions

The success of a digital workplace safety initiative depends on deeply integrating safety into the business operation, using proactive risk management principles.

Identify-analyze-recommend is a well-established three-step approach that helps organizations assess digital mitigation risks and opportunities. The approach combines existing processes, tools and systems for best use in the transformation journey.

The safety considerations described in this paper are examples for the purpose of illustrating our methodology, rather than universal or exhaustive categories/lists. Any company that implements this use case is responsible for ensuring that their safety guidelines and philosophy are incorporated into the software requirements of a bespoke project.

A risk mitigation framework

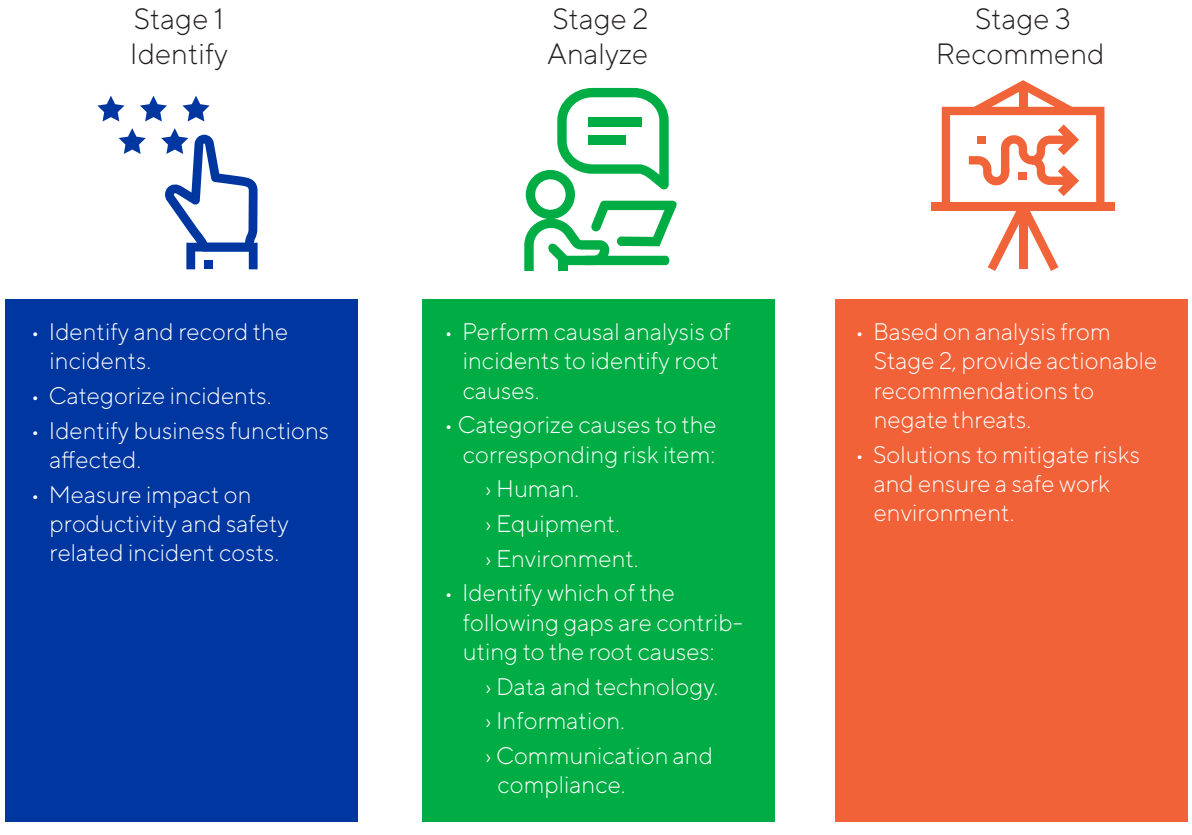

Figure 6

Identify: risk discovery

Figure 7 is an example of a classification matrix that categorizes safety risk based on the severity and frequency of workplace incidents. This allows the business to identify which risks to prioritize for mitigation. The specific categories will vary within the industry.

An incident classification matrix

			Probability				
			4	3	2	1	0
			Likely	Frequent	Occasional	Rare	No monitoring required
Impact	4	• Major infrastructure loss. • Loss of life. • Uncontrollable/uncontained hazard to the environment.					
	3	• Equipment damage/failure causing major downtime. • Critical injuries to the worker. • Uncontrollable but contained hazard to the environment.					
	2	• Equipment damages/failure with minimal downtime. • Minor injuries to worker. • Controllable and contained hazard to the environment.					
	1	• Minor damages to equipment with zero or minimal downtime. • Near-miss incident for the worker. • Reportable environmental hazard.					
	0	No impact.					

