Leveraging wearables and the Internet of Things to disrupt, transform, and unlock value

Predictions on the future of wearables and IoT in the enterprise

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Synopsis

Across industries, wearable technologies are transforming enterprise performance and enabling innovative business models. As part of the Cognitive Internet of Things (IoT) ecosystem, and augmented by other Industry 4.0 technologies, these body-worn technologies provide up to four core applications to businesses: real-time monitoring, remote collaboration, personalized perspective, and enhanced ability.

Wearables transform enterprises by increasing efficiency, safety, quality, and collaboration; improving productivity; and reducing costs. As the technology and its adoption evolve, head-mounted displays, body-worn sensors, and exoskeletons will improve employee safety and productivity; and retinal devices and adjustable clothing will enhance employee and user experience.

Combined with the power of IoT, wearables will disrupt traditional business models, help drive the data economy, and offer new value and insights to enterprises. Changes in differentiated services and revenue models will include shifting from B2B to B2B2C and as-a-service, while offering dynamic demand distribution opportunities. As wearables integrate into control centers in IoT enterprises, they will guide new, efficient business processes, and revenue generating and cost saving monetization opportunities.

Wearable technology is already on the agenda of business leaders for its transformational potential—and it’s imperative that your business invests in wearables to stay competitive in the market. As you begin your wearables journey, IBM’s cross-industry experts can partner with you to develop and maximize your IoT strategies and operations with wearables.
Summary of Predictions

**Mass Adoption**
- Bridges B2B relationships with consumers
- Retinal devices used to control objects
- Head-mounted displays used for productivity, information sharing, and automation
- Tracking of worker movement for health and safety

**Transformative**
- Exoskeletons used to augment strength

**Limited Change**
- Adjustable clothing via sensors

**Low Adoption**
- Across Industries
- Present Day
- Within 3 yrs
- 5+ yrs

**Within Enterprises**
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Industry use cases

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How wearables disrupt industries
As part of the dynamic Internet of Things ecosystem, leaders are adopting wearable technologies—devices worn on or in the body in support of enterprise activities—to transform operations and performance.

The market for global enterprise wearables will increase to **63.9 million unit shipments in 2020**, up from 6.9 million in 2015.¹

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**Performance Enhancement**

Wearables across industries improve enterprise and customer experience.

76% of enterprise adopters report improvements in business performance since deploying wearables.²

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**Revenue Generation**

Wearables enable innovative and differentiated services and revenue models.

51% of technology and business leaders identify wearables as a priority for their organization.³

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**Cost Reduction**

Wearables reduce costs through operational improvements.

Smart glasses will save $1 billion per year through field service deployments.⁴
Enterprise wearables fall into seven broad categories.

**Head-worn**
Enhances navigation, information sharing, audio visual, and text viewing
*Examples: Vuzix M100, Daqri, Microsoft HoloLens, Atheer AiR*

**Chest and Neck-worn**
Monitors fitness and healthcare metrics such as heart rate and blood pressure; enhances gaming experience
*Examples: Fineck, Cattle Watch, Toyota BLAID*

**Arm and Wrist-worn**
Watches function as extension of smart phone functionality; wrist and arm bands offer health and security applications
*Examples: Apple Watch, Fitbit, Samsung Gear*

**Embedded and Ingested**
Allows large amounts of medical data to be analyzed and carried within the body
*Examples: Given Imaging PillCam, Proteus Discover, Lumee Oxygen Sensing System*

**Hearables**
Provides health, fitness, navigation, and notification feedback
*Examples: Bragi Dash, Samsung Gear IconX, LifeBeam Vi*

**Smart Clothing**
Tracks vitals through conductive or optical sensors woven into shirts, shorts and underwear; Provides haptic feedback
*Examples: Hexoskin, Heddoko, Mimo*

**Leg and Ankle-worn**
Tracks location, and health metrics such as calories burned, heart rate, and blood pressure
*Examples: ExoSOLS, Wiiv, Fly Fit*
Wearables that utilize cognitive learn from real-time, contextual data, and augment other technologies.

