The Ergo-Skeletons Are Coming!

Wearable Tech, Big Data, And The Future Of Workplace Safety

INTELEX

STRONGARM TECH

OVERVIEW OF PRODUCTIVITY, WORKPLACE SAFETY AND ERGONOMICS

The remarkable progress over the past century in industrial technology, the advent and rapid acceleration of software, along with the emergence of data as a science unto itself, have all contributed to improved workplace productivity and worker safety. Despite these gains, however, persistent occupational hazards continue to generate tremendous costs. In the United States alone, the total cost of workplace related injury is some $250 billion per year.[1]

In the past, primary risk factors were obvious, exposed through tragic accidents and untimely deaths, and preventable largely through extending process improvement and quality efforts into the domain of worker safety. Now, many unaddressed risk factors lie below the surface, their consequences emerging cumulatively, and their prevention requiring larger systems t hinking. Automation, real-time data analysis, and wearable technologies are emerging as key components for addressing these challenges and encouraging continued advances in productivity and workplace safety across industries.

If one believes in the mantra that a company's greatest assets are its people, the corollary must also hold true: decreased worker health and workplace safety represent a company's greatest liability. Recognizing these threats, employers allocate a considerable amount of their operating budget to protect their workers. Conservative estimates suggest that at an average of $4,000 per year per worker is spent on injury prevention.[2] However, these funds are often spent reactively, allocated to lagging indicators and based on incomplete notions of work-place safety and risk management efforts that fail to account for the new risk profile of the modern workplace.

As the incidence of catastrophic accidents in the workplace decreases, conditions caused by unaddressed risk factors are emerging as a significant concern. This includes musculo-skeletal disorders (MSDs), defined as injuries or pain affecting muscles, joints and tendons and encompassing a range of conditions such as back pain, arthritis and carpal tunnel syndrome. More than half of all American adults have been diagnosed with an MSD.[3] Frequently chronic, deteriorative and debilitating, MSDs are the most common cause of severe long-term pain and disability worldwide.[4,5]

There is a significant body of research linking MSDs to the workplace.[6] According to the World Health Organization, 30% of back pain worldwide is due to work conditions.[7] Risk factors include awkward postures, forceful movements, repetitive motions and heavy lifting as well as workstation layout and tool characteristics.[8] In fact, ergonomic hazards can account for up to 50% of all MSDs.[9]

When one component of a system is poorly designed or does not work properly, be it the workplace, the environment, tasks or tools, it becomes an ergonomic hazard with the potential to cause MSDs. By contrast, when all the parts of an ergonomic system are well-designed and work well together, worker comfort, morale, satisfaction, health and productivity improve and workers' compensation costs and employee turnover are reduced.

These hazards are harder to spot than other workplace safety risks, often requiring more data, evidence, and expertise than companies have in-house within their safety management departments and programs. Until recently, identifying and ameliorating these risks was labor intensive and intrusive, and were often common reasons cited as barriers to implementing ergonomic improvements.[10]

Ignoring ergonomic issues in favor of a strict focus on traditional areas of safety and risk management represents short-term thinking. It exposes employees' long term health to elevated risk. Worker long-term safety risk translates into a company's long-term financial risk. And both self-insured and workers' compensation insured companies can benefit from the financial savings associated with a reduction in worker risk and injury claims.

New wearable technology with embedded software and predictive data science, coupled with an integrated management system approach, addresses this challenge, replacing the antiquated methods previously used to evaluate worker risk on site. With real-time streaming data linked to body motions and exoskeleton sensors, the potential for creating precise interventions is realized. Wearable technology offers feasible solutions to apply broad system thinking (i.e., the context of why and what things need doing) to specific knowledge on ergonomic risk factors (i.e., how things get done) in any number of industrial activities.

One of the benefits of wearable tech is the ability to inform precise safety equipment deployments, tailored to specific tasks and individual workers. While many of these tools began as ways to improve process excellence, they have proven able to increase the ergonomic quality of work, thereby improving productivity in a number of ways.[11] The other less obvious benefit is that they can increase the resilience of workers in repetitive or dangerous occupations.[12] Well-designed exoskeletons can build resilience by helping workers develop the correct postures and strengths over time. Think human system enhancers, not crutches.

