Critical Challenges Facing Occupational Health & Safety: Today and Tomorrow

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21st Century Characteristics

- **Volatility**
  - Nature, speed and magnitude of change
- **Uncertainty**
  - Unpredictability of issues and events
  - Info about past less useful in present
- **Complexity**
  - Multiple, and difficult to sort, causes
  - Algorithms manage complexity
- **Ambiguity**
  - Science seldom produces unambiguous results
  - Requires interpretation, but interpretation influenced by individual's point of view creating controversy
  - Guidance is less clear than before

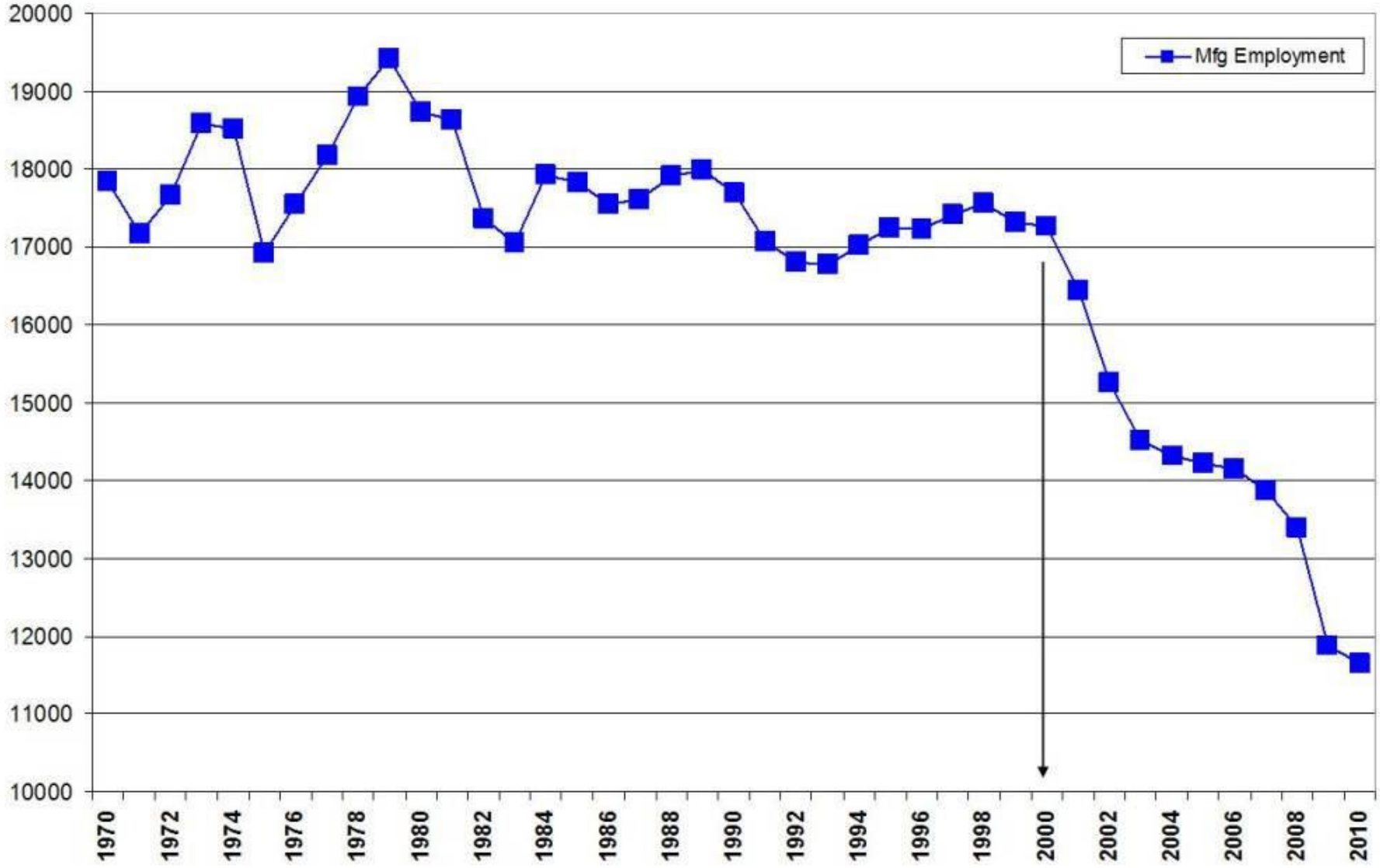
Issues

- Economy and Jobs
- Jobs & Automation
- Employment Arrangements & Risk
- Sensors and IoT
- Predictive Analytics and Safety
- Are Safer Companies Better Investments?

Economics of Our Time

- Slower GDP growth
- Decline of manufacturing employment
- Rise of low-wage service sector jobs
  - Concentrated in health care, leisure and hospitality

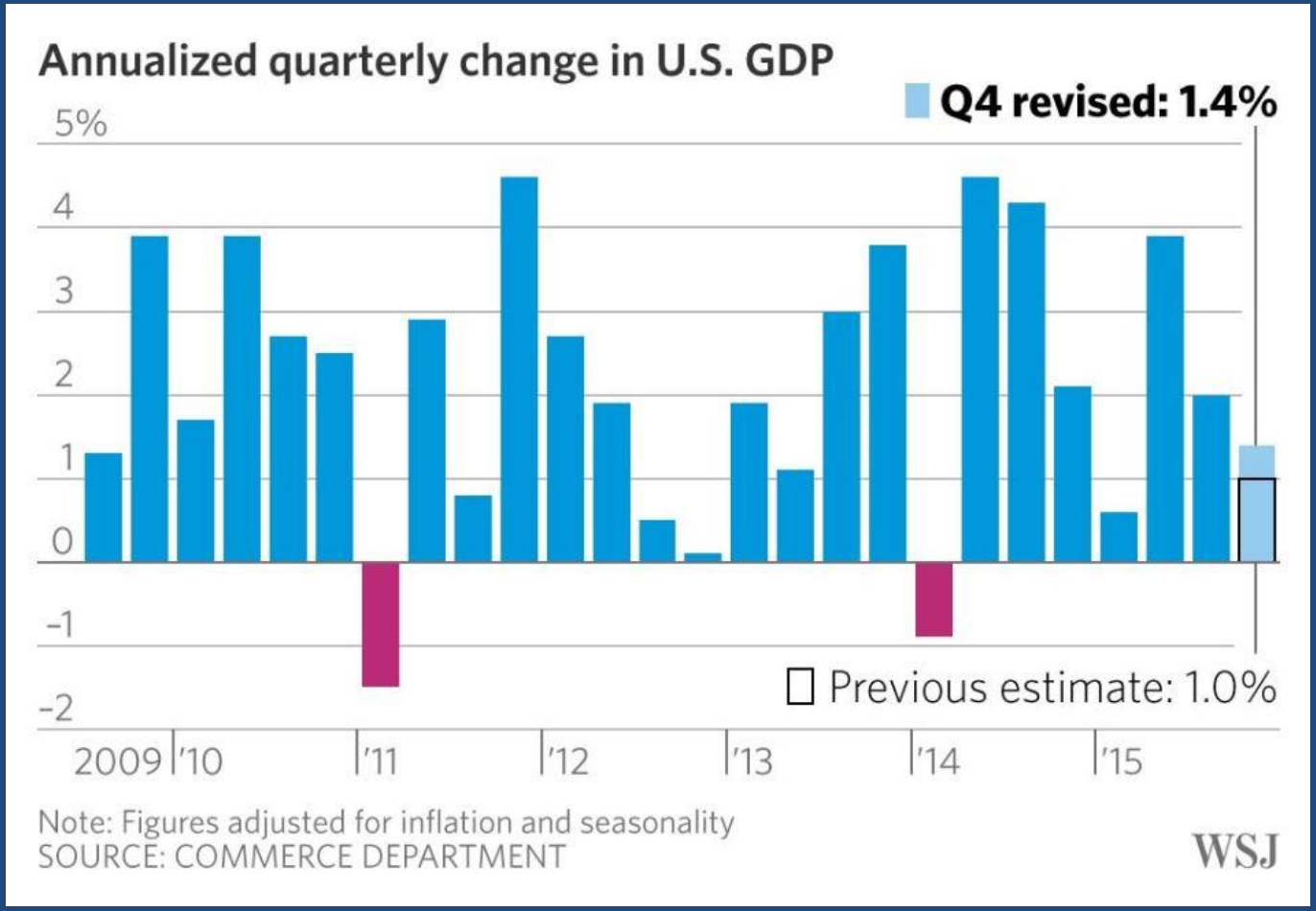
US Manufacturing Employment 1970-2010



Source: US Bureau of Labor Statistics http://www.bls.gov/iag/tgs/iag31-33.htm#workforce

Increasing GDP

- **An increase in GDP can be generated by (1) increasing number of workers, (2) hours worked per worker, or (3) productivity per worker.**



Increase Number of Workers

- Workforce growth rate from 2.2% in 1960s to 0.5% in 2010s
- Participation rate declining from 63.7% to 61.6%
- Adding new workers through immigration into U.S. difficult

Increase Hours Worked

- Weekly hours
  - U.S. workers already exceed other developed country averages
- Could you increase retirement age for Social Security benefits?
  - Would increase total hours worked
  - Unfair to those in physical labor jobs?

Increase Productivity per Worker

- Common solution is to emphasize education
  - Few jobs of the future will require STEM
  - Technical education may be more productive

- Jobs of the future
  - Of the top ten jobs of the next decade, only registered nurses and operations managers will require education beyond high school (BLS)

- Recent job creation by type—Jan 2015 to Jan 2016
  - Education and health (620K)
  - Professional services (620K)
  - Hospitality (458K)
  - Construction (264K)
  - Financial services (149K)
  - Manufacturing (45K)

Do the Benefits of Trade Exceed Its Costs?

- **Theory**
  - Developed countries like the U.S. adjusts to import competition by moving workers into more advanced industries that can successfully compete in global markets

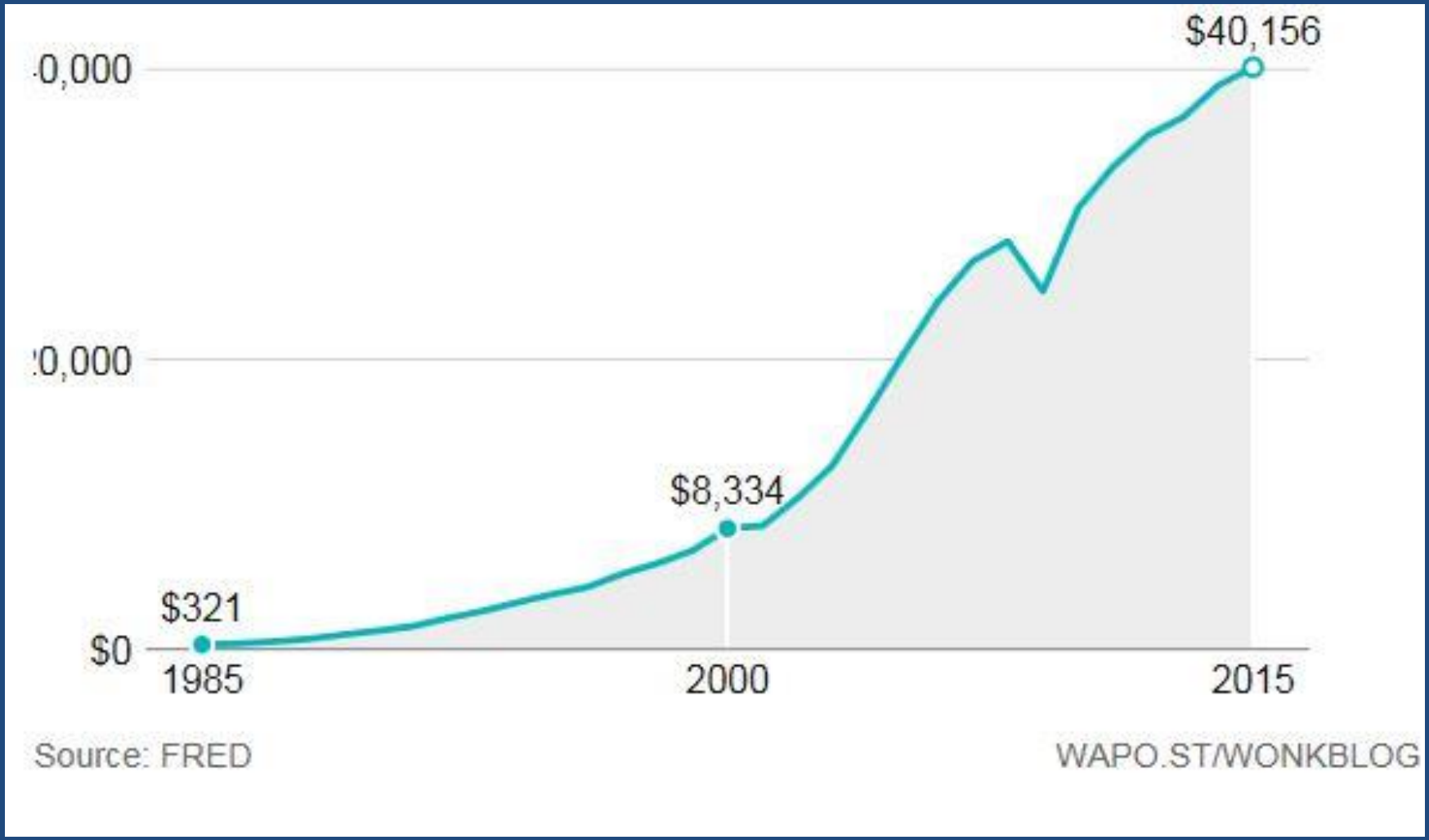
- Economists dismiss voters saying that they don't understand the economic trade-offs

- "Serious economists have never supported the Panglossian view of trade as a win-win for everyone"
  - Krugman, New York Times, March 28, 2016

- Belatedly, economists are finding out that the benefits of trade do not always justify its costs

U.S. Imports from China

In millions of dollars



New Scholarship on Effect of Trade on Labor Markets

- The expected adjustment to import competition never happened or at least has not happened yet.
- Wages remain low and unemployment high in the most affected job markets.
- No sign of offsetting job gains elsewhere in the economy.
- Sagging wages in low labor markets exposed to Chinese competition reduced earnings by $213 per adult per year.