Cognitive Internet of Things (IoT) is…

<table>
<thead>
<tr>
<th>Instrumented and Interconnected</th>
<th>Intelligent</th>
<th>In Real-time</th>
<th>In Context Data</th>
</tr>
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<tbody>
<tr>
<td>Marrying structured data with unstructured data (e.g. social media, text, email, voice)</td>
<td>Applying adaptable machine learning techniques to interconnected physical device data patterns and trends</td>
<td>Responding dynamically to chronic, multi-dimensional and/or time sensitive problems</td>
<td>Creating a personal and consumable experience by understanding the human element in the context of both structured and unstructured data</td>
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</tbody>
</table>

Wearables are part of the Cognitive IoT ecosystem

Wearables utilizing cognitive connect to other devices to expedite processes and interactions. Other devices augment the wearable experience.

Adaptive Robotics  3D Printing  Autonomous Vehicles  Drones
Workforce, market, technology, and product factors are business drivers for the growing enterprise wearable market.

**Workforce**

Wearables enable training and safety measures for workers requiring greater supervision.

Workforce safety is a concern, with more than 2.3m work-related deaths per year.\(^5\)

**Industry/Market**

Companies are required to adopt wearables to compete in the marketplace.

Search for new revenue streams is a priority, with 65% of CEOs preferring IT projects that make money rather than save money.\(^6\)

**Technology**

Wearables are an economically and technologically viable option.

Cognitive technology is increasingly used for data analytics and automation, with 80 of the top 100 largest software enterprises integrating cognitive.\(^7\)

**Products**

Wearables are more rapidly designed for user needs and customized experiences.

Continually changing consumer preferences and desire for personalization are part of living in the "age of the customer."\(^8\)
Wearables impact enterprises by increasing efficiency, safety, quality, and collaboration; improving productivity; and reducing costs.

- Reduce the need for multiple devices through hands-free operations
- Re-engineer existing business processes, improving productivity
- Increase efficiency, and reduce operational errors and costs

**Improve Operations, Efficiency & Convenience**

- Monitor and coach on the wellness and safety of the user
- Prevent and detect hazards, and notify employees and supervisors

**Increase Safety**

- Provide rich data points for operational and customer understanding
- Measure final product size and shape, and verify specifications
- Predict defects to optimize machines
- Create new personalized customer service interactions

**Increase Quality**

- Provide remote training and real-time feedback
- Enable faster decision-making and responsiveness

**Improve Collaboration & Training**
Wearables provide up to four core applications: real-time monitoring, remote collaboration, personalized perspective, and enhanced ability.

<table>
<thead>
<tr>
<th>Real-time Monitoring</th>
<th>Remote Collaboration</th>
<th>Personalized Perspective</th>
<th>Enhanced ability</th>
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</thead>
<tbody>
<tr>
<td>Remotely monitor machinery</td>
<td>Monitor vitals and safety, and identify hazards</td>
<td>Real-time view of factory floor</td>
<td>Operate and move heavy objects</td>
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<td></td>
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<td>Hands-free access to information</td>
<td>Speed-up rehabilitation</td>
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<td>Integrate sensors with attire for data</td>
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<td>Facilitate real-time predictive analytics</td>
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<td>Live view overlaid with relevant data</td>
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Enterprise wearables are found today across industries, with industrial and manufacturing primed for mass adoption.

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<tr>
<th></th>
<th>Training</th>
<th>Corporate Wellness</th>
<th>Security</th>
<th>Employee Safety</th>
<th>Stock Management</th>
<th>Repair &amp; Maintenance</th>
<th>Customer Experience</th>
<th>Payments</th>
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Source: MD&I analysis of over two dozen IT industry analyst and media reports
Initial enterprise wearable pilots are delivering value in customer experience, employee training, and operational efficiency.

<table>
<thead>
<tr>
<th>Customer Experience</th>
<th>Employee Training</th>
<th>Operational Efficiency</th>
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<tbody>
<tr>
<td>Their Magic Band wrist-worn device unlocked doors, fast-tracked lines, and ordered food. Magic Kingdom accommodated 3,000 additional daily guests and reduced the park entry time by 25% during the holiday season.⁹</td>
<td>This HVAC, electrical, and plumbing contractor used smart glasses to audibly and visually connect employees with senior technicians for hands-free technical support. The device improved the technician experience and customer satisfaction. The 500-technician deployment delivered a $20.11 return for every $1 Lee invested in the technology.¹⁰</td>
<td>Their “vision picking” pilot used the AR capabilities of smart glasses to view product location, replacing handheld scanners and paper. 20,000 items fulfilling 9,000 orders were picked, increasing efficiency by 25%.¹¹</td>
</tr>
</tbody>
</table>
New enterprise models with wearables
Prediction: Wearables will bridge the gap between B2B and consumers, transforming many industries.