Many companies are leading the new wave in safety innovation by applying supplemental systems like exoskeletons to support proper conditioning and physical requirements. For instance, StrongArm Technologies has developed two different devices, which, in their most basic form, enforce postural conformance to OSHA lifting guidelines (the FLx ErgoSkeleton™), and physical enhancers to assist with lifting and to improve neutral spinal kinematics (the V22 ErgoSkeleton™). During proper use, these respective devices claim significant reduction (~30%) in several risk factors contributing to lower lumbar injury, with both devices equipped with sensors for real-time feedback. Safety forward organizations are already starting to implement these new innovations; including a major Canadian based construction company, that has found value in utilizing wearable technology, like StrongArm Tech, to better understand, quantify and deploy new interventions to help lower ergonomic risks and costs.

Employers need to take a proactive approach to risk management when addressing worker health and safety, particularly in conditions of exposure to ongoing physical (and mental) stress, to ensure the productivity of their workforce for the future. Designing ergonomically safe workplaces is not merely a matter of removing environmental risk factors and reducing stressors. Rather, it is about applying a philosophy of continuous improvement through which organizations, with the assistance of wearable technology and integrated management software solutions, are able to assess their risk and ergonomics initiates, providing programs to re-train healthy postures and motions in vulnerable workers.

HIGH-RISK INDUSTRIES AND PROFESSIONS

Ergonomic hazards impact almost all industries, from office workers to hospitality staff. In the United States alone, 22 million workers are at "high" risk of a lumbar injury, and 8.5 million are at a "very high" risk.[13] It is no surprise, therefore that the increasing incidence of musculoskeletal disorders is occurring across industries.

Nonetheless, certain industries and professions face a much higher incidence and severity of MSDs due to their heightened exposure to ergonomic hazards. Labor-intensive occupations in which workers repeatedly are exposed to physically challenging manual tasks involving forceful exertion immediately come to mind. Construction workers, for example, are at a significant risk of work-related musculoskeletal injury.[14] In 2014, WMSDs (e.g., sprains and strains) accounted for 40% of all lost-time claims[15] and approximately 47% of all disabling injury claims in the construction industry in Canada.[16] Other perhaps less obvious professions are also at risk. Healthcare professionals and office workers are reporting increasingly higher incidences of MSDs. Nurses, for instance, have a higher incidence of work-related back injuries than most professionals.[17]

Top 15 Occupations with Musculoskeletal Disorders[18]

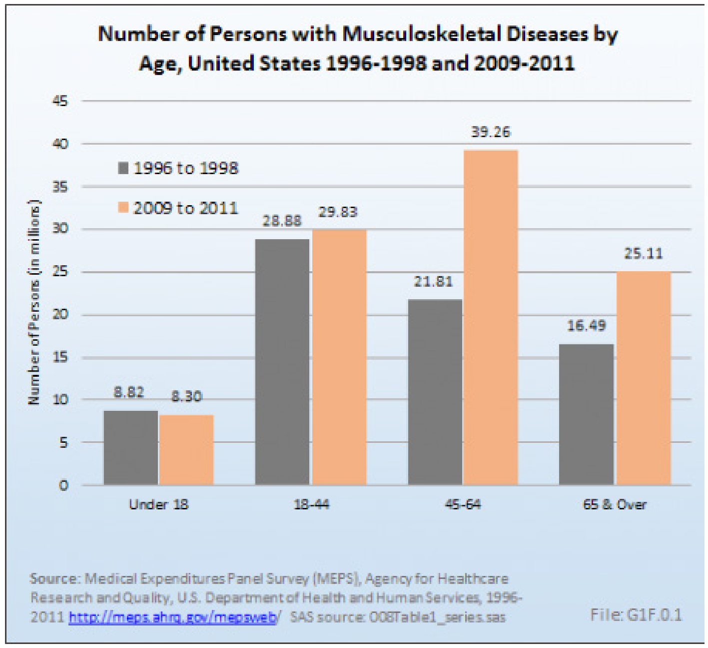
- Nursing assistants
- Laborers
- Janitors and cleaners
- Heavy and tractor-trailer truck drivers
- Registered nurses
- Stock clerks and order fillers
- Light truck or delivery services drivers
- Maintenance and repair workers
- Production workers
- Retail salespersons
- Maids and housekeeping cleaners
- Police
- Firefighters
- First-line supervisors of retail sales workers
- Assemblers and fabricators