Serious	Major	Moderate	Minor

Figure 7

Analyze: gap identification

Most incidents are associated with a risk item that can be attributed to a human, equipment or environmental cause. Figure 8 presents examples of risk items within these categories. The specific risks will vary within the industry.

Causes of incidents & associated risk items

Human Causes	Risk Items
Personal factors	Sabotage
	Fatigue
	Mental stress
	Inattentiveness
Job factors	Inadequate communications
	Inadequate skills/Lack of practice
	Ineffective decision-making/Lack of judgment
Unsafe procedure/Unsafe work environment	Safety procedure violation
	Lack of safety knowledge
	Improper use of equipment or inadequate equipment or tools
	Failure to use personal protective equipment (PPE) or inadequate PPE
	Dereliction of duty
	Poor workplace ergonomics
Equipment Causes	**Risk Item**
Equipment malfunction	Inadequate maintenance
	Inadequate monitoring
Foundation/Structural failure	Poor design standards
	Usage beyond standard lifetime
Safety system malfunction	Equipment monitoring and maintenance
Environmental Cause	**Risk Item**
Dangerous working/weather conditions	Inclement weather, emission of noxious or asphyxiating gases and fumes, flammable gases and fumes

Figure 8

In order to establish the root cause of the incident or to proactively mitigate potential incidents, you can deploy various safety and incident reviews. Figure 9 illustrates an example of a fundamental gap analysis that can be applied to uncover safety issues in a company's operations. These gaps can be related to most, if not all, of the risk items referenced in Figure 8 (previous page). The analysis details may vary within the industry.

Fundamental gaps

DATA GAP	• Do all your critical assets and equipment inform you of critical parameters? • Do you have access to real-time data? • Do you analyze the right data?
TECHNOLOGY GAP	• Do you have tools and bespoke HSE solutions in your IT landscape? • Have these tools helped or not in reducing the number of incidents?
INFORMATION GAP	• Does the data processed lead to deriving the right information? • Is the information derived in time to address a foreseeable incident? • Does the information obtained via analysis consider all data points/scenarios?
COMMUNICATION GAP	• Is the right information passed on downstream in the right time? • Is it passed on to the right stakeholder?
COMPLIANCE GAP	• Does your IT system identify noncompliance issues proactively? • Do you assess safety cases autonomously?

Figure 9

Recommend: digital opportunities

Numerous organizations have digital transformation on their safety agenda.

Advancements in technology have provided a wide array of options for organizations to adopt an accurate health and safety system to improve their ability to respond to safety incidents at any moment.

The opportunities should be prioritized based on the potential business benefits and the relative ease of execution in order to arrive at a roadmap for worker safety (as illustrated in Figure 10, next page).

Multiple "personas" of the connected worker would need to be created to ensure that a solution drives maximum business values. This also ensures that workers are properly trained and have access to the right information at the right time, boosting their confidence to operate in the field.

An approach to digital prioritization

	Criteria	Parameters
Business benefits	Business value	• Improve safety index. • Reduce O&M costs. • Reduce revenue loss.
	Business impact	• Ability to provide cross-functional benefits. • Improved cash flows and financial health.
Ease of execution	Technology requirements	• Data availability and readiness. • Technology readiness. • Complexity of implementation.
	Cost	• Implementation cost.

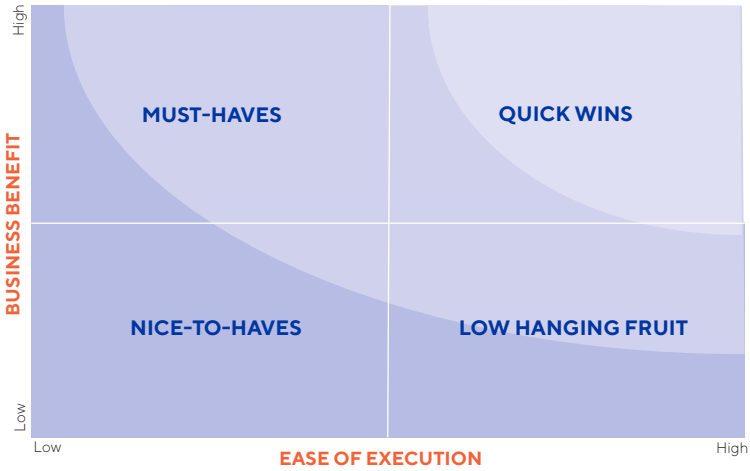

Figure 10

Figure 11 provides a few examples of how digital technologies can help mitigate specific worker safety-related risk items.