The Opportunity

As wearables enable B2B2C solutions, businesses will:
- transform customer experience to be more on-demand and personalized
- create new products and services
- enable customized health offerings for employees
- distribute wearables for employee and customer authentication

Wearable providers will be able to work directly with businesses to offer their customers and employees customized solutions.

Services on the market today will make that change possible.

Salesforce Wear offers tools and applications for B2B and B2B2C solutions. The Salesforce CRM—in partnership with top wearable brands and developers—is used to transmit and track data and information, such as reference material for field workers. Salesforce can also be used to track and implement consumer offerings such as authentication and customized services.

The $2 billion corporate wellness industry is a prime example of how wearables enable B2B2C opportunities. Wellness providers partner with wearable devices, employers, and insurance companies to collect data and offer more customized benefits and risk profiles.
In the context of a business model, wearables enable innovative and differentiated services and revenue models.

B2B
Wearable manufacturers sell devices to businesses

B2B2C
Wearable manufacturers sell devices to businesses, which resell or use them for customer experiences

As-a-Service
Wearable manufacturers partner with business and data providers and/or buyers to offer devices for services in exchange for data

Bionym is a wearable B2B and B2B2C provider that sells the Nymi authentication band. It’s authenticated through the user’s heart pattern. A business can sell the band to a user, who can then activate VIP benefits, including customized experiences and incentives.

Fitlinxx is a B2B2C company that provides wearable devices to track health and fitness vitals in partnership with hospitals, insurance companies, and corporate wellness programs. Users receive incentives for participation such as lower health insurance rates.
Wearables will disrupt traditional distributor business models and require companies to provide personalization.

Without Wearables

Manufacturer ➔ Distributor ➔ Consumer

- Drink is automatically ordered from a third-party distributor.
- Manufacturer uses the data to improve their products.
- Distributor gets access to data to optimize products and inventory.

With Wearables

- Athletic shirt with sensors monitors performance, tracks vitals, learns, and coaches wearer.
- Shirt business partners with a sports drink manufacturer to sell drinks tailored to the wearer’s performance.
- After a strenuous workout, sensor and historical data is analyzed.
- Shirt app coaches wearer on which sports drink will best replenish electrolytes and improve performance and recovery.

All parties access and analyze data independently.
As data producers, wearable devices access, control, and/or collect diverse data sets that IoT enterprises can monetize.

<table>
<thead>
<tr>
<th>Location</th>
<th>Environment</th>
<th>Attribute</th>
<th>Orientation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wearable tracks location of injured worker.</td>
<td>Device data is combined with environmental data to understand patterns.</td>
<td>Device monitors user activity to identify health patterns.</td>
<td>Device understands if worker is in a distressed position.</td>
</tr>
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</table>

<table>
<thead>
<tr>
<th>Machine</th>
<th>Living</th>
<th>Event</th>
<th>Motion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wearable used to look inside machines for repairs.</td>
<td>Device monitors and interacts with vitals data for remote healthcare.</td>
<td>Wearable notifies worker in case of emergency.</td>
<td>Wearable coaches workers on less stressful motions.</td>
</tr>
</tbody>
</table>
Wearables enable a number of revenue generating and cost saving monetization opportunities.

Revenue Generating

- Derive valuable insights
- Market to segments
- Sell data assets to buyers
- Provide new data discovery interfaces

13.7% of companies use IoT to productize and sell data.\textsuperscript{12}

A retailer can use attire sensor data to sell products to segments, and sell data to partners. A retail employee can use a head-mounted display to personalize the customer experience and upsell products.

Cost Saving

- Optimize staff time and productivity
- Reduce and prevent operational errors
- Predict and prevent safety issues
- Reduce insurance premiums

Locke Supply saved training costs by reducing training time from 3 days to 3 hours using a hearable device for warehouse pickers.\textsuperscript{13}

Cloud consultancy Appirio cut their Anthem insurance bill by 5% by citing data gathered from employee fitness trackers and their wellness program.\textsuperscript{14}
In the operating model, command centers will transition to control centers as cognitive and wearables use grows.