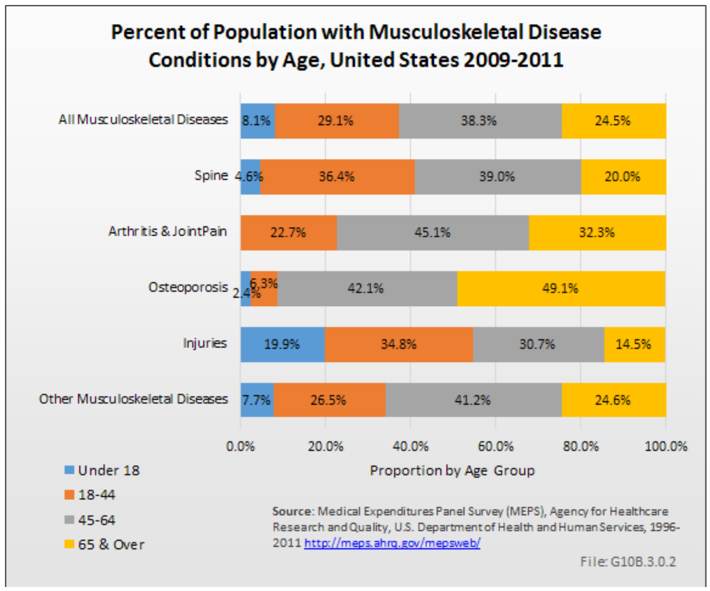
An Aging Workforce Increases Safety Risks

Demographic trends demonstrate that the labor force will continue to age as workers live longer and work longer. Already, the number of senior workers is on the rise: from 2000 to 2012, the number of people age 45 and older in the workforce increased from 34% to 44%.[19,20] In 2014, 23% of men and 15% of women aged 65 and older remained in the labor force. By 2022, these levels are projected to rise to 27% and 20% respectively.[21]

Aging employees bring to work physical changes that are not always immediately recognized or accommodated in the work environment. Physical capacity declines over time, and is the sum of physiological changes and external environmental factors. Changes in functions of the body occur as early as 40.[22] Workers may begin to experience changes related to vision, hearing, muscular strength and range of joint movement, cardiovascular capacity, posture and balance.[23] The prevalence of MSDs also increases with age. As the population ages, MSDs will therefore become even more widespread.

The impact of the association between age and increased safety risks is already evident. While the rate of workplace injuries and illnesses among younger workers are decreasing, it is increasing in the over 55 cohorts, who are more likely to show symptoms of chronic conditions. This trend can be reversed by modifying behaviors and implementing ergonomic interventions that affect the progression of MSDs over time to promote healthy ageing.





The Cost of Ergonomic Hazards

Ergonomic hazards represent a significant risk to industry and employer interests. MSDs, the primary consequence of exposure to ergonomic hazards, are tremendously expensive. Moreover, for every $1 expended on direct costs, an additional $4 is lost to indirect costs.[24] Across the European Union, the costs attributed to lost productivity and absences due to work-related MSDs total ~2% of GDP (240 billion Euros).[25] In the United States the indirect and direct costs of MSDs are equivalent to ~ 1.4% of GDP (213 billion).[26] The direct and indirect costs of work-related MSDs to the Canadian economy are estimated at $20 billion.[27]

Employers lose in the following areas:

Safety Performance
(e.g., worker's compensation costs associated with lost time and increased premiums)
	• The direct cost of lift-related injuries in the United States is $15 billion; $56 billion when indirect costs are considered.[28] Furthermore, in the US:
	  • The average cost of a back injury is $60,0000.
	  • MSDs account for 31% of nonfatal occupational injury and illness cases.[29]
	  • MSDs account for ~50% of all work absences and 60% of permanent work incapacity.
	  • In 2012, 25.5M people lost an average of 11.4 days of work due to back or neck pain, a total of 290.8M lost workdays in just one year. [30]