  - Autor, D.H. et al. (2016). The China Shock: Learning from labor market adjustment to labor changes in trade. NBER Working Paper No. 21906.
  - Acemoglu, D. et al. (2014). Import competition and the great U.S. employment sag of the 2000s. NBER Working Paper No. 20395.

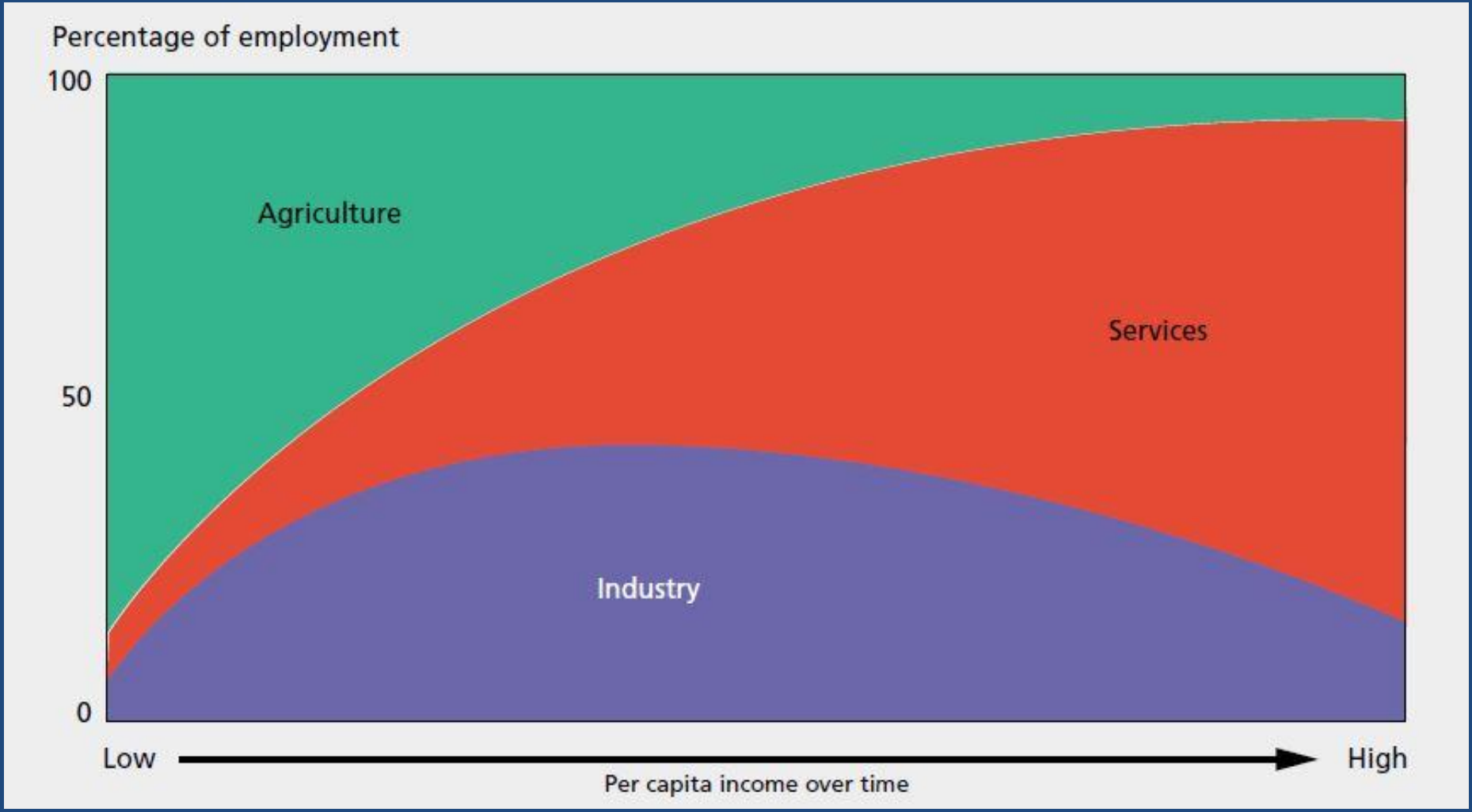
Jobs & Automation

Technology & Jobs

- 1914 1 in 3 Americans worked on a farm
- 2016 <2% work on a farm, produce far more food!

A lettuce thinner created by an agricultural tech startup uses cameras and sensors to thin lettuce rows. Salinas, Calif., has hired a venture capital fund to help it attract other high-tech agricultural companies to the area.

Changing structure of employment during economic development



Automation

- **Which jobs are safe?**
  - 47% job categories will be subject to automation in next two decades
- **Job Transitions**
  - Like the machine age in the 19th century, *new machine age* jobs will look different
  - Nobility of jobs controversy
    - **19h century**—working in the fields, nobler than at the loom?
    - **21st century**—working in manufacturing, nobler than working in the shared economy?

Bring on the personal trainers

Probability that computerisation will lead to job losses within the next two decades, 2013
(1=certain)

Job	Probability
Recreational therapists	0.003
Dentists	0.004
Athletic trainers	0.007
Clergy	0.008
Chemical engineers	0.02
Editors	0.06
Firefighters	0.17
Actors	0.37
Health technologists	0.40
Economists	0.43
Commercial pilots	0.55
Machinists	0.65
Word processors and typists	0.81
Real estate sales agents	0.86
Technical writers	0.89
Retail salespersons	0.92
Accountants and auditors	0.94
Telemarketers	0.99

Source: "The Future of Employment: How Susceptible are Jobs to Computerisation?" by C.Frey and M.Osborne (2013)

Robotics

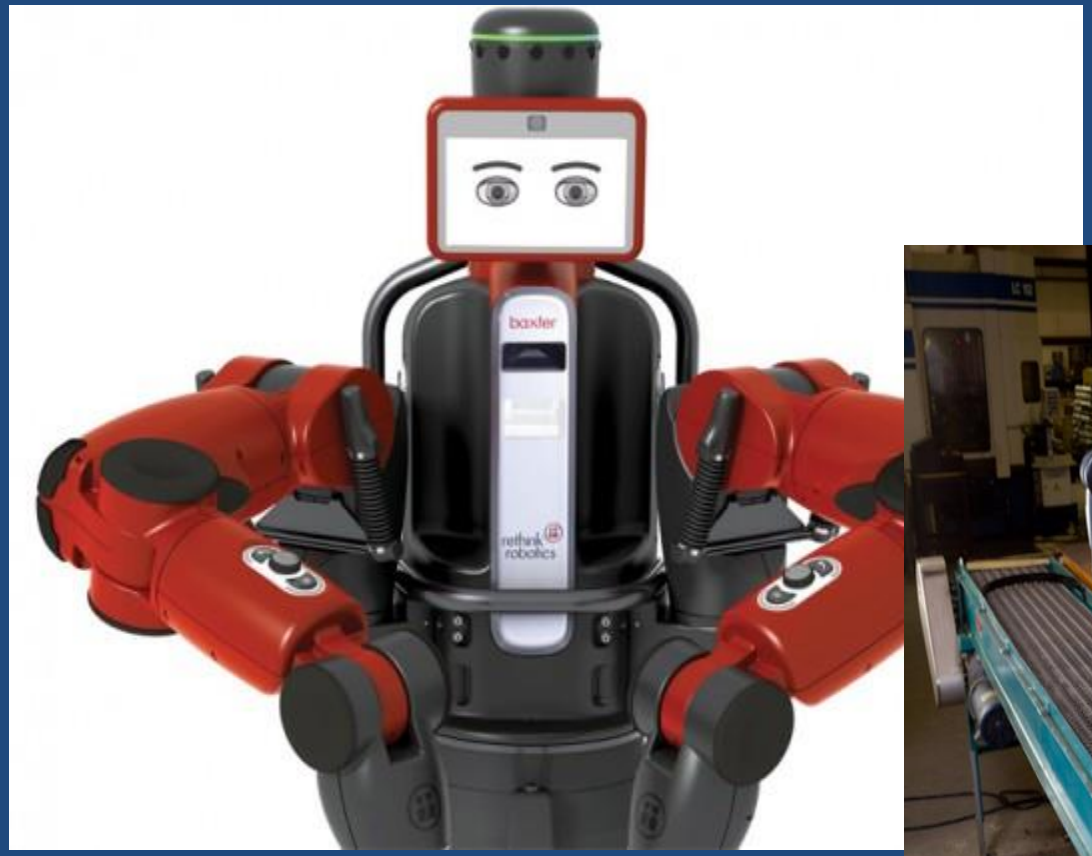
Scope of Robotics

- Robots are simply better than people at some tasks.
  - Mundane, repetitive, and precise jobs as clear candidates.
  - Robots already taken over as the primary worker in many factories.

- With perfect memories, internet connectivity, and high-powered CPUs for data analysis, robots can also provide informational support beyond any human capability.
  - Keep perfect record of project progress
  - Provide real-time scheduling and decision support
  - Have perfect recall

- Robots be placed in management positions where they can remind a team of deadlines, procedures, and progress.

Humanoid Robots



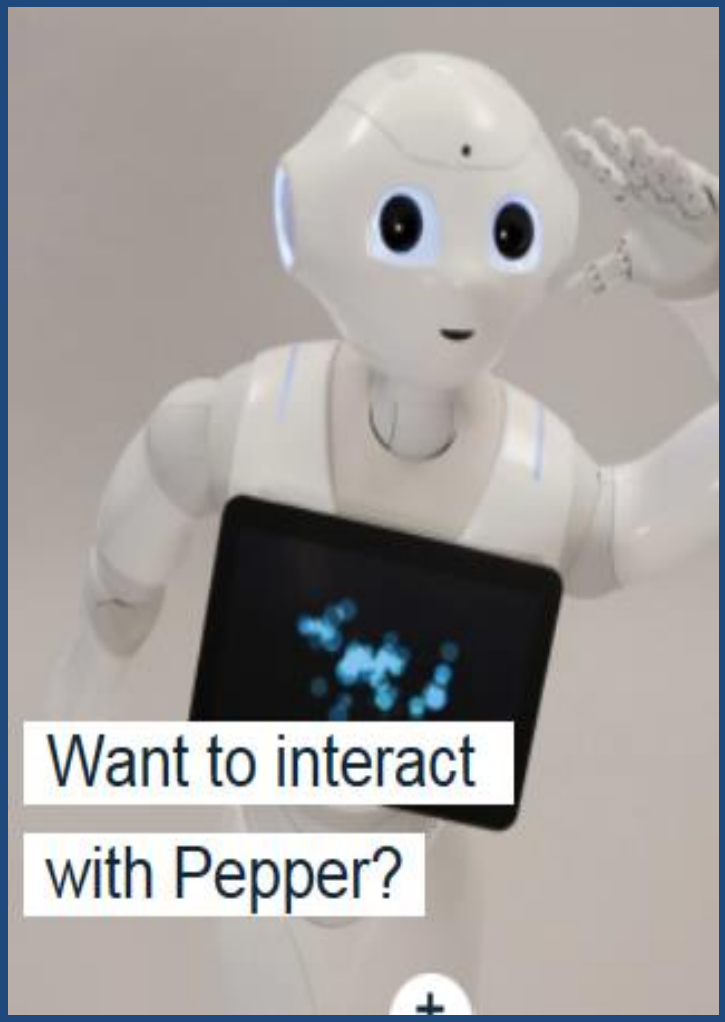
Companion Robots

- ***Pepper*** is a humanoid robot by Aldebaran Robotics and *SoftBank* Mobile designed with the ability to read emotions. An emotional robot.
  - Introduced on 5th June 2014 to enhance human well-being.
  - Available on February 2015 at a base price of JPY 198,000 ($1,931) at Softbank Mobile stores.
- Pepper's emotion comes from the ability to analyze expressions and voice tones.