<table>
<thead>
<tr>
<th>Command Center</th>
<th>Control Center</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manual</td>
<td>Cognitive</td>
</tr>
<tr>
<td>Collects enterprise and other data, with human oversight to take action</td>
<td>Processes and acts dynamically on enterprise and other data with minimal human effort</td>
</tr>
<tr>
<td>Monitors</td>
<td>Learns</td>
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<tr>
<td>Analyzes</td>
<td>Predicts</td>
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<tr>
<td>Visualizes</td>
<td>Prevents</td>
</tr>
</tbody>
</table>

Cognitive and wearable growth
These control centers will drive new and efficient business processes by activating other devices and actions.

**Without Wearables:** Command center requires manual data input and inquiry.

- Worker performs high-risk task to repair machine; falls from ladder
- Colleague calls emergency services and supervisor
- Emergency services lacks access to worker health data
- Supervisor searches database for employee health data
- Supervisor notifies emergency services of worker's allergies

**With Wearables:** Control center enables learning and prediction, and activates processes.

- Utility worker sent to site of previous injuries
- Wearable informs worker to take extra precaution during repair; worker still falls
- Wearable notifies emergency services and supervisors, and sends health data so that emergency services are aware of worker's allergies prior to arrival
- Control center sends notification to investigate site's safety protocols
- Emergency services lacks access to worker health data
Operationally, wearables can enhance processes, improving productivity, efficiency, and cost-savings.

<table>
<thead>
<tr>
<th>Process scenario</th>
<th>Select processes with wearables opportunity</th>
</tr>
</thead>
</table>
| **Order/invoicing**               | • e-Commerce/web orders  
|                                   | • Returns  
|                                   | • Customer specific instructions  
|                                   | • Customer pick-ups  
|                                   | • Rebate programs  
|                                   | • Rush orders (with add-ons)  
|                                   | • Quotations  
| **Shipping and receiving**        | • Warehouse receives delivery via EDI  
|                                   | • Proof of delivery  
|                                   | • Picking  
|                                   | • Bar coding integration  
|                                   | • Dock to stock  
| **Environmental, health, and safety** | • Safety management  
|                                   | • Risk assessment  
|                                   | • Employee health monitoring  
|                                   | • Emissions monitoring  
|                                   | • Incident management  
|                                   | • Corrective/preventative actions  
| **Manufacturing**                 | • Goods receipts for production  
| **Maintenance and reliability**   | • Maintenance notifications  
|                                   | • Maintenance work orders  
|                                   | • Labor confirmations  
|                                   | • Emergency work orders  
| **Sourcing**                      | • Inspection process  
|                                   | • Material returns  
|                                   | • Invoice verification  
| **Quality management**            | • Field testing/samples (return processing)  
| **Warehouse management**          | • Picking from storage  
|                                   | • Pick sequencing  
| **Inventory management**          | • Obsolete inventory  
|                                   | • Inventory monitoring  

For example, wearables can improve accuracy and productivity in distribution operations.

**Pain Points Wearables Address**
- Additional hand-held devices not required to identify location and scan items
- Worker less fatigued from packing, lifting, loading, and unloading
- Less time required to identify and find inventory location
- Repetitive processes now automated
- Variance decreased in training time and skill of workers

Locke Supply used a hearable solution to guide and track picker activity, improving accuracy 95-99%.15

GM is developing a Roboglove with sensors and actuators to reduce worker picking fatigue.

Head-mounted displays and haptic devices can enable efficient inspection and navigation.
Industry use cases
With technology developments, short term adoption is driven by enhancing experiences and safety, while long term adoption will be driven by brand new services.