Employee Morale and Engagement
(e.g., employee turnover and increased premiums)
	• It is difficult to quantify the human costs of MSDs to employees[31] and how they may impact morale and engagement at work.
	  • Back strain is one factor associated with presenteeism (i.e., working sub-optimally while sick or injured) in the modern workplace.[32,33]
	  • Anxiety, depression and fatigue that often accompany chronic pain also contribute to presenteeism.[34]
	• Employees with better physical and mental health are more likely to have lower stress levels and higher engagement and job satisfaction.[35] Employees who rate their overall health as excellent, are more likely to describe themselves as "highly engaged" at work. [36]

Product Quality (e.g., scrap rate or re-work rate)	• Ergonomic hazards (e.g., high forces, awkward working postures) are associated with increased assembly errors.[37,38] • Tasks deemed as having "high ergonomic risk issues" are shown to have 5–8 times as many quality errors as tasks with low risk issues.[39] • However, more research is needed to determine the ergonomic factors that contribute the most to assembly errors.[40]
Productivity (e.g., cycle time or production time, retraining costs)	• MSDs carry a psychological cost as fear of (re)injury, distress due to pain, and reduced confidence in the ability to perform physical activity causes movement avoidance.[41,42] • Workers also adopt coping strategies that could impact overall productivity.[43] For instance, one study found 75% of subjects with musculoskeletal complaints started taking more breaks, 37% modified their work schedules, 35% took medications for symptom relief, and 22% reduced working hours.[44] • MSDs are associated with higher retraining costs due to injured workers exiting the labor market. For example, MSDs were found to be responsible for 75% of disability-related retirements among sheet metal workers and roofers with an MSD were eight times more likely to leave the profession than those who did not.[45]

The Benefits Of Ergonomic Interventions

The benefits of ergonomic changes (i.e., modifying the postures and movements of workers or changing workplaces to accommodate employees) can be seen across sectors: "implementing an ergonomic process has been effective in reducing the risk of developing MSDs in industries as diverse as construction, food processing, office jobs, healthcare, beverage delivery, and warehousing."[46] By decreasing the incidence of musculoskeletal disorders, ergonomic interventions also reduce direct and indirect costs. [47]

Promoting good postures and body motions at work can reduce absenteeism and presenteeism, enhance performance and save money.[48] In fact, ergonomic initiatives are credited with saving companies anywhere from $2 million per year in worker compensation costs[49] to $1.2 million per year in reduced product build costs.[50] According to a survey of 45 organizations who actively implemented ergonomics programs, 70% of these companies reported productivity increases and 30% reported increases in product quality.[51] More than three-quarters reported decreased workers' compensation or medical costs.[52] Another review of 23 interventions found that good ergonomics projects typically give a direct-cost benefit of anywhere from 1:2 to 1:10, with a payback period of 6 to 24 months.[53]

Relevant Regulations Addressing Ergonomics

Most jurisdictions require some degree of training for workers performing tasks in which there may be a risk of ergonomics-related injury. However, broad regulatory approaches to ergonomic hazards vary by jurisdictional authority. Some state in detail the types of procedures and equipment required in certain work processes, while others take a risk-based approach; where the results of a risk assessment dictate the need for preventive measures. Some jurisdictions have broader requirements that include an ergonomics risk assessment, while others detail a risk evaluation process unique to ergonomics.[54]

United States

In the United States, employers must keep the workplace free from recognized serious hazards, which include some ergonomic hazards.[55] OSHA has also developed a set of voluntary guidelines by industry[56] and issue citations or ergonomic hazard letters. 22 states have developed their own state occupational safety and health laws, regulations and standards.

New regulation includes OHSA's 2016 rule on publicizing injury records. Employers in high-hazard industries will have their records posted for the public access on the agency's website. These regulations increase reputational risk alongside that of human and financial costs. As regulatory standards become more stringent and more public, wearable technology in tandem with integrated EHSQ management software, that promotes safety and prevents injuries is an increasingly relevant strategy for risk mitigation.