How technology can address worker safety risk

Use Cases	Risk Items	Factors	Causes
Wearables and video analytics to monitor workers and their vitals; panic button for emergencies.	Sabotage	Personal Factors	Human causes
	Fatigue		
	Mental stress		
	Inattentiveness		
	Bad workplace ergonomics	Unsafe procedure/ Unsafe work environment	
Big decision/analytical engines analyze the process parameters to generate insights to aid the decision-making process.	Ineffective decision-making/ Lack of judgement/ Lack of access to effective safety resources	Job factors	
Augmented reality for training field engineers on unfamiliar tasks on new equipment or a hazardous environment.	Inadequate skills/Lack of practice		
Drones for monitoring and inspecting hazardous locations.	Exposure to hazardous materials/ Working from heights/Confined space entry	Unsafe work environment	

Figure 11

Moving forward: A call to action

Effective application of digital to optimize business processes can help drive performance gains as measured by improved productivity, fewer injuries and lost work time, and improved reputation.

Three key principles to implement a successful digital initiative for occupational safety in operations:

- **A human-centric design approach to develop innovative insights:** The opportunities for transformation need to carry high value, and the solution needs to be innovative.
- **A framework to prioritize opportunities:** Prioritize core operational digitalization mandates to get right management attention (e.g., operational excellence).
- **Value-adds should be produced:** You should realize business benefits, lower total cost of implementation, build future scalability and flexibility, and integrate with existing infrastructure.

The oil and gas industry has carefully assessed and embraced new and more innovative digital technologies. A strong business case and a proven digitization approach can significantly augment an organization's safety efforts. At the end of the day, everyone agrees that the best level of safety for employees is Job One. A human-centric approach and precision framework to assess and mitigate risk are great first steps for converting conventional wisdom to practical reality.

References

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Endnotes

[1] David Reinsel, John Gantz, John Rydning, "The Digitization of the World – From Edge to Core," IDC and Seagate, November 2018, www.seagate.com/files/www-content/our-story/trends/files/idc-seagate-dataage-whitepaper.pdf.

[2] "Worldwide Wearables Market Ticks Up 5.5% Due to Gains in Emerging Markets, Says IDC," Sept. 4, 2018, IDC press release, www.idc.com/getdoc.jsp?containerId=prUS44247418.

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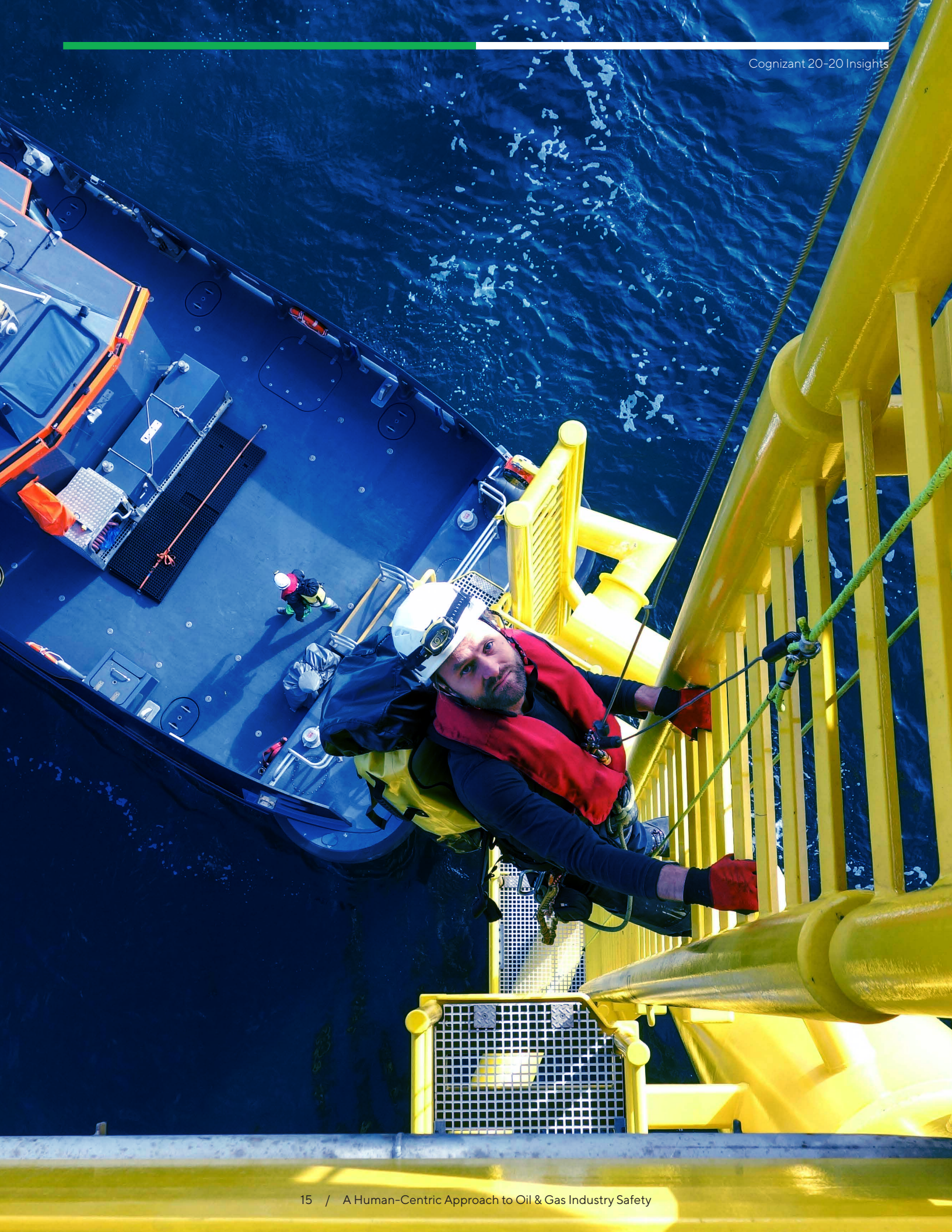