Companion Robots

- “Our goal at Aldebaran is to create robots for the well being of humans, kind robots living with humans as a new artificial species. In order to realize this dream, it's not enough to simply have Pepper working at SoftBank stores. The ultimate goal is for Pepper to live with humans, the stores are just the beginning...”

- https://www.aldebaran.com/en/a-robots/who-is-pepper



Managerial Robotics

- At MIT
  - Management robot is learning to run a factory and give orders to cobots (collaborative robots)
- Can robots be managers?
  - Key element of a manager is the ability to dole out duties and to have team members perform them
  - If a robot were placed in a managerial position by the higher ups, would it have any actual authority over people?

University of Manitoba

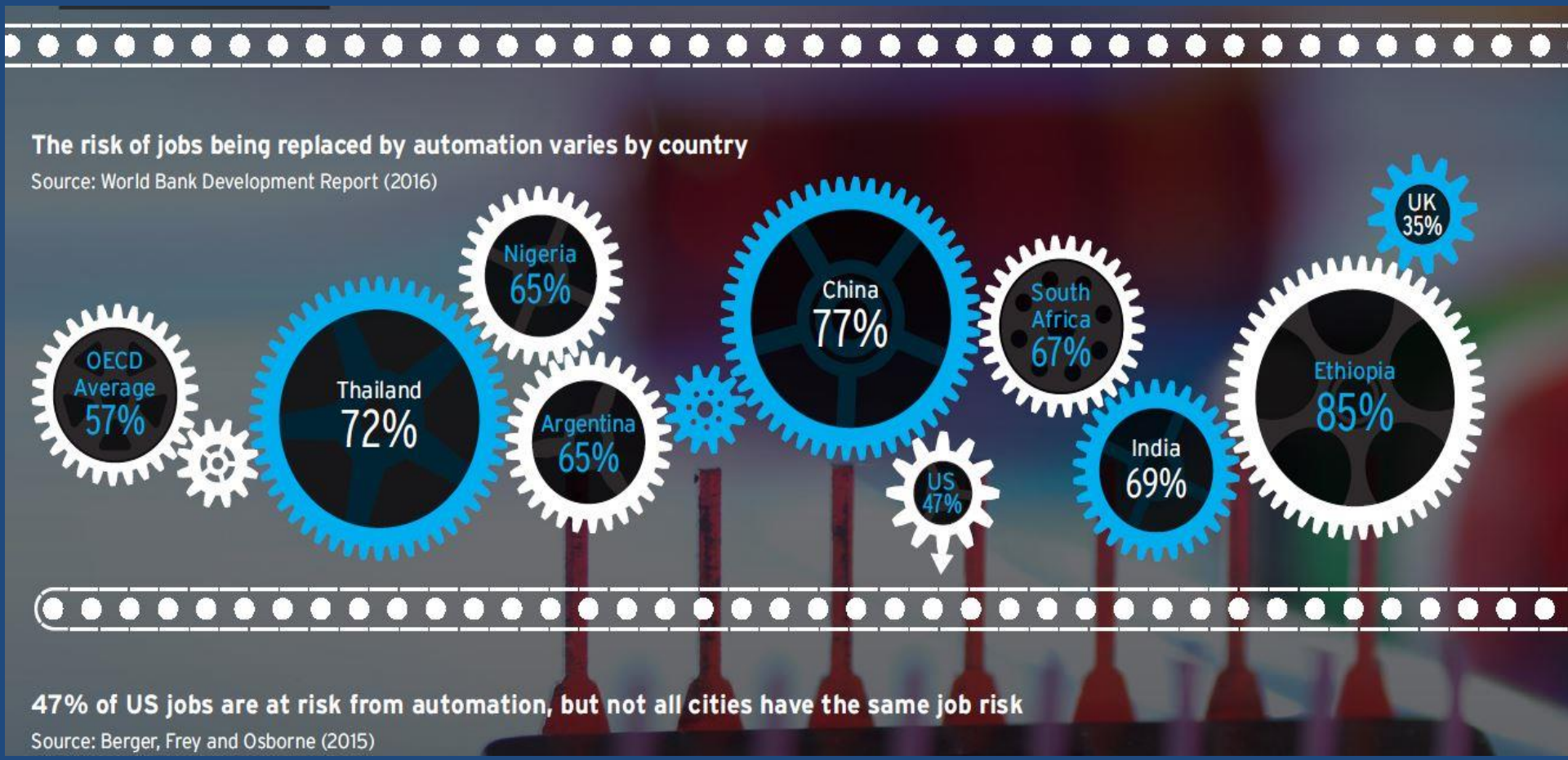
- Experiment to see if people would follow a robot's commands to do things, when they clearly did not want to.
  - Participants asked to rename files for 80 minutes
- 86% of participants obeying all the way through to the 80-minute mark
- People engaged the robot as if it were a person and argued with it, proposed compromises and used logic to try and sway its opinion
- Post-test, some reported that the robot may have been broken,
- Although they continued anyway, following a potentially-broken robot to do something they would rather not do.

  - Young & Cormier, Harvard Business Review, April, 2014
  - https://hbr.org/2014/04/can-robots-be-managers-too/

White-Collar Jobs Already Taken by Robots

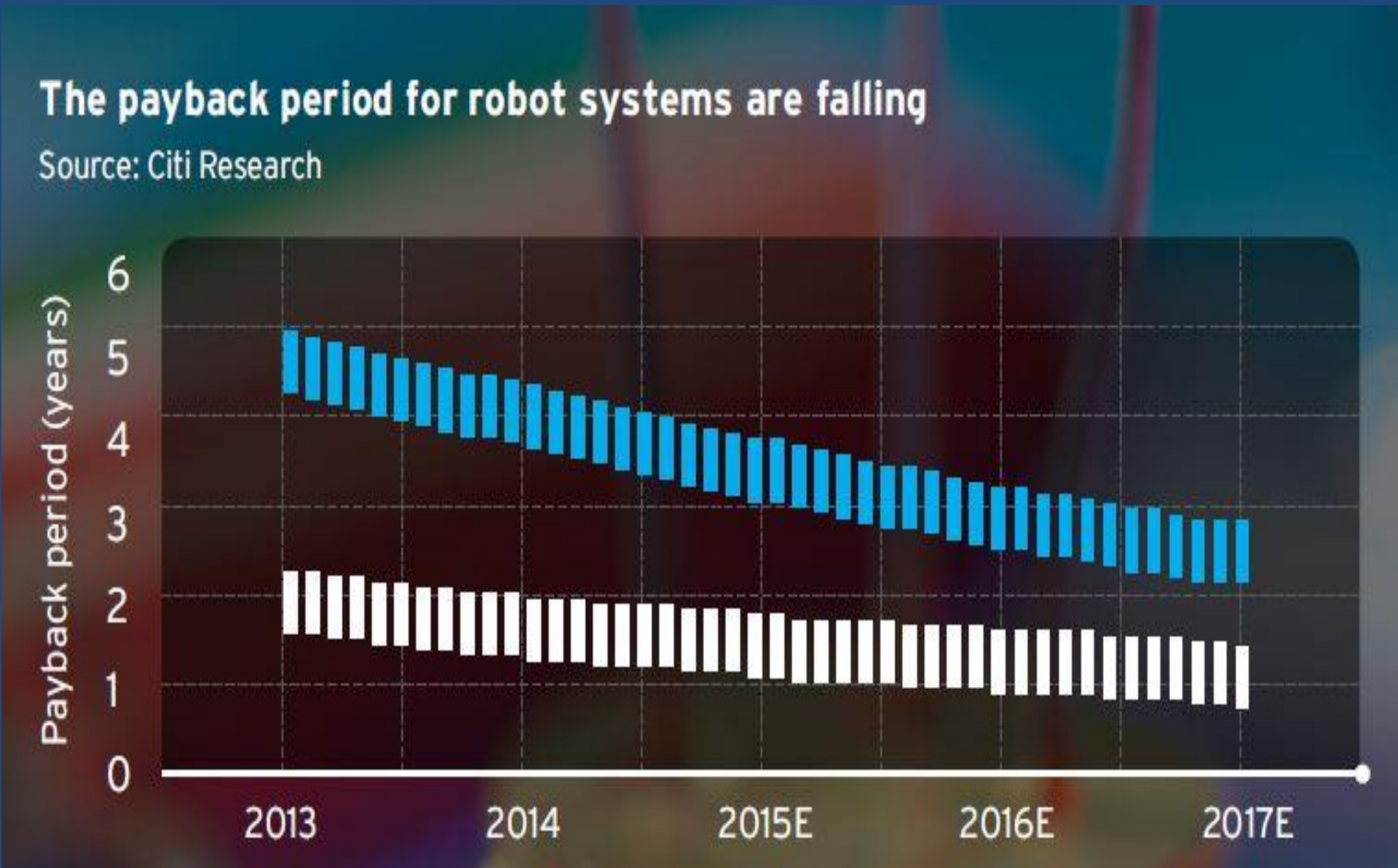
- **Financial and sports reporters**
  - Gathering information & answering who, what, when, why and how
  - Given level of writing by college graduates, the hurdle machines have to cross to out-perform humans isn't that high
- **Online marketers**
  - Craft ad messages
  - Programmatic ad buying
- **Anesthesiologists, surgeons & diagnosticians**
  - Automate delivery of anesthesia
  - Keeping pace with release of medical data
  - Watson vs. Doctor—90% vs. 50%
- **E-Discovery lawyers and law firm associates**
  - Models that predict outcome of arguments most like to prevail—71% accuracy for SCOTUS cases
- **Financial analysts and advisors**
  - Rob-advisors
  - *SigFig* uses algorithms to diversify and manage investment accounts

Risk of Automation by Country



Oxford & Citigroup (2016). *Technology at Work v2.0.*
http://www.oxfordmartin.ox.ac.uk/downloads/reports/Citi_GPS_Technology_Work_2.pdf

Investment in Robots



Robotic Safety Standards

- **ANSI/RIA R15.06-2012**
  - American National Standard for Industrial Robots and Robot Systems-Safety Requirements
    - Approved March 28, 2013 (revision of ANSI R15.06-1999)
- Provides guidelines for the manufacture and integration of Industrial Robots and Robot Systems
  - Emphasis on their safe use, the importance of risk assessment and establishing personnel safety.
- Offers a global safety standard for the manufacture and integration of robotic systems.

- **OSHA** (1999)
  - https://www.osha.gov/dts/osta/otm/otm_iv/otm_iv_4.html

Occupational Robotics

- New field for safety and health practitioners?

- Robot Types:
  - Industrial
  - Professional & Personal Service
  - Collaborative—direct interaction

- Risky interactions between human and robot workers

Recommendations

- Safety practitioners should be directly involved in the development of international standards aimed at ensuring safety of workplaces with human and robot workers.