Canada

Employers are responsible for developing, implementing and monitoring a program for the prevention of hazards, including ergonomics-related hazards. Provincial Occupational Health and Safety (OHS) Acts and Regulations address MSD prevention through the control of how physical work, such as lifting, standing, and sitting is managed. The Government of Canada has also set up an Ergonomics Working Group to discuss the regulation of ergonomics.

Mexico

The new Federal Regulation of Occupational Health and Safety (2015) establishes general provisions for workplace health on ergonomic risk factors, including employer preparation of analysis of ergonomic risk factors of relevant work positions and disclosures to employees.[57]

European Union

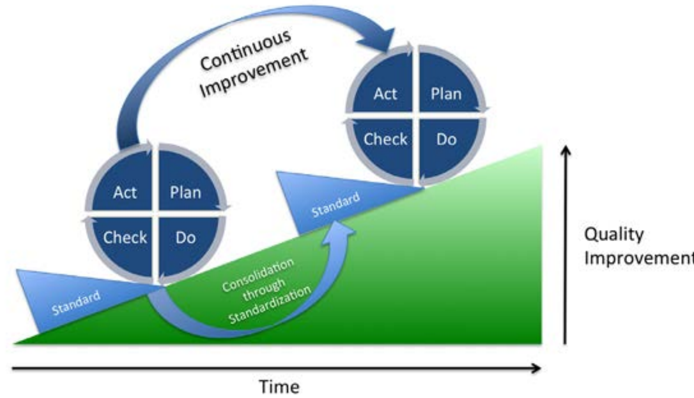
The European Union and its Member States have adopted guidelines for the prevention of MSDs, including the general OSH Framework which recognizes MSDs as a priority. The EU-OSHA regulations monitor the incidence, causes and prevention of MSDs and support the sharing of good practices.[58]

Integrating Ergonomic Risk Management and Quality Control

Given the implications for productivity, workplace safety should be aligned with other competitive priorities.[59] The evidence shows that "companies using a joint management system – in which production and safety goals were seamlessly married, rather than segregated – were most successful in fostering a culture and strong organizational capabilities to support safe production".[60] Moreover, by proactively solving ergonomics and quality issues through simultaneous risk assessment in early product development, late reactive action costs can be greatly reduced.[61]

Aligning ergonomic risk management with quality control – managed through a typical continuous improvement process such as Plan, Do, Check, Act (PDCA) – is an excellent starting point with many advantages. Not only do the two frameworks share common objectives, but both frameworks respond best to proactive measures. Incorporating the two also signals that workplace safety is integral to good management, and not a stand-alone concept. A study of 13 companies found that all of them had aligned their ergonomic interventions with continuous improvement processes.[62] In one case, the application of PDCA to back pain resulted in a 50% decrease in back-related absences over the course of a year.[63]

Plan, Do, Check, Act (PDCA) is a problem-solving process, a foundational concept of quality management and a framework for continuous improvement.



Plan: Establish process to deliver the desired outcome
Do: Implement new process
Check: Measure results against the desired outcome
Act: Analyze differences between results and desired outcomes

Source: http://www.wikiwand.com/en/PDCA

It takes a structured approach to process improvement, including risk and knowledge management, design thinking and strategy design. Designed for repeated application, PDCA facilitates dynamic continuous improvement through breakthroughs (significant advances) or kaizen (frequent small advances). It is well-suited to the use of technology as well because it links measurement to improvement and is a system that requires the development of critical thinking.