<table>
<thead>
<tr>
<th>Industrial</th>
<th>Short Term</th>
<th>Medium Term</th>
<th>Long Term</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Multiple sensors and capabilities</td>
<td>Non-invasive data collection and application</td>
<td>Virtually invisible and autonomous new experiences</td>
</tr>
<tr>
<td></td>
<td>Employee safety; Hazmat detection</td>
<td>Disaster management</td>
<td>Simulate machinery repair</td>
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<tr>
<td>Manufacturing</td>
<td>Field services and training</td>
<td>Remote maintenance</td>
<td>Exoskeletons</td>
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<tr>
<td>Logistics</td>
<td>Warehousing and parts tracking</td>
<td>Measuring parts</td>
<td>Gesture-controlled warehousing</td>
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<tr>
<td>Travel</td>
<td>Check-in; Payments</td>
<td>Customer service and personalization</td>
<td>Facial and personality recognition</td>
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<td>Healthcare</td>
<td>Remote patient care; Diet and exercise</td>
<td>Vascular imaging; Clinical trial participation</td>
<td>Remote surgery</td>
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<td>Sports</td>
<td>Performance monitoring</td>
<td>Umpiring</td>
<td>Imbedded rehabilitation devices</td>
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<td>Government</td>
<td>Law enforcement</td>
<td>Security management</td>
<td>Bio-authentication</td>
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<tr>
<td>Retail</td>
<td>Alerts; Customer service; Payments</td>
<td>Identifying customer preferences</td>
<td>Facial recognition</td>
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<td>Insurance</td>
<td>Corporate wellness</td>
<td>Claims management</td>
<td>Underwriting and pricing</td>
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<tr>
<td>Media</td>
<td>Gaming; Advertising</td>
<td>Personal VR/AR devices</td>
<td>Holograms</td>
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<tr>
<td>Banking</td>
<td>Payments</td>
<td>Alerts; Basic services</td>
<td>Bio-authentication</td>
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</table>
**Prediction:** Most industries will adopt head-mounted displays for business processes, transforming their operations.

### The Opportunity

Head-mounted displays will be used across industries for:
- remote collaboration
- access to images, video, and information such as manuals
- object and facial recognition
- holograms and 3D visioning
- internal machine insight and repairs
- simulations and training

These devices will enable greater productivity and collaboration, especially between field/factory workers and headquarters.

### Services and developments on the market today will make that change possible.

General Electric’s Smart Helmets connect oil and gas field workers with headquarters employees, who guide the workers through tasks with two-way audio and visuals.

Germany’s Ubimax is a leading solution provider in Europe that partners with hardware vendors including Epson, Google, Brother, and Vuzix, to deploy head-mounted display solutions across various industry and business value chains.

Purdue University researchers developed an AR tele-monitoring system for surgeons to receive remote guidance on procedures.

39.9m head-mounted display units expected to be sold in 2020, compared to 1.4m units in 2016.
In the future…

automotive manufacturers will use wearables for cost-effective prototyping and enhanced user feedback.

Prototyping
Virtual reality (VR) used to design prototypes with users for immediate feedback and reduction in time and costs.

John Deere reduced design time by 18 months and design costs by $100,000 by using virtual reality simulations.17

User Feedback
Wearables worn by users will provide emotional sensing feedback while test-driving cars.

The Zenta biometric bracelet tracks and analyzes the wearer’s emotions overtime, in addition to heart rate, skin temperature, and respiration.

Cost Effective Design
Cognitive trade-off analytics will be used during VR simulations to determine the most resource-effective designs.
In the future...

aerospace companies will use wearables to monitor machinery and enable virtual simulation and remote support for repairs.

**Machine Monitoring**
Employee with wearable measures the change in surface temperature, power, vibration, or sound to detect early signs of machine failure.

**Repairs**
AR used to pull up repair documents for on-the-spot fixes to machines.

The Schlumberger oil and gas company tested Google Glass to replace paper and tablet checklists for field workers.

**Simulation**
Wearable used to view inside machinery to simulate repairs prior to fixing.

Agricultural manufacturer AGCO Corp is experimenting with hologram-like images to help guide workers through a welding process with three-dimensional images.

**Remote Support**
Employee uses head-mounted display to video conference with remote expert to advise on repairs.
**Prediction:** Many industries will track worker movement for health and safety, transforming their operations.

**The Opportunity**

Wearables can track a range of vitals to:
- coach workers on safety measures
- track workers in distress
- alert supervisors and emergency services
- understand health factors
- monitor actions and activity that put the employee at risk

These use cases are applicable across almost all industries. Businesses will centralize this data into a control infrastructure to properly track and prevent health and safety issues.

10% of wearable patents are for health monitoring.¹⁸

**Safety wearables on the market today will make that change possible.**

The SmartCap Technologies that alerts managers when workers operating equipment lose focus. The worker’s drowsiness level is measured via sensors in the cap.

AlertGPS integrates location tracking with safety monitoring, combined with a “mobile personal emergency response system (mPERS)” alert system. When a worker falls or is in distress, the system alerts appropriate parties of the worker’s issue and location.