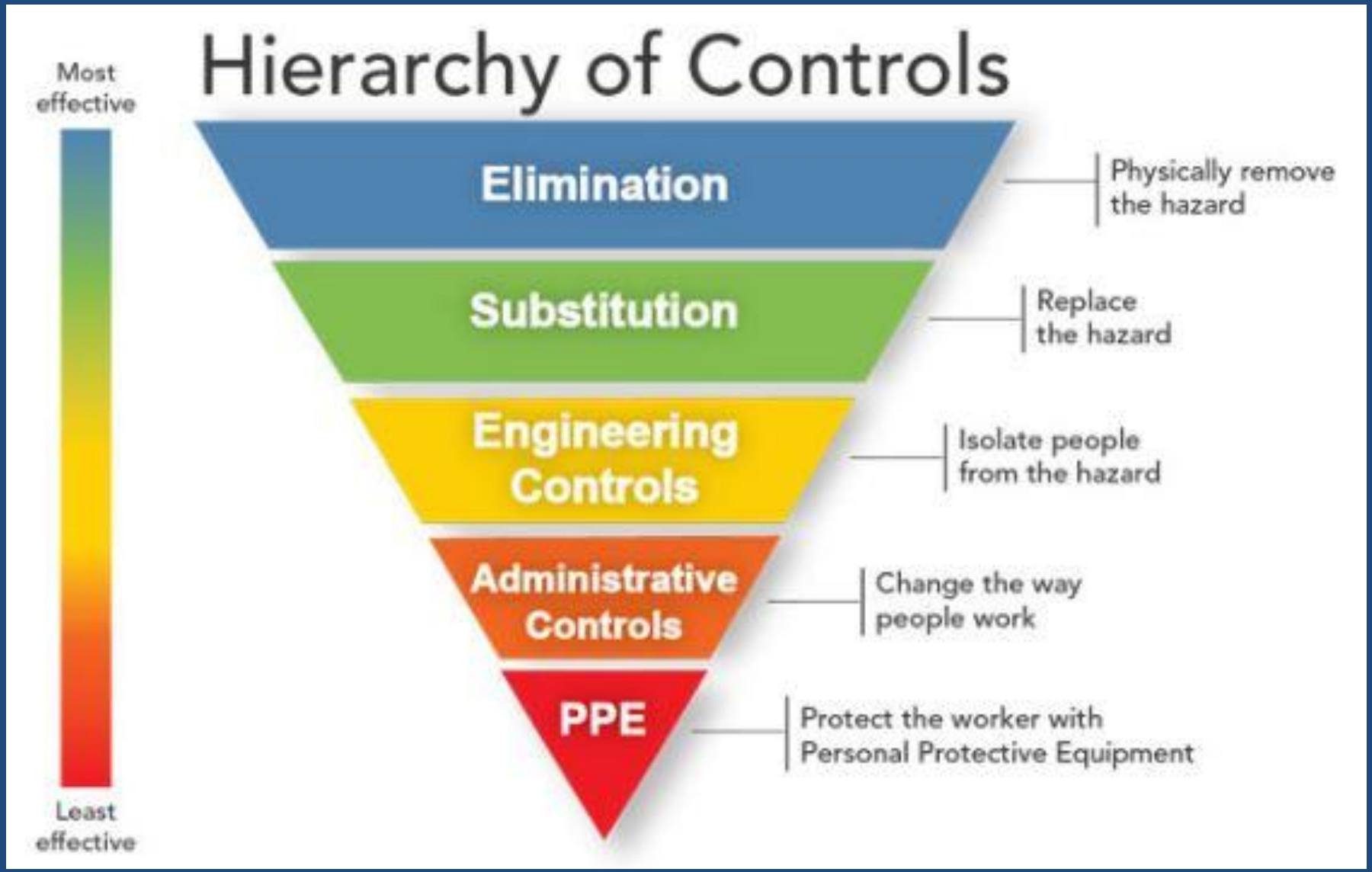
- Workplace safety standards for maintenance, operation, and interaction with human workers, of professional, personal service and collaborative (including managerial) robots should be developed.

- Proactive approaches for establishing risk profiles of robotic workplaces should be developed; and

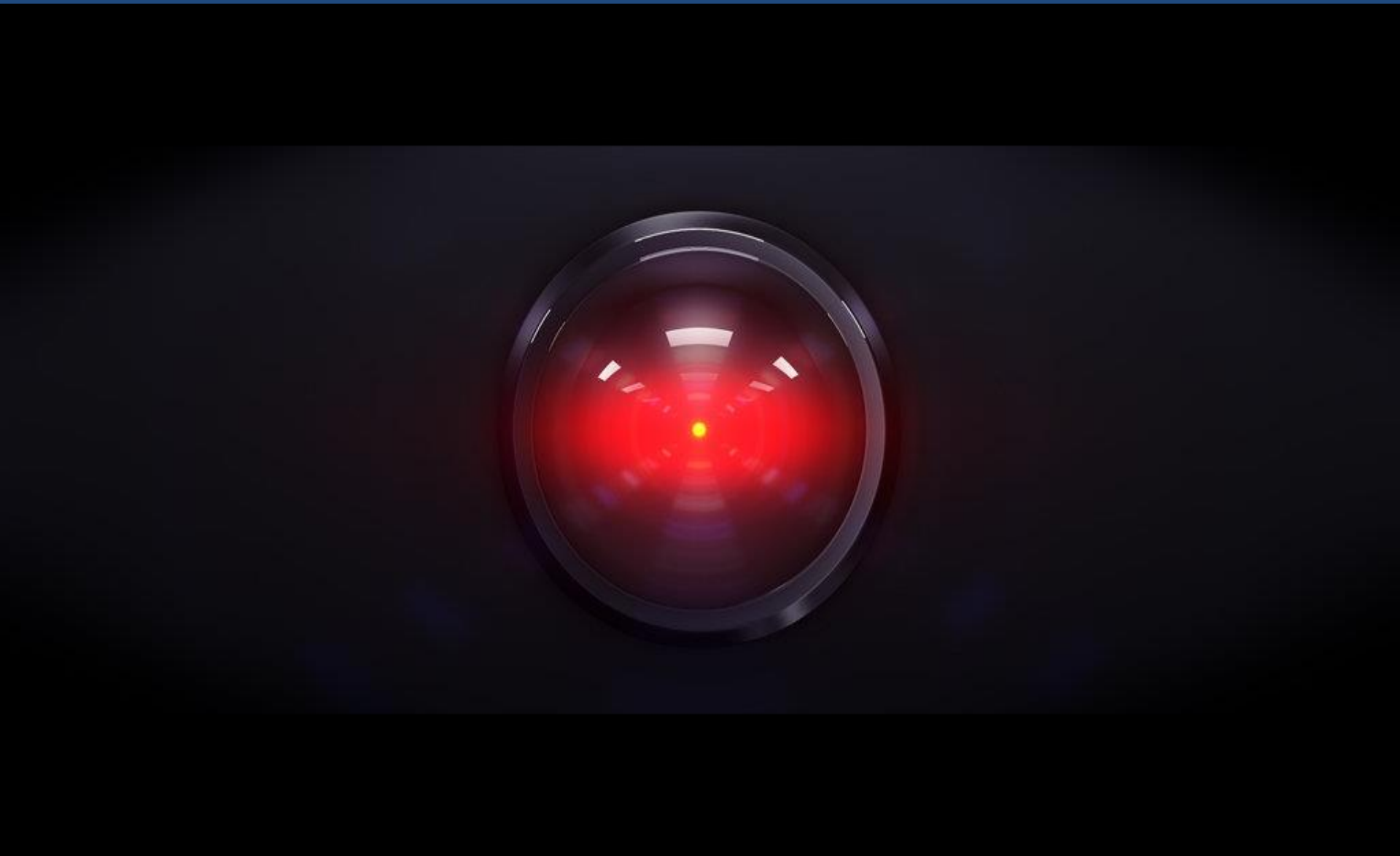
- Redundant safety measures should be developed and operationalized to protect human workers while performing maintenance tasks on robot workers.

  - Murashov, V., Hearl, F., Howard, J. (2016). Working Safety with Robots. *J Occup Environ Hygiene* 13(3):D61-D71 Working Safety with Robots.

Human and Robot Workers: Risk Profile



"I'm sorry Dave, I'm afraid I can't do that"



Employment & Risk

21st Century Work Characteristics

- **Engineering + Digital Technology**
  - Miniaturization & Robotization
  - Smart systems reshaping human-machine relationship

- **New business structuring focusing on digital work product**
  - Knowledge work that can be digitized can be separated from geography
    - Resulting in telework, nomadic work, & virtual work;
    - Reducing hierarchical and geographical barriers, modifying conceptions of space and time and further blurring the line between work and home life.

- **"Gig" instead of a job?**
  - Series of shorter-term jobs
  - Some coordinated through a mobile app

- **"New" employment arrangements—a matter of perspective**
  - Longstanding work arrangements in blue-collar work are being "newly" applied to white collar work

Employment: From *Stability* to *Precariousness*

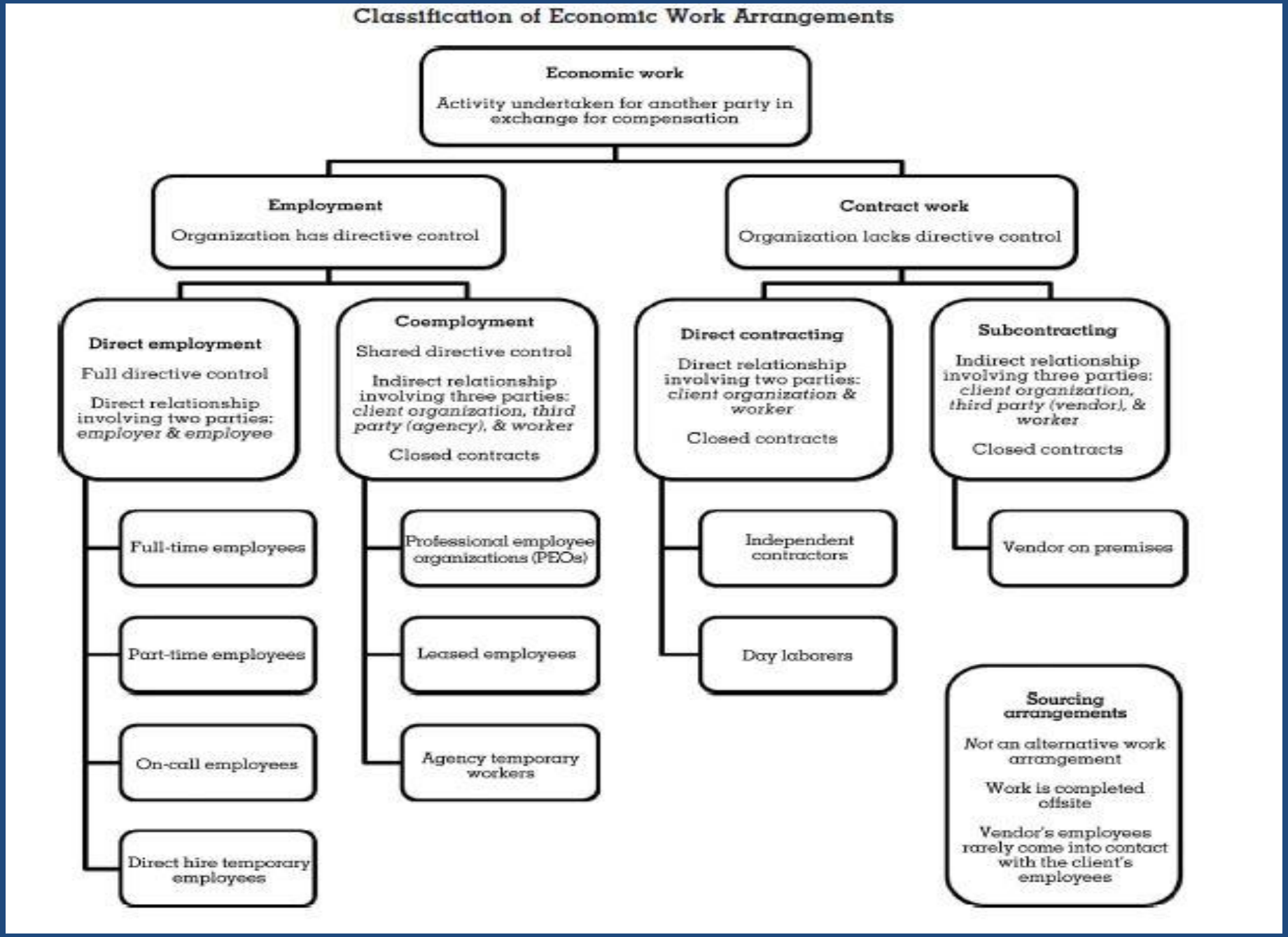
- Growth of companies created by industrial revolution
  - Vertical structure differentiated jobs from one another

- "Good" job =
  - Being an "employee" (as American law understands the term) of a particular company for your entire working life until you qualified for a private or social security pension

- Government built social welfare laws along same lines
    - Workers got security, benefits, protections, and steady wage increases
      - Social Security (1935), FLSA (1938), Medicare (1965)
    - Companies got stable workforce in which they could invest with a fair expectation of positive returns including retention

Employment: From *Stability* to *Precariousness*

- Erosion of the *Standard* Employment Relationship
  - From internal labor market to external labor market
- Rise of "temporariness"
  - In a triangular or dual employer relationship
- Increase in job insecurity
  - Stress continuum: permanent → downsizing → temporary → unemployment
- Decline in social protections
  - Workers' compensation, health insurance, wage & hour protections
- Disempowerment
  - Declining unionization in the private sector leading to individualized bargaining between employer and worker
- Powerless to exercise legally granted workplace rights
  - Worker protection laws written based on a mid-20th century model