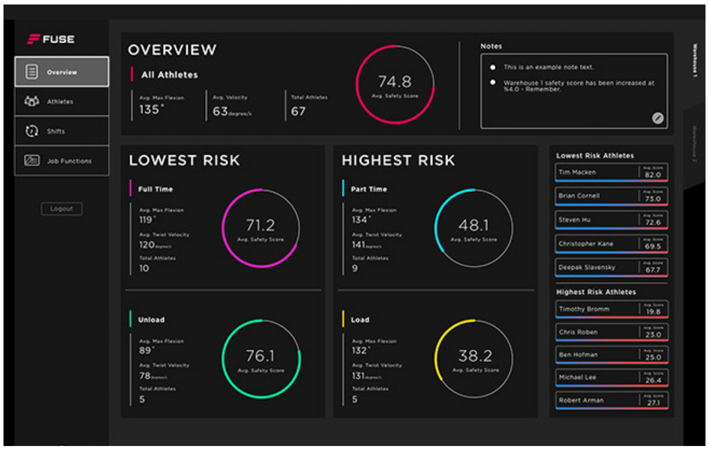
Direct Measurement for Effective Assessment

Ergonomic assessments describe and quantify the risks associated with conditions, processes and actions. Practical assessment is essential to mitigating ergonomic risks and reducing MSDs. Unfortunately, typical evaluation methods to date have limited the effectiveness of ergonomic interventions. The unreliability of these assessment methods can lead to inaccurate analysis outcomes, thereby affecting the accuracy of risk intervention plans.

The most commonly used assessment methods, self-evaluation (workers report back through diaries, interviews and questionnaires) and observation (ergonomist or task analyst observes workers' postures and actions in real-time or from video recordings), are labor-intensive, intrusive, and vulnerable to bias.[64,65] Even the incidence of injuries and illnesses are notoriously undercounted (anywhere in the range of 20% to 70%, according to recent estimates).[66]

Alternatively, direct measurement is the most reliable and unbiased form of assessment. Until recently, its use has been restricted by technology and resource limitations to small population samples and academic studies. However, new technology is now making direct measurement assessments possible in real life situations. These include mobile eye trackers, 3D laser models, and wearable technology such as tracking devices and exoskeletons that can provide real-time ergonomic risk assessment.

StrongArm Technologies Wearable Tech, Sensors and Monitoring



For instance, StrongArm Technologies, has developed the FUSE Platform which includes a wearable device with a variety of sensors, including motion, and an software system which allows for the direct, accurate, and verifiable consideration of the human factors in assessing the safety conditions of the worker. These technologies that include risk management sensors reduce reliability errors to less than a 5% margin of error.[67]

Part of risk mitigation is, of course, the evidence gathered from injury investigations. Here it is important to not only think of culpable agents, both humans and machines, but also on whether the causal factors are confined to individual failures versus evidence of systemic problems. Was an accident the result of a terrible random misfortune, or was it the result of something that in future can be reasonably anticipated, or worse still is it evidence of a system run in near critical states of risk where transitions to injury are probable and highly likely outcomes.

In physics, a system is in a critical state when it is ripe for a phase transition. For example, water that is one degree above freezing appears to the naked eye like all other water but with only a slight one-degree change in temperature, everything about that water seemingly changes. This thinking applies to workplaces. If the environment physically pushes its workers close to their limits continuously, then risk should be measured not just by its prior record of job injuries but more importantly by its proximity to a phase transition to a negative state. With feedback from sensors on people, the future likelihood of injury based on current data and monitoring ongoing risk status becomes accessible.

Fortunately, workplace safety is increasingly predictable. The often-cited accident ratio study demonstrating that for every major injury, there are 600 near miss incidents has prompted many companies to track near misses. Wearables track the equivalent near misses by providing ongoing load and posture feedback in real time. Likewise, MSDs are precursors/indicators of operational injuries are prevented proactively by reducing and tracking exposure to ergonomic hazards. Wearable technology can now be used to assess workplace safety and better predict injury, preventing injuries before they occur.

THE ADVANTAGES OF WEARABLE TECHNOLOGY

Wearable technology has real benefits. It allows for the quantification of movement within the physical work environment. This in turn allows for the capture of big data and the more efficient use of this information. Both immediate feedback to the worker and real time analytic reports to managers serve the shared goals of improved performance and safety.[68]

Recent technological advances have made wearable technology sufficiently reliable, sensitive and non-intrusive.[69] Current capabilities include physiological, chemical, and motion sensors that gather, record and relay information as well as provide automated feedback to the worker.[70] For example, monitoring devices have proven effective at collecting accurate data on the position, velocity and acceleration of movement in the lower back from concrete laborers.[71]

Especially in industries with a distinctive work structure and culture, "for a new tool or piece of equipment to be readily adopted it must be easy to use [and] easy to learn to use… otherwise, potential long-term benefits may never be realized because the innovation may not be given a fair chance due to the time pressures of the job and time required for familiarization".[72] Often, in the manufacturing sector, for example, it is unrealistic to stop production to assess risk or implement interventions.