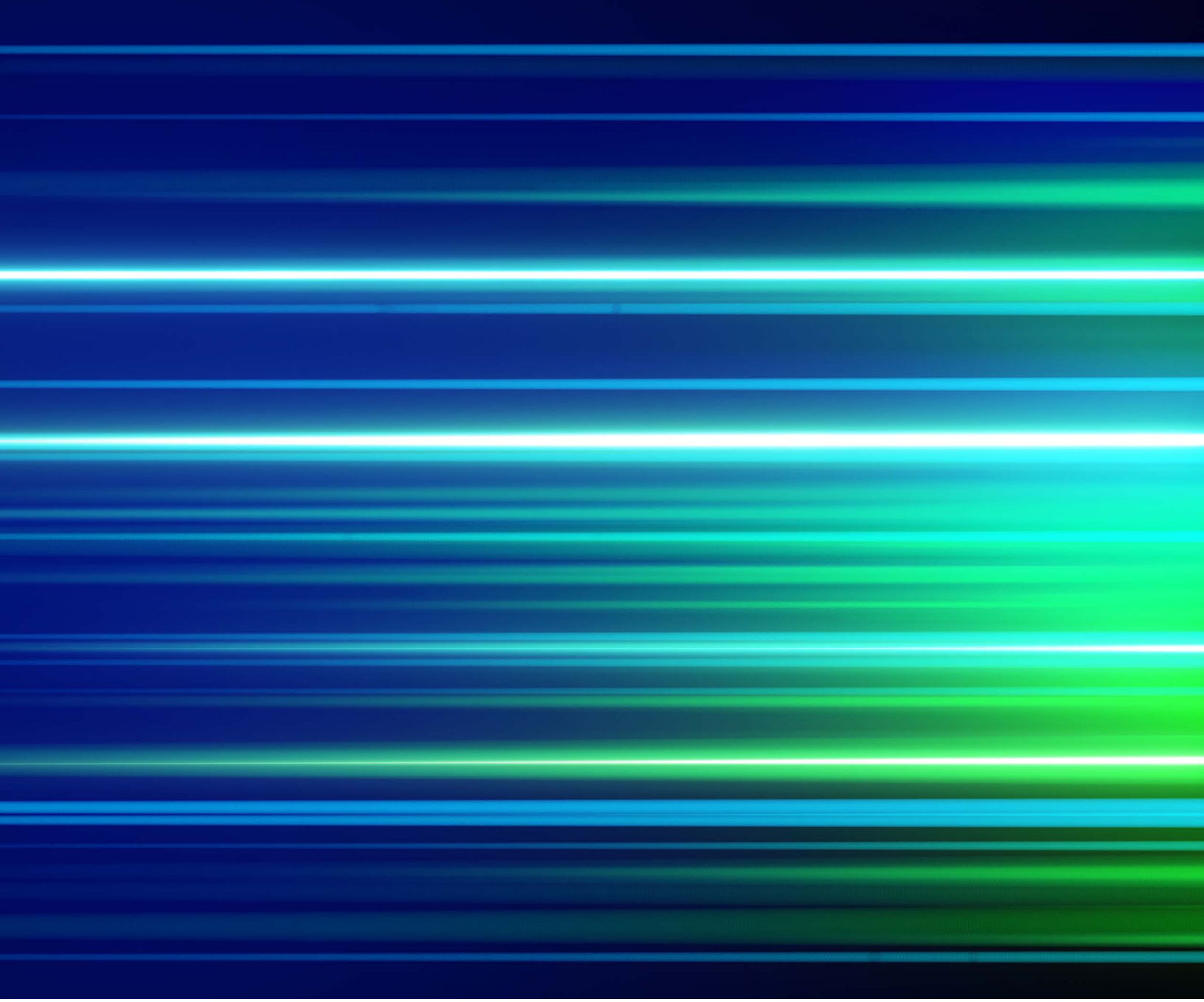

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