Fujitsu’s Ubiquitousware package of head-mounted displays, wristbands, and badges can locate workers, track their safety status, and transmit actionable data.
In the future...

oil & gas companies will monitor the location and safety of their workers and provide more immediate emergency assistance.

**Safety**
Employee uses a wearable device to monitor heart rate and safety factors.

IBM’s Employee Wellness and Safety Solution tracks vitals and safety, and alerts workers and management when on-site safety requirements aren’t being followed.

**Coaching**
Wearable virtual personal assistant used to coach employees on safety and health best practices, and alert of potential hazards.

Proxxi is an armband that warns utility workers when they are at risk of high voltage, and notify supervisors if there is a warning, shock, or fall detected.

**Location**
Wearable used to alert supervisors and locate all employees with their health status in case of accident.

**Health Data**
Wearable stores and can pull up medical and emergency information on employee in case of accident.
Prediction: Exoskeletons will be used to augment strength in a select number of industries, in a transformative way.

The Opportunity

Exoskeletons will be used by enterprises for their employees and for healthcare patients to:
- increase stamina and reduce fatigue
- prevent injury
- make tools and heavy loads lighter
- support physical rehabilitation in cases of limited mobility
- provide bullet-proof protection

Exoskeletons are already being used in the military, construction, warehousing, shipbuilding, and in hospitals.

Use cases and developments in the market show this change is possible.

Researchers at Duke University got eight paralyzed patients to feel sensation in their legs with the use of a VR headset controlling a robotic exoskeleton on their legs.

General Atomic's TALOS program for the military is building a lower-body exoskeleton suit to take armor weight off the spine. The suit can cool in temperature and covers over half the body with bullet-proof material.

The Daewoo Ship Building exoskeleton weighs 62 pounds on the body and can lift 62 pounds. It’s projected to be able to eventually lift 220 pounds.
In the future... logistics workers will use wearables to augment their strength and make their workflow more efficient.

**Heavy Lifting**
Exoskeleton used to prevent injury and augment strength and productivity for intense jobs.

Lockheed Martin claims that its exoskeleton makes shipyard workers 20 times more productive.\(^{20}\)

**Robotics**
Adaptive exoskeleton robot will help workers reduce fatigue and prevent injury from repetition.

Factory floor use of exoskeletons is estimated to save firms up to $4.1b in lost productivity.\(^{21}\)

**Data fusion**
Exoskeleton will be instrumented to sense and fuse data to enhance decision-making and coaching.

**Rehabilitation**
Injured employee uses exoskeleton to speed up rehabilitation after injury.
**Prediction:** Retinal devices used to control objects will be transformative across many industries, replacing hand-held devices.

**The Opportunity**

Wearable devices embedded in retinas are the next generation of head-mounted display use cases to:

- identify, select, and control objects
- adjust and improve eyesight
- take pictures
- authenticate users

Retinal devices will gain in popularity for being more discrete than head-mounted displays.

**Patents and prototypes show this change is possible.**

Fujitsu has developed several retinal devices for gaze tracking, and iris authentication. One device is a retina scanning laser that uses a micro-projector on glasses to use the retina as a screen. People with impaired vision are able to see more clearly with this device.

A Samsung patented device projects images onto the user’s eye and takes and sends photos to their phone via a built-in camera and antenna.22

University of Washington in Seattle researchers developed prototypes to harvest Bluetooth signals in embedded devices to transmit wi-fi signals. This paves the way for smart contact lenses to connect with other devices.
In the future...

the automotive industry will use retinal devices to increase productivity and enhance customer experience.

**Hands-Free**
Gesturing used to signal a retinal device to direct machinery in hands-free manner.

Google has patented a smart contact lens that can control other objects by using gestures.\(^2\)

**Inventory**
Connected contact lenses used to identify items and stock for picking.

**Eye authentication**
Customer will scan their iris to unlock their car.

EyeLock and Voxx Electronics partnered to develop a system for the car to start only when the correct driver's iris is detected.

**Gaze tracking**
Car windows and mirrors will track eye gaze to alert the driver of potential distractions out of sight.
**Prediction:** Clothing items with sensors will allow more personalization over time, transforming a select number of industries.