Assessment, monitoring, and feedback delivery devices that do not disrupt the continuity of the work process are essential so that improvement can occur in systems already in use. They are also now available. For example, StrongArm's FUSE wearable sensor device only takes a few seconds to put on at the beginning of a shift that fulfills the promise of real-time feedback and system wide improvement.

In the past, worker discomfort was cited as the disadvantage of technology-based interventions, including wearables[73] as some sensors limited worker's ability to freely perform some of their tasks. However, laborers now report being able to move about without restriction and do not find the devices cumbersome.[74]

The concept of wearable technology has also been embraced by employees. Consider the following statistics. "Only 12% of employees currently use wearables for work-related tasks, but of those who use them, 71% say they make them more efficient and more productive at work.[75] Furthermore, "72% of employees believe that wearable technology in the workplace will eventually be the norm."[76] "Nearly two-thirds of employees would be willing to use wearable technology if it helped them do their job better. More than three in four employees would wear devices that track job performance and productivity and give their employers access to that information."[77]

Automating Data Collection and Feedback Delivery

A recent study by Deloitte concluded:

> "By effectively implementing advanced data analytic strategies, companies can do more than realize clear financial benefits through increased productivity, reduced litigation and sanctions, and the ability to focus limited dollars on the most effective interventions. More critically, organizations can reduce the human cost of safety by cutting the number and severity of workplace incidents."[78]

The digitalization of data management enables companies to identify patterns in a comprehensive way. However, it also necessitates increasing the capacity to collect data. Wearable technology can collect vast amounts of reliable data that provides a dynamic picture of worker activity allowing for "real time visualization" over the course of the whole production process. In addition to monitoring, wearable sensors also have diagnostic applications. The automated collection of raw data permits the identification of specific risk factors and target areas for continuous improvement, for example, high-risk employees, or patterns across shifts, facilities, and other variables.

Absorbing this data then enables organizations to develop more effective ergonomic solutions. For instance, big data allows for safety personalization: the identification of unique individual characteristics and the customization of improvements. Predictive modeling allows organizations to better identify leading indicators, as opposed to relying on lagging indicators, and thereby adopt a proactive approach to the development of effective interventions and prevention strategies. And in-system prescriptive notifications allow workers to take immediate mitigation actions to significantly reduce or remove the risk of an incident occurring.

Effective risk control requires the translation of acquired knowledge to applied knowledge. Technology-based feedback delivery systems are a new line of research in organizational behavioral management with a number of critical applications to the field of ergonomics and workplace safety. Wearable technology, in particular, allows for the automation of feedback delivery, thereby enabling proactive risk assessment and control. Research on MSD prevention shows that consequence-based interventions (e.g., feedback and reinforcement) are much more effective than antecedent-based interventions (e.g., training and goal setting).[79]

One major benefit of wearable technology is its ability to automate the delivery of immediate and continuous feedback, proven to be more effective than delayed or intermittent feedback.[80,81] This form of immediate feedback has been shown to significantly increase the effectiveness of behavior change interventions.[82] For example, one study found that safety-related information needed to be continuously provided to employees at suitable intervals and that this was particularly important in high-risk organizations.

By contrast, many reactive safety initiatives, such as collecting incidents and pointing and calling, are not well suited to the reduction of ergonomic hazards. "The advantage of tracking parameters in real-time is that the workers can directly relate the feedback to their actual work instead of having to transfer theoretical universal and abstract recommendations. This enables them to directly identify the problem themselves and autonomously act against it."[83]

Wearable technology has also been shown to equip people with chronic MSDs to overcome psychological barriers to physical activity.[84] Such interventions have included programming in suggestions to take a break during pain provoking activities, sending encouraging messages when low movement confidence is detected, and providing the user with weekly visual representations of their levels and quality of physical activity, including any distress alerts, to improve self-awareness.[85]

The Evolution of Software

For years now, improving relations between humans and their environment has been the arena of productivity gurus, what Toyota calls "building people before building cars." The science of ergonomics is interested in the interactions between workers and systems, with the aim of improving the performance of both. To do so, it applies knowledge about the physiological, psychological and biomechanical capacities and limitations of the human, to the planning, design, and evaluation of work environments, jobs, tools, and equipment. Advances in software technology are now making this knowledge-gathering and application of findings instantaneous.