Cappelli, P. Classifying work in the new economy. *Academy of Management Review* 2013;38(4): 575-596

- **Employment—**Organization has directive control
  - Direct Employment—Standard employment relationship
    - Full-time employees
    - Part-time employees
    - On-call employees
    - Direct hire temporary employees
  - Co-employment—3rd party added to the relationship
    - Professional employment organizations
    - Leased employees
    - Agency temporary or temporary help services
      - Represents ~ 70% of co-employment relationships

- **Contract Work—**Organization lacks directive control
  - Direct contracting
    - Independent contractors
    - Day laborers
  - Subcontracting
    - Vendor on premises

Prevalence of New Arrangements

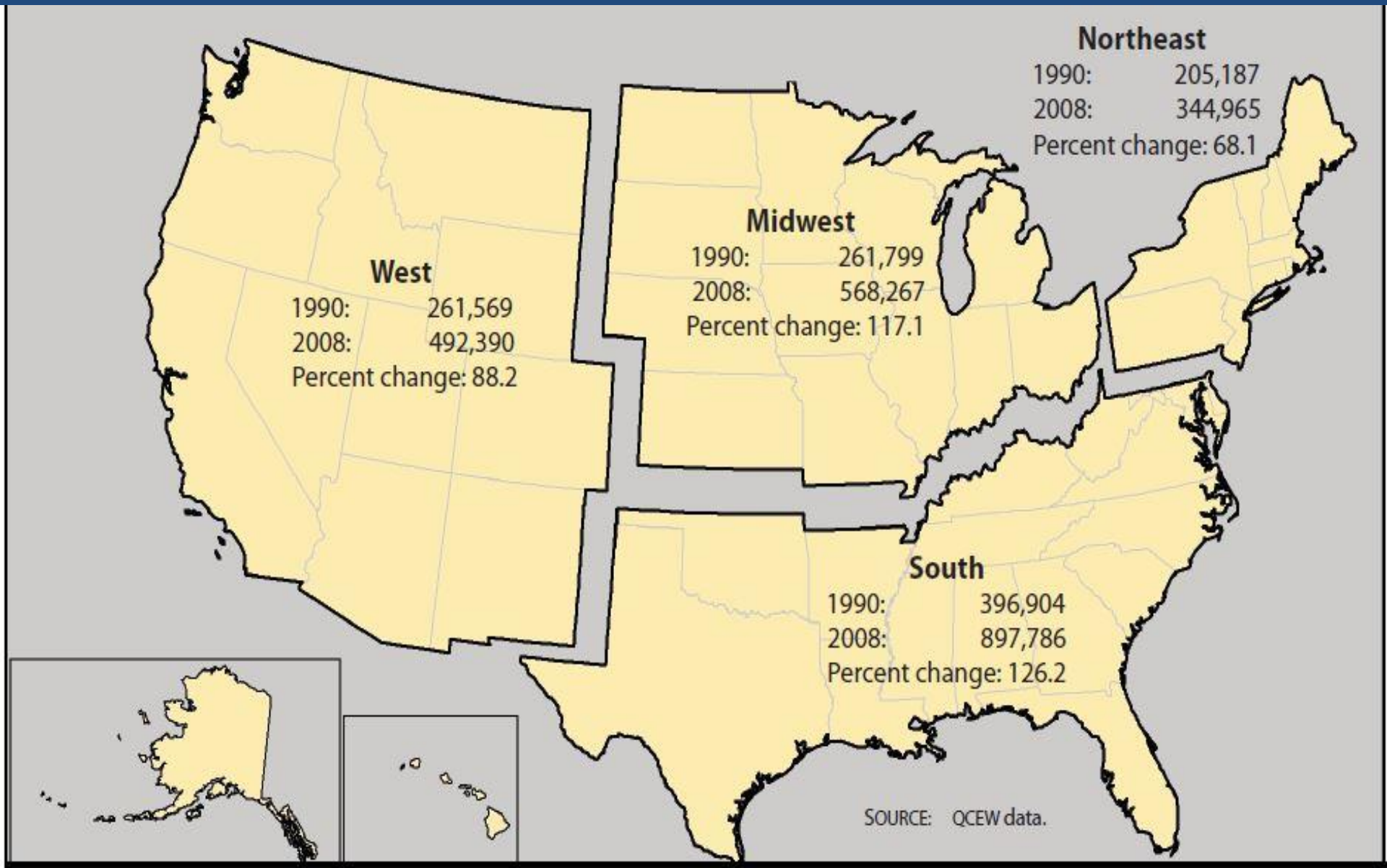
- **1995—2005**
  - 9.3 to 10.1% of total employment
- **2005—2015**
  - 10.1 to 15.8% of total employment
  - Represents an increase of 9.4 million over ten year period
    - Greater than the rise in total employment for same period
    - Meaning there was a small net decline in number of workers in standard arrangements
      - Katz, L.F. & Krueger, A.B. (2016). NBER.
- **2010 National Health Interview Survey**
  - 18.7% of 27,157 adults work in non-standard arrangements
  - Represents ~29 million total US workers
      - Alterman, T. et al. (2013). Am J Ind Med
- **GAO, 2015**
  - Size of the contingent workforce can range from less than 5% to more than 33% of total employed labor force, depending on widely-varying definitions of contingent work

Firms Using Temporary Workers by Size

	25-99 Employees	Average 25+ Employees	100+ Employees
Percent of Firms Using Temporary or Leased Workers	12%	15%	24%

Source: American Staffing Association, Client Survey (ASA, 2011)

Temporary Employment by Region

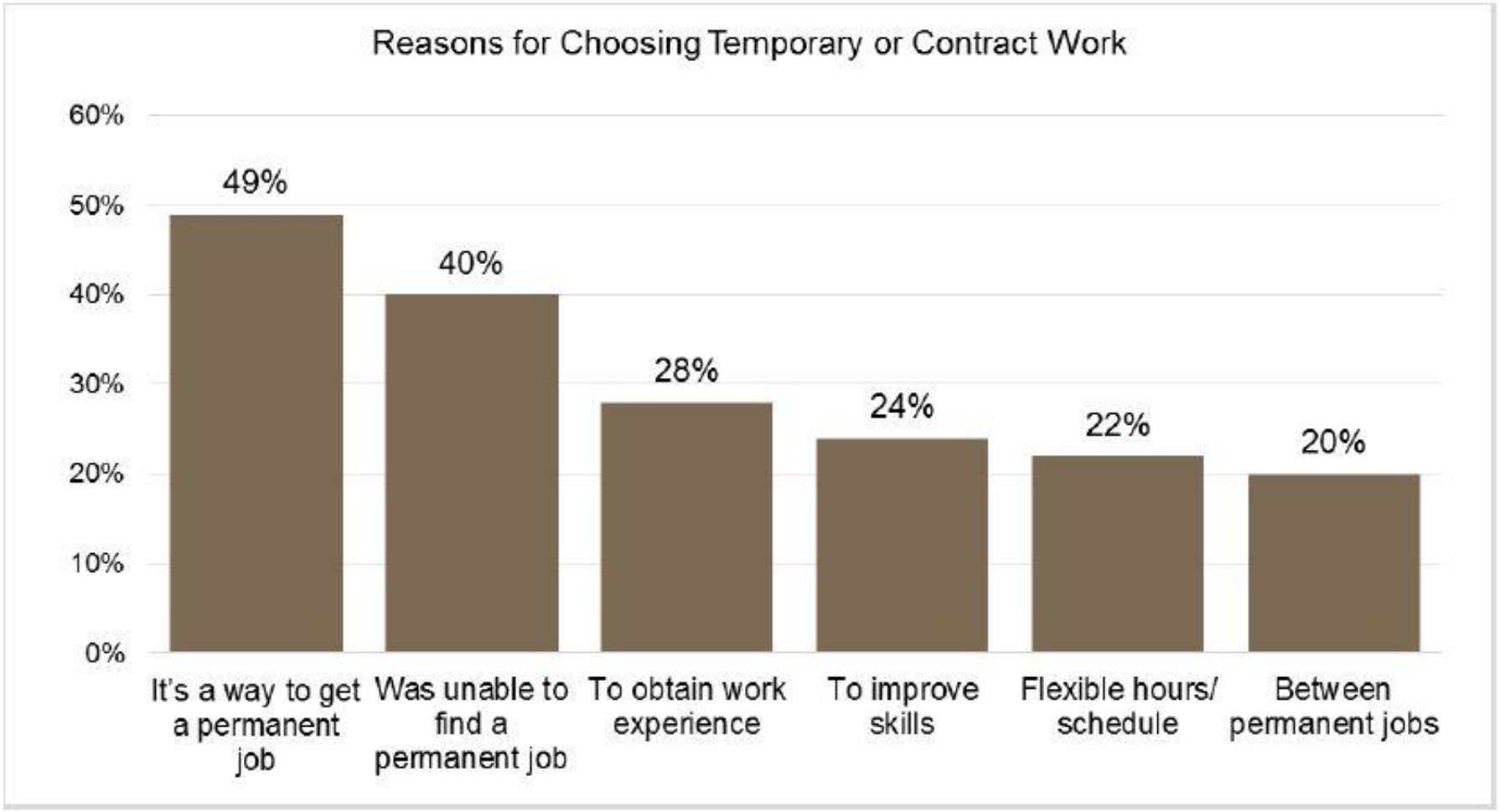


Why *Employers* do Temporary Staffing

- When **Expertise** Is Needed
  - Domestic outsourcing to smaller firm allows firm to tap into expertise
- When **Flexible** Staffing Is Needed
  - Helps adjust to fluctuations in demand—temps easier to replace
- When **Costs** Need Saving
  - Cost of expert services less if obtained in the market vs internally
  - Reduces social protection costs
    - Health, pension, workers' compensation, unemployment insurance
- When **Capital** is Needed
  - Financial markets incentivize corporations to shed all but their core business
    - Working under corporate brand name, but working for serial subcontractors
    - Lean management—a contractor can do peripheral tasks cheaper than can primary employer because of specialization

Why *People* Do Temporary Staffing Work

Source: ASA (2014) https://americanstaffing.net/wp-content/uploads/2014/08/Fact_Sheet_Aug_20141.pdf



Issues in New Economic Work

- **Management**
  - How do organizations decide which arrangement to use?
  - How do workers in different employment arrangements, but working side by side, alter the social context of work and managers' ability to get work done?
  - How are efforts at safety culture affected?
- **Legal**
  - How do the various definitions of employee and employer affect the new economic work arrangements?
  - Differing ways to determine the legally responsible employer.
- **Economic**
  - Western countries taking on features associated with informal economies of less developed countries
  - Is all temporary work low wage work? It was, but changing...

Toward Higher Skill and Pay

Table 1. Employment and wages in employment services occupations for 2008, and percent change for 2004–08