### The Opportunity

Sensors on clothing items will activate changes, including to:
- adjust the size of the item
- moderate the item’s temperature
- shift colors based on mood
- 3D-print better fitting items
- help athletes adjust form to prevent overuse and injury

Wearables providers will work directly with retail companies to understand and design for customer preferences. This is another example of the bridging of B2B and consumers.

### Patents and prototypes show this change is possible.

One university patent uses sensors to adjust the straps and size of a shoe.  

Digitsole is a shoe insole that is temperature controlled via a smartphone. The insole temperature can also be auto-adjusted based on user preferences.

Google patented a fragrance-emitting device for clothing items to monitor odor levels, emit fragrance, and connect to social networks.
In the future…

oil and gas employees will have connected uniforms that adjust to the wearer’s needs.

Temperature
Shirt sensors will measure the outside and body temperature, cooling or heating the shirt to the employee’s preference.

Invisible Sensors
Uniforms will be fitted with sensors as small as dust, instead of bulky materials or add-ons.

EPIC Semiconductors reports developing nano cloud processors the size of dust that powers itself and connects to the Internet.

Custom Fit
Employees will wear new gear and uniforms that can self-heal through nanosensors in fabric and fibers.

The Advanced Functional Fabrics of America Institute is developing sensing fabrics that can capture energy, monitor vitals, and engage in self-repair.

Flexible interface
Smart glove with flexible interface will be used to interact with machinery data.
Barriers to implementation
Enterprises face a range of complications from security concerns to legal implications when deploying wearables.

<table>
<thead>
<tr>
<th>Category</th>
<th>Description</th>
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<tbody>
<tr>
<td><strong>Personal Data</strong></td>
<td>Companies risk loss, manipulation, or theft of employee personal data.</td>
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<tr>
<td><strong>Legal</strong></td>
<td>Wearables open up legal questions of liability.</td>
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<tr>
<td><strong>Health Data</strong></td>
<td>Employee sharing of health data is legally protected, and required to be voluntary.</td>
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<tr>
<td><strong>Safety</strong></td>
<td>Wearables pose safety risks from malfunction to electric or chemical exposure.</td>
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<tr>
<td><strong>Security</strong></td>
<td>Poor encryption and protections make wearables easy hacking targets.</td>
</tr>
<tr>
<td><strong>Video and Search</strong></td>
<td>The legal precedents for use of AR and VR in public and private spaces are nascent.</td>
</tr>
</tbody>
</table>
Global regulations are disparate and slow to change; health data and medical devices are the most regulated.26

**Canada:** Personal Information Protection and Electronic Documents Act requires consent for data collection

**UK:** Software and applications with medical purposes are regulated as devices and require conformity assessment

**EU:** Stricter data regulations including EU Directive on Data Protection, Article 8 of European Convention on Human Rights, and EU-US Privacy Shield

**Russia:** Conducts own device clearance and does not recognize other national approvals; new networked medical device regulations unlikely

**China:** Highly censored, including Apple Watch; networked medical devices not regulated; policies favor domestic manufacturers

**Australia:** Privacy Act and Telecommunications Act apply to IoT; no major updates to regulations for networked medical devices; follows lead of US and EU

**Brazil:** No new regulations for medical devices despite expectations as the largest devices market in Latin America

**Japan:** Connected software programs treated under same regulations as medical device hardware; second largest medical devices market

**US:** Authority dispersed across Federal and State government; health data regulations most restricting

**PCI Security Standards** the same worldwide for secure payment processing
Technical barriers may limit mass adoption until there are improvements in usage, design, and cost.

**Long-term use**
AR devices can now be worn for up to 8 hours, but not VR devices.

**Interoperability**
Devices must be able to exchange information with existing software platforms.

**Battery life**
Battery life not long enough to last a full day shift or long video conferences.

**Price**
Cost per device remains high.

**Aesthetics**
Design needs to appeal to diverse tastes while withstanding harsh environments.
IBM’s role in the enterprise wearables market
IBM can partner with businesses at different stages of their wearables journey.