Automation, real-time data analysis, and intelligently designed wearable technology offer great promise in risk management. Software focused on ergonomics eases the labor-intensive process of data collection, standardizes measures, incorporates data aggregation across various databases, and provides real-time intelligent reporting and alerting appropriate to different roles within the enterprise (front-line workers, safety managers, shift supervisors, operations leadership, etc.) Efficient software tools, including the Intelex platform, can work to assess and mitigate ergonomic risks, and begin to incorporate opportunities for predictive and prescriptive solutions. Further, rather than taking a "one off" or silo approach, companies benefit from broader EHSQ platforms that integrate ergonomics as part of a larger risk framework and system thinking.

The benefits to managing ergonomic process and assessments using software include:

- Standardization of data collection for data aggregation and reporting
- Real-time, cost efficient, automated visibility into ergonomic assessments for trending and risk mitigation versus post hoc, expensive, manual assessment methods
- Big picture insights, the gestalt of viewing all measures/issues in one centralized, integrated EHSQ management system (i.e., the whole is greater than the sum of its parts)

Specifically, software such as Intelex's Ergonomics Analysis solution uses standardized methodologies to evaluate the posture and movement of each worker's body and limbs as they perform job tasks. Sensors on devices have the potential to provide this feedback in real-time to expose ergonomic issues faced by employees. When integrated with cloud tools, these risks can be immediately evaluated using industry standard assessments such as the Job Strain Index, the Rapid Entire Body Assessment (REBA) and the Lift/Lower Force Assessment, which available within Intelex's Ergonomics Analysis solution. Of course, the demands of different sectors, companies and use cases also allow for the relatively easy creation of novel methodologies according to the physical requirements of the job.

In all, these in-system assessments calculate the level of risk associated with various tasks, including their duration, repetitive nature, the range of motion required, and amount of strain. Each ergonomic issue gets catalogued and defined as high, medium or low risk. With such a system in place, companies can analyze and prioritize the risks associated with various ergonomic designs and task requirements.

Ergonomics analysis on its own does not allow for this "big picture" approach. Companies need to consider overall Ergonomics and Risk Management software that facilitates the identification, analysis, monitoring, review and treatment of both existing and potential hazards and risks throughout their organization. Aligned with the requirements for ISO 31000 Risk Management standards, Intelex's user-friendly solutions provide organizations with the strategic advantage of managing, mitigating and preventing risk in their business.

FINAL CONSIDERATIONS

People focused technology is key to transforming the next generation of worker safety. Alone, neither better technology nor fitter people are drivers of transformation. Applying technological change without social redesign automates a process. Applying social change without technological redesign reorganizes effort. Real change occurs through a combination of the two.

Much gets written on the integration of the Internet of Things (IoT) into production machines, robotic collaborative applications, autonomous transport systems and self-organized production facilities. Ergo-skeletons are a great addition to this promising list. Bodily movement sensors integrated with safe lifting designed wearables provide not only improved productivity but also increased safety. "The machine-man-task system approach allows for the voice of the worker to be included in the design of the production system as well as implementation and validation."[86] Rather than "man versus machine" think "people with machine learning technology."

The way to bring about real change is through better ergonomic design, including ergo-skeletons that enhance human physical capabilities integrated with software that provides both real-time feedback and an overall system based view of risk across multiple interrelated job functions, such as environmental, health and safety, and quality management (EHSQ). Bring together systems thinking, risk management focused on strengthening versus deteriorating physical conditions, new ergonomic technology, and the application of tried and true processes such as PDCA to bring about the next generation of breakthroughs in workplace safety.

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