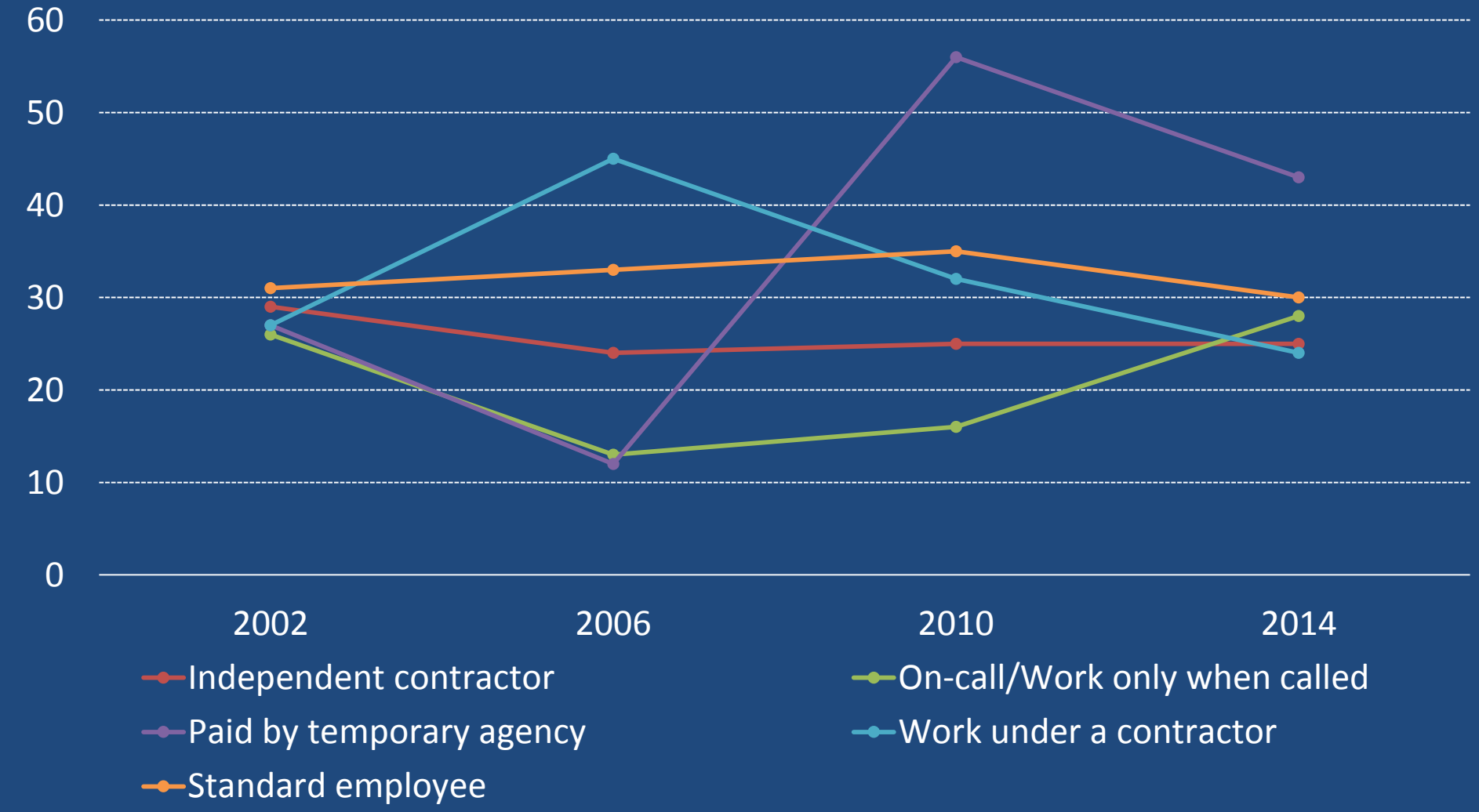
	2008			Percent change, 2004–08	
	Employment	Percent of total	Mean annual wage	Employment	Real wage
All occupations, all industries	135,185,230	. . .	$42,270	5.5	0.2
All occupations, employment services	3,408,230	100.0	32,530	–.1	5.6
Office and administrative support	843,560	24.8	27,890	1.1	–2.0
Transportation and material moving	660,530	19.4	22,460	–21.6	3.6
Production	654,030	19.2	23,700	18.4	1.8
Construction and extraction	186,590	5.5	30,360	–4.9	8.8
Healthcare practitioner and technical	168,270	4.9	62,770	11.3	–1.1
Business and financial operations	156,300	4.6	57,640	49.7	7.5
Sales and related	102,930	3.0	37,560	13.3	8.3
Building and grounds cleaning and maintenance	91,970	2.7	21,730	–12.5	1.1
Healthcare support	79,940	2.4	26,200	–8.8	–3.2
Computer and mathematical	77,970	2.3	71,020	41.2	–7.4
Food preparation and serving related	74,490	2.2	20,800	–23.5	5.1
Management	58,090	1.7	97,990	–5.0	3.9
Installation, maintenance, and repair	54,880	1.6	35,600	10.4	2.1
Architecture and engineering	47,460	1.4	66,260	7.2	–2.6
Personal care and service	37,190	1.1	21,670	26.0	–3.4
Education, training, and library	30,930	.9	43,240	40.5	–2.9
Arts, design, entertainment, sports, and media	26,320	.8	49,670	23.3	–9.5
Life, physical, and social science	15,830	.5	52,130	11.3	12.4
Protective service	14,580	.4	24,220	24.8	–2.0
Legal	10,950	.3	80,650	87.2	14.7
Community and social services	7,940	.2	34,570	39.8	–1.8
Farming, fishing, and forestry	7,490	.2	23,030	–75.3	23.1

SOURCE: OES data

Health & Safety Implications Using Differential Risk Analysis

- Access to social insurance benefits
- Unequal lifespans
- Social *determinant* of health
- Mental Health
- Specific risks:
  - Mortality
  - Morbidity
    - Injury
    - Illness

Percentage Change in Work Stress by Type of Employment: 2002-2014



Source: NIOSH Quality of WorkLife survey (http://www.cdc.gov/niosh/topics/stress/qwlquest.html)

Mortality Risk—Europe

- Longitudinal data from 10 towns in Finland—26,592 men and 65,759 women
- Overall mortality 1.2-1.6 times higher among temporary employees compared to permanent employees
  - For alcohol-related causes, hazard ratio was more for men with temporary jobs as was smoking-related cancer.
    - Corresponding risks were greater for the unemployed
  - Moving from temp to permanent work associated with lower mortality than remaining continuously in permanent employment

- Conventional research practice of treating the employed as a single group may attenuate the association between employment status and mortality!

  - Kivimaki, M. et al. (2003). Temporary employment and risk of overall and cause-specific mortality, *Am J Epidemiology, 158(7*), 663-668.

Mortality Risk—U.S.

- **CFOI**
  - In 2013, Census of Fatal Occupational Injuries (CFOI) reported
    - 17% of all workers killed were working in alternative arrangements
    - Such workers represented less than 3% of total private sector workforce
- **NIOSH**
  - Odds of reported fatal incident as opposed to a reported non-fatal incident were 2.8 times higher for contract workers than operators.
  - Other factors associated with fatality:
    - Being a contract worker or being more than 8 hours into a working day
    - Having less overall experience in that specific mine
    - Contractors had higher reported fatality rates than direct employees but lower reported non-fatal injury rates.

» Muzaffar et al., (2013) J Occup Environ Med, 55, 1337-1344.

Morbidity: Injury

- **European Studies**
  - 7 of 13 European reports show increased risk (Virtanen 2005).

- **U.S. Studies**
  - Higher injury rates in subcontracting turnaround procedures at ***petrochemical*** facilities (Rebitzer 1995).
  - Temps had twice injury rate at a ***plastics*** manufacturer (Morris 1999).
  - Workers' comp injury claim rates for temps double those of permanent workers in Washington state (Smith 2010).
  - ***PROPUBLICA,*** using Florida workers' compensation data and BLS data, found an injury odds ratio of close to 4 for temporary workers compared to all other workers (Pierce 2013).

Morbidity: Illness

- **European Studies**
  - Finnish study showed that temporary employment was associated with 1.2 to 1.6 times higher all-cause mortality compared with permanent employment
  - Those who were removed from temporary to permanent had lower mortality than those who remained in temporary employment.
    - Kivimaki, M. et al. (2003). *Am J Epidemiology*, 158(7), 663-668.

- **U.S. Studies**
  - Few studies have been undertaken
  - National databases do not currently collect information on employment status with any detail to be able to discern health outcomes
  - Insurer and provider databases may provide some data

Why the Differential Risks?

- New economy jobs are more hazardous than standard jobs
  - Less experience & familiarity with operations due to short tenure at a worksite
  - Fewer hours of safety training relevant for the specific job assignment
  - More distant relationships with longer-term workers who could help navigate worksite hazards
- Limited availability & use of personal protective equipment
- Less likely to report unsafe conditions because of risks associated with precarious employment
- Confusion (real or perceived) about who is responsible for worker safety:
  - Who is the responsible employer? How do you tell?
  - Common law test, economic realities test, IRS test, various court cases

Research 1

- **Agreed on definitions** of economic work arrangements
  - Standard indicators for survey research needed
  - Precarious, contingent, temporary, alternative, new economy, gig
  - Definitions of new economy relationships lack standardization across intra- and inter-national databases
    - » Benach et al. (2012)
- **Improved surveillance** about extent of new economy arrangements and number of workers involved in each type is needed
  - Data challenges in measuring extent of new economy arrangements
  - Dynamic arrangements
    - » Bernhardt (2014)

Research 2

- **Are existing models for employment quality that relate to health outcomes useful?**
  - Pressures-Disorganization-Regulatory (PDR) Failure Model
    - Quinlan, M. et al. (2004).
  - Employment strain model (demand/control model)
    - Lewchuk, W. et al. (2008).
  - Rodger's multidimensional definition of precarious work
    - Rogers, G. (1989).
  - Employment Precariousness Scale (EPRES)(2012).

- **If so, use a model to:**
  - Organize data and understand links between employment & health
  - Encourage observation/testing of causal pathways & mechanisms
  - Identify potential entry points to implement interventions

  - Benach et al. (2016). What should we know about precarious employment and health in 2025? Framing the agenda for the next decade of research. Int J. Epidemiol, 45(1), 232-238.

Research 3

- **Possible Studies?**
  - Prospective study of health consequences of new economy employment
    - Chronic stressor vs shorter isolated exposures
    - Choice vs. forced
  - Intervention effectiveness study of a range of policy approaches
    - Boden et al. (2016)

- Emphasize study of the “new” organization of work as distinct research area
  - NIOSH
    - Healthy work design and worker well-being (NORA 3)

Some Final Thoughts

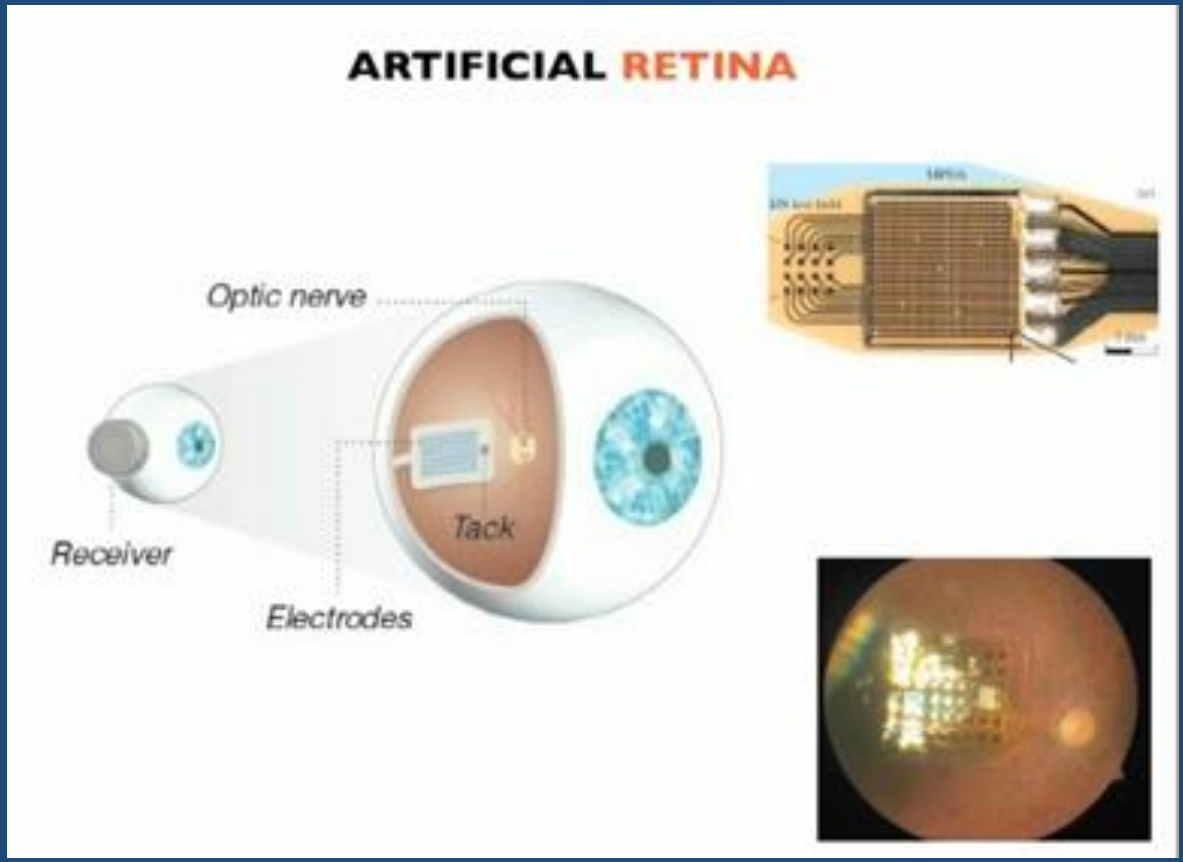
- **Risk from New Arrangements Are Real**
  - Evidence is unequivocal that employers are shifting burden of protecting workers from the things that go wrong in life to the worker.
  - Evidence suggests that workers employed in a triangular arrangements (co-employment) are at higher risk for occupational safety and health risks than workers in direct employment arrangements or direct contracting.

- **Better Taxonomy, Better Surveillance, and New Research Methods and Research Needed**

Sensors and
The Internet of Things

Sensor Replacement & Enhancement

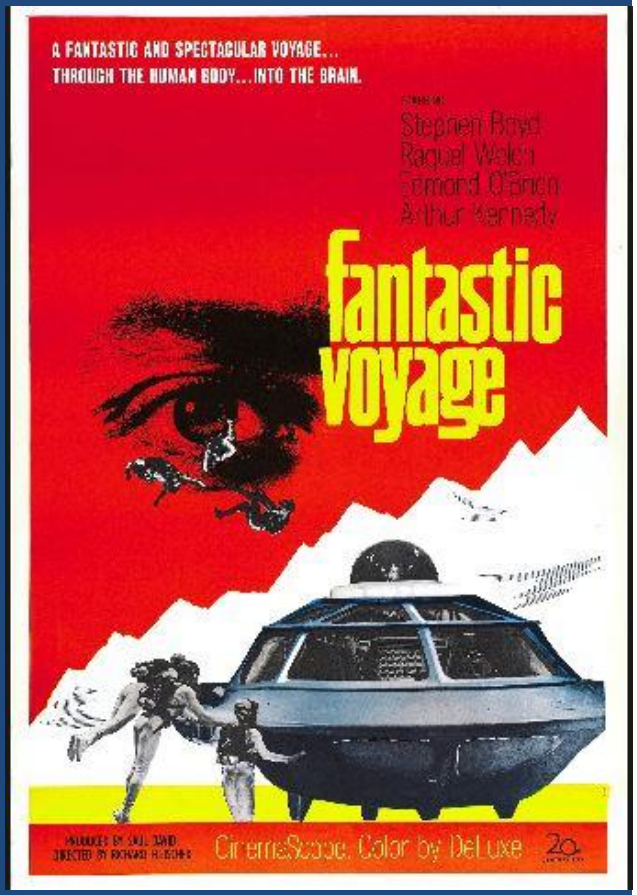
- Human Sensors
  - Sight
  - Hearing
  - Taste
  - Smell
  - Touch



Sensor Technology Is Expanding

- Enabling capabilities increasing exponentially
  - Improvement of measurement science
  - Readily available geographic and spatial information
  - Miniaturization of instruments
  - Utilization of smart phone/tablet technologies

- Types of Sensors
  - Environmental sensors
    - Air, Water environment
    - In-vehicle monitoring
  - Wearable sensors
    - Clothing
    - Hard hats
  - Embedded sensors
    - Internal biologic monitors

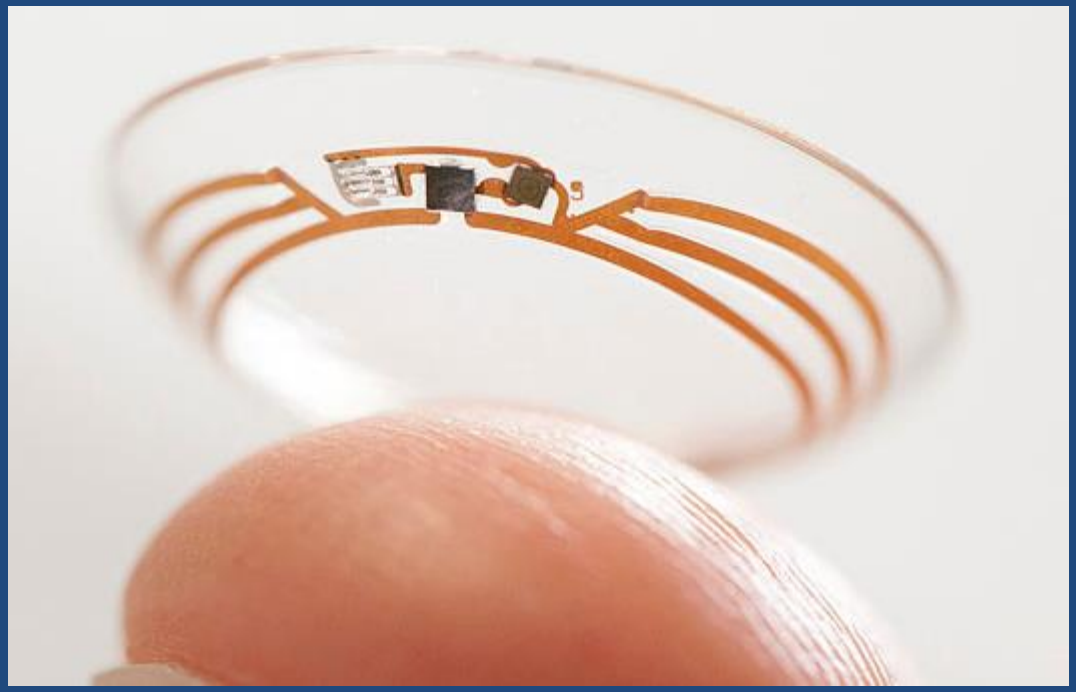


FANTASTIC VOYAGE

iPill.... Diagnosis and Rx

Bio-Sensors

- Google announces 'smart' contact lenses that monitor glucose levels (January 16, 2014)



Direct Reading and Sensor Technology

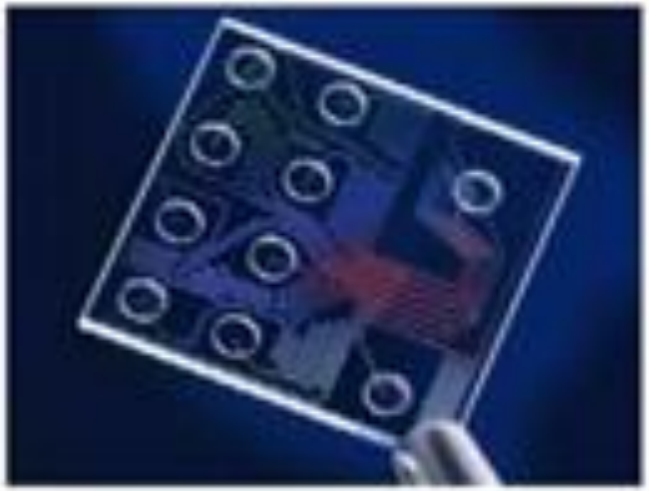
iBGStar

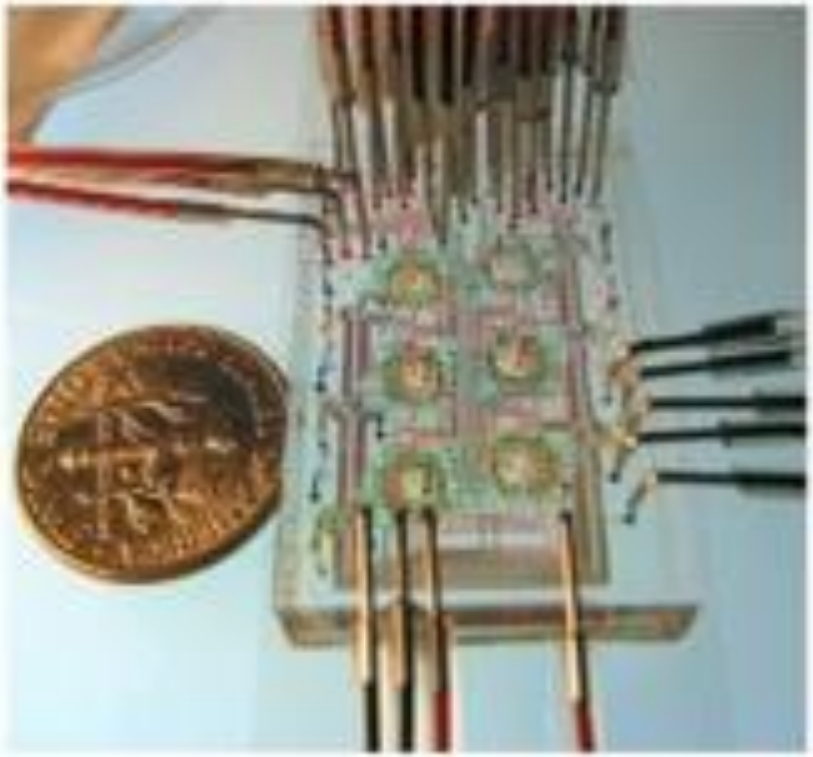
Glucose Meter integrated with iPhone

Modern Self = Quantified Self

- Keeping track of personal health data
- Chemical load counts in the body
- Personal genome sequencing
  - Monitoring your *epigenome* to see how exposures have altered it?
    - www.23andme.com
- Life-logging
- Self Experimentation
- Behavior monitoring
- Location tracking
- Non-invasive probes
- Digitizing body info
- Sharing Health Records
- Psychological Self-Assessments
- Medical Self-Diagnostics

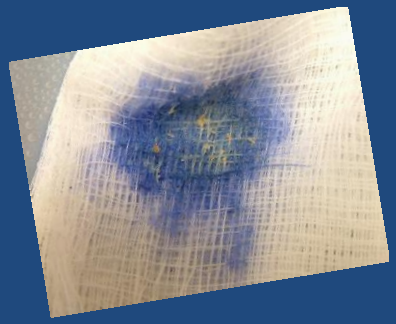
LAB ON A CHIP





Quake lab, Stanford

NIOSH Center for Direct Reading and Sensor Technologies









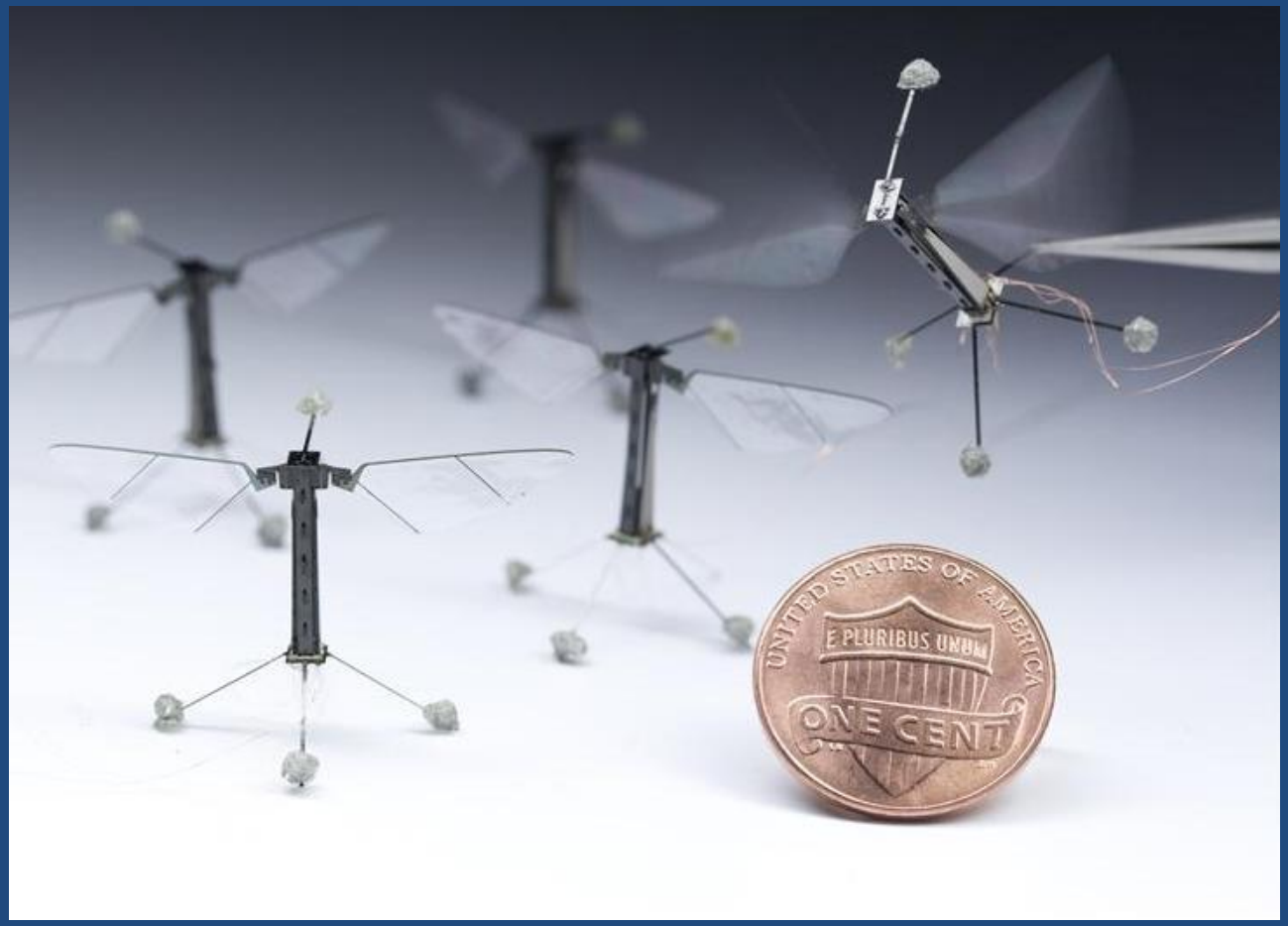
Enabling a new era of worker safety, health & well-being

Occupational Exposure Science

Exposome

- **Work environment**
  - Direct-reading instruments
    - Personal Dust Monitor
    - Explosibility Meter
  - Sensors
- **Biologic environment**
  - Biomarkers of exposure
  - Biomarkers of effect
    - In-dwelling monitors enabled by nanosensors that circulate sending data back to a central database

Robotic Insects Make First Controlled Flight



Insect-Scale Robots

- 80-milligram flapping-wing robot modeled loosely on the morphology of flies (*Diptera*).
- Harvard School of Engineering and Applied Sciences (SEAS) and the Wyss Institute for Biologically Inspired Engineering at Harvard.
- Nano-enabled with exposure sensors and cameras?

– Ma KY, Chiraattananon P, Fuller SB, Wood RJ. *Science* 2013;340:603-607

IoT—Internet of Things

- Integration of machines with sensors, software & communication systems enables the Internet of Things
- Industry 4.0
  - Mechanization
  - Mass production
  - Introduction of computers and electronics
  - Internet of Things
- Microelectronics makes it possible to connect just about everything to the Internet
  - Milk cartons, roads, air, people, bridges, vehicles, trees, machines, medical devices, and power systems—all become data points.

IoT and Sensors

- Sensors are at the heart of the Industrial Internet
  - Deploying sensors, the entire workplace and everything and everyone in it can become a type of information system
- Sensors can become intelligent assets—devices equipped with sensors and connected to one another produce sensor-based analytics
  - The *industrial hygienist* becomes a data scientist with ideas for controls and redesign
  - Exposure assessment may become automated

Big Data & Predictive Analytics: What's the Value for Safety?

What is BIG Data?

- *"Big data"* is
  - high-volume
  - high-velocity
  - high-variety
- information assets that demand cost-effective, innovative forms of information processing for enhanced insight and decision making.

  - Gartner, Leading global information technology research and advisory company

3 V's = Driving Dimensions of Big Data

- **Volume**
  - Increase in job site observations
  - Increase in observers
- **Variety**
  - Safety professional discrete data = old methods
  - Sensor data streaming = new methods
- **Velocity**
  - Instantaneous collection
  - Analysis and interpretation

Public Administration

Health

Retail

Data

Agriculture

Science and Education

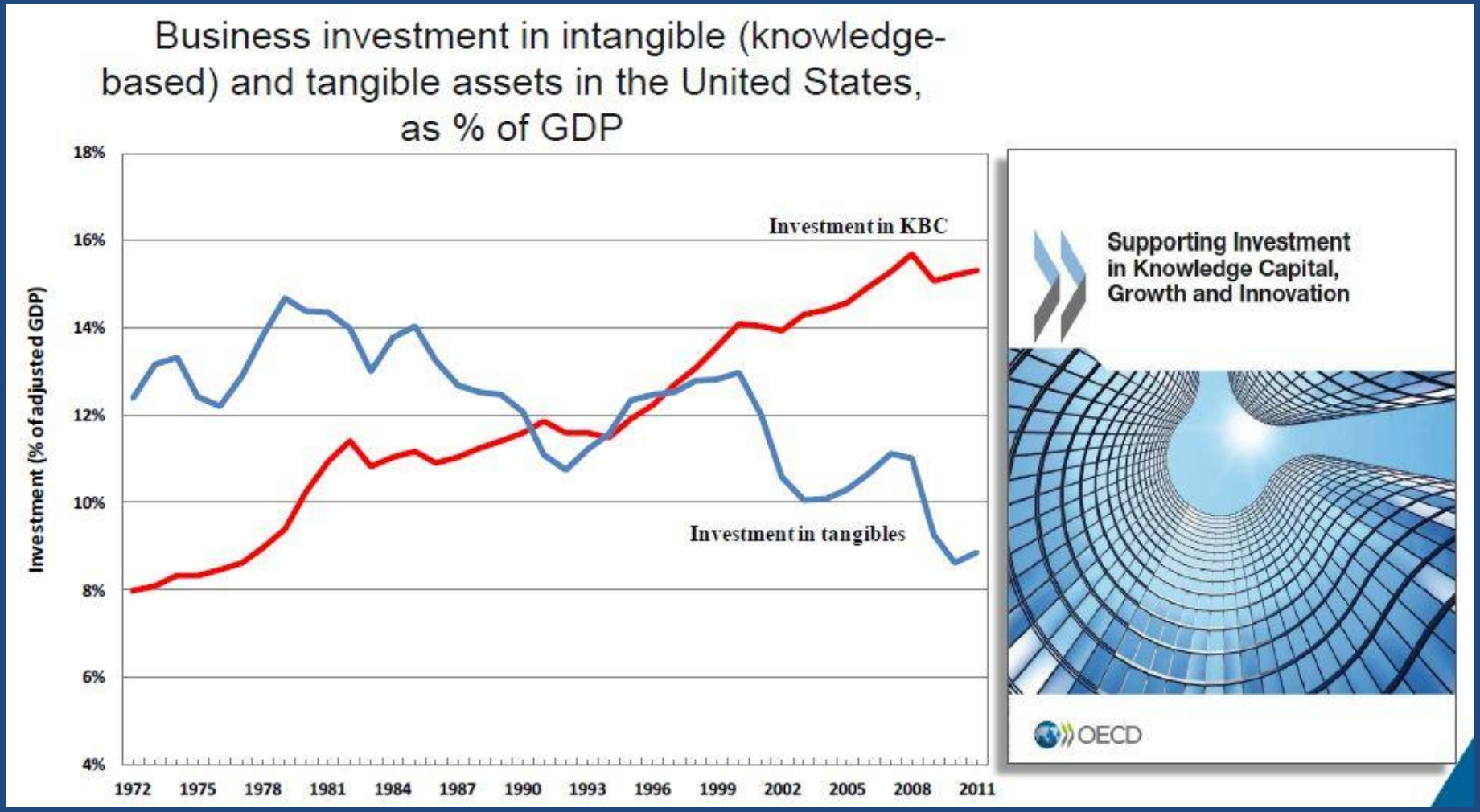
Transportation

Differing Views on BIG Data

- **On one hand:**
  - *End of Theory: The Data Deluge Makes the Scientific Method Obsolete* (Anderson, 2008)
    - "With enough data, the numbers speak for themselves"
      - http://archive.wired.com/science/discoveries/magazine/16-07/pb_theory

- **On the other hand:**
  - *Big Data: Are We Making a Big Mistake?* (Harford, 2014)
    - "There are a lot of small data problems that occur in big data"
    - "Big data has arrived, but big insights have not"
      - http://www.ft.com/intl/cms/s/2/21a6e7d8-b479-11e3-a09a-00144feabdc0.html

Knowledge-based Capital (KBC): New Source of Economic Growth



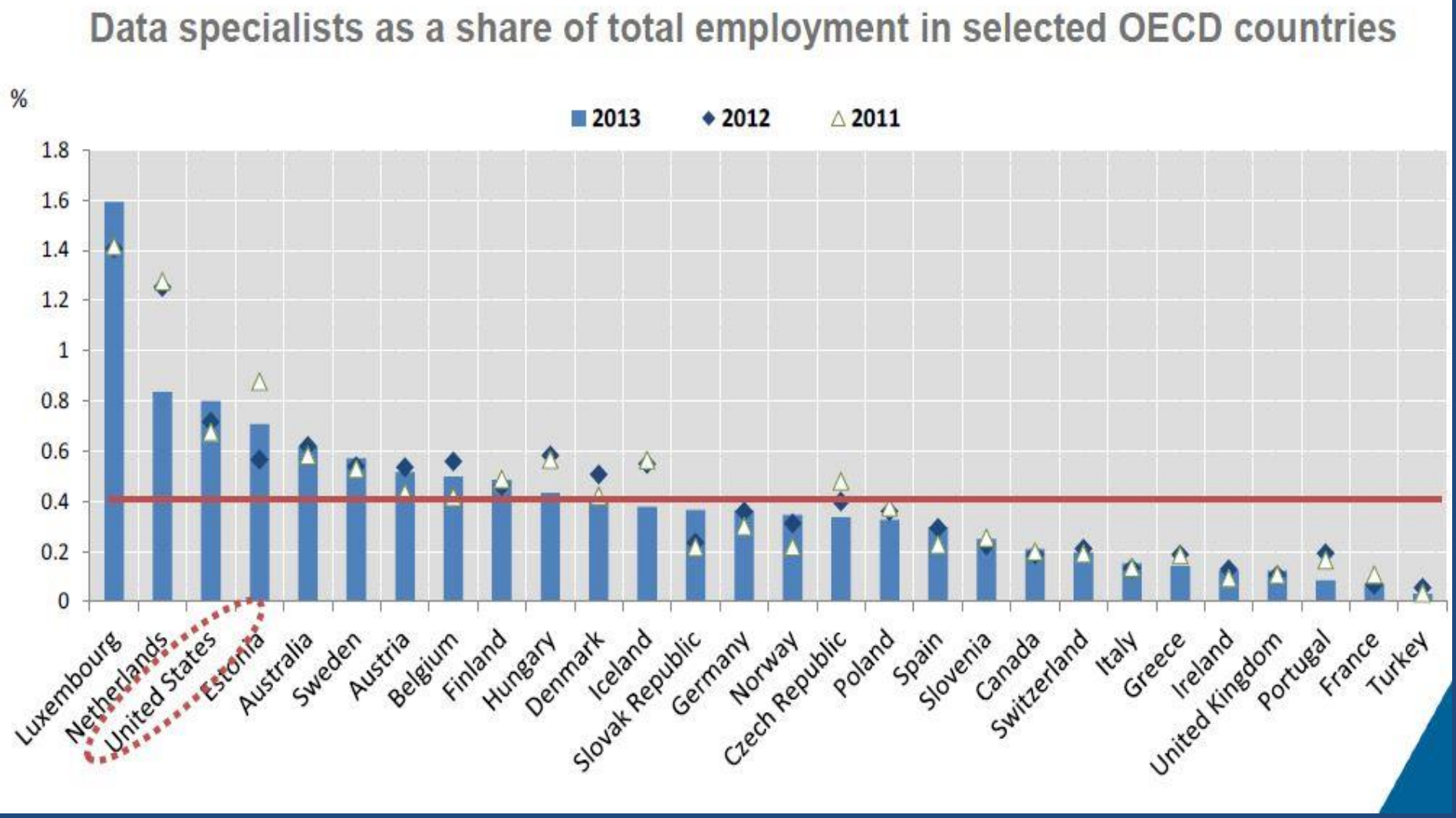
Gartner

- Predicts that information assets and data will appear on the balance sheets of corporations within the next few years.
- What is the financial value of BIG data:
  - Ability to align data points, collection and analysis in a way that delivers deep insights
  - *Theoretically*:
    - If you could put the right sensor systems & software in place—and access it through computing power, a
    - 100% accurate forecast would be possible!
    - Field of predictive analytics is born

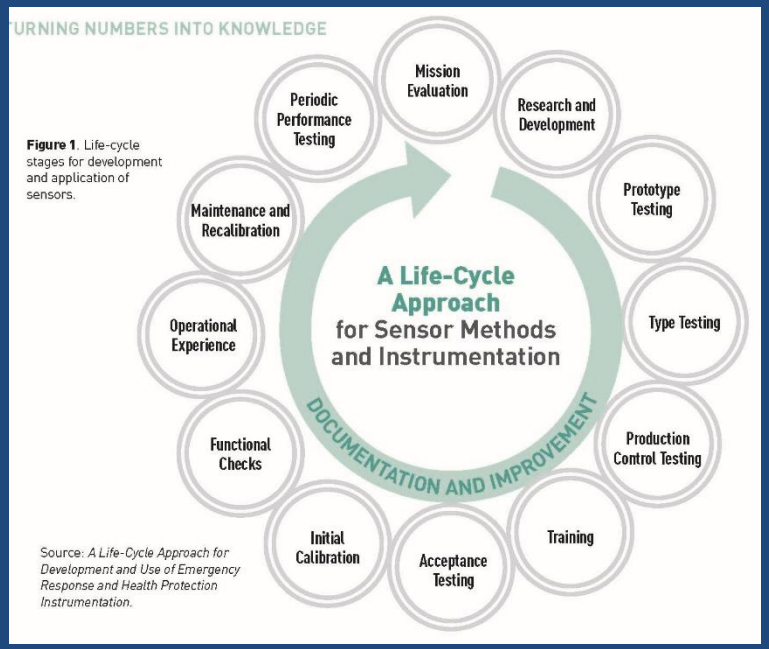
Data Scientist