### Stage of business

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<tr>
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<tr>
<td>Example use cases</td>
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<td></td>
<td>■ Exoskeletons</td>
<td>■ Disaster management</td>
<td>■ Employee safety</td>
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<td>■ Facial recognition</td>
<td>■ Remote maintenance</td>
<td>■ Field service</td>
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<td>■ Bio-authentication</td>
<td>■ Personalization</td>
<td>■ Corporate wellness</td>
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<td>Initial engagements</td>
<td>■ Build value proposition</td>
<td>■ Build standard operating procedures</td>
<td>■ Performance monitoring</td>
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<tr>
<td>with IBM GBS</td>
<td>■ Process/workflow</td>
<td>■ Construct pilot:</td>
<td>■ Wellness</td>
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<td>■ assessment for dynamic</td>
<td>■ Technical integration</td>
<td>■ Payments</td>
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<td>■ insight opportunities</td>
<td>■ Simulation of a wearable’s impact within a workflow</td>
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<td>■ Business activity</td>
<td>■ Implementation plan</td>
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<td>■ monitoring for workstep</td>
<td>■ Develop performance metric scorecard to measure</td>
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<td>■ value proposition</td>
<td>effectiveness</td>
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<td>■ scorecard</td>
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<td>■ Market assessment of</td>
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<td>■ wearable evolution</td>
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<td>■ Assessment of current</td>
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<td>■ workforce wearable</td>
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### Ecosystem dynamics

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<thead>
<tr>
<th>Multi-modal application across industries (theme parks, hospitals, hotels)</th>
<th>Service-level agreement session</th>
<th>Technical integration camp</th>
<th>Control-center teaming</th>
<th>IoT ecosystem consortium (wearables and other emerging technologies)</th>
</tr>
</thead>
</table>
IBM’s cognitive solutions exemplify how wearables can improve the workplace and consumer experience.

**IBM’s Employee Wellness and Safety Solution**

North Star BlueScope Steel has partnered with this Watson IoT and wearable solution to prevent injuries.

Wearable devices collect data from multiple sensors about skin temperature, heart rate, and level of activity, and compare it with external weather data. The solution provides personalized safety guidance to employees, and alerts management and emergency services when issues occur.

**IBM + Under Armour**

The UA Record fitness app uses cognitive coaching for data and guidance on sleep, fitness, activity, and nutrition. The app will incorporate visual recognition, personalization, and weather-based data and advice.

Under Armour’s wearable gear such as shirts, socks, and wristbands transmit data that is incorporated with larger data sets used for analysis and predictions by IBM’s Watson.

**IBM + Bragi**

This hearables company has a set of headphones—The Dash—that can receive and transmit instructions and situational awareness, and allow for interaction among colleagues.

With IBM, they are investing in cognitive capabilities in six areas: worker safety, guided instructions, smart employee notifications, team communication, workforce analysis and optimization, and biometric ID.
IBM’s Global Watson IoT Consulting Solutions Practice develops and deploys IoT-enabled business solutions to impact an enterprise’s top and bottom lines.

<table>
<thead>
<tr>
<th>Connected Solutions</th>
<th>Building &amp; Asset Optimization</th>
<th>Next Generation Supply Chain</th>
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<tbody>
<tr>
<td>Deliver differentiated services and new revenue streams in response to evolving market conditions</td>
<td>Maintain and optimize your cost to serve in unforeseen market conditions, events, and challenges</td>
<td>Improve insights and efficiency, and optimize working capital through agile operations</td>
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</table>

**Offerings**
- IoT Insights Workshop
- IoT Data Monetization
- Cognitive IoT
- Connected Devices & Vehicles
- Advanced metering & infrastructure
- Blockchain for Operations
- Facilities & Asset Management (C2O) – Tririga and Maximo implementation
- Building Optimization (aaS/C2O)
- Predictive Asset Optimization
- Predictive Project Health (aaS)
- Field Asset Inspection, Monitoring, Maintenance (aaS, C2O)
- Working Capital Management (C2O)
- Workflow Optimization (aaS/C2O) – links connected solutions with process automation
- I4.0/ CPS Factory (C2O)
- Supply Chain Optimization (aaS/C2O)
- Cognitive Manufacturing

**Example solution**
- Adopting wearable technologies for data monetization opportunities
- Deploying sensors on employees for optimizing building and energy use
- Implementing a wearables strategy for inventory picking and warehouse logistics

**IBM’s differentiation**
- Industry-specific solutions/semantic models in industrial and energy & utilities
- Consult to Operate including white labeling
- Pre-built assets for aaS IoT offerings
- Pay per Device with Watson IoT
- Rules-based optimization
- Industry specific solutions with asset class detail
- Simple subscription-based agreement for aaS assets

aaS – as-a-service; C2O – consult to operate
Sources
Sources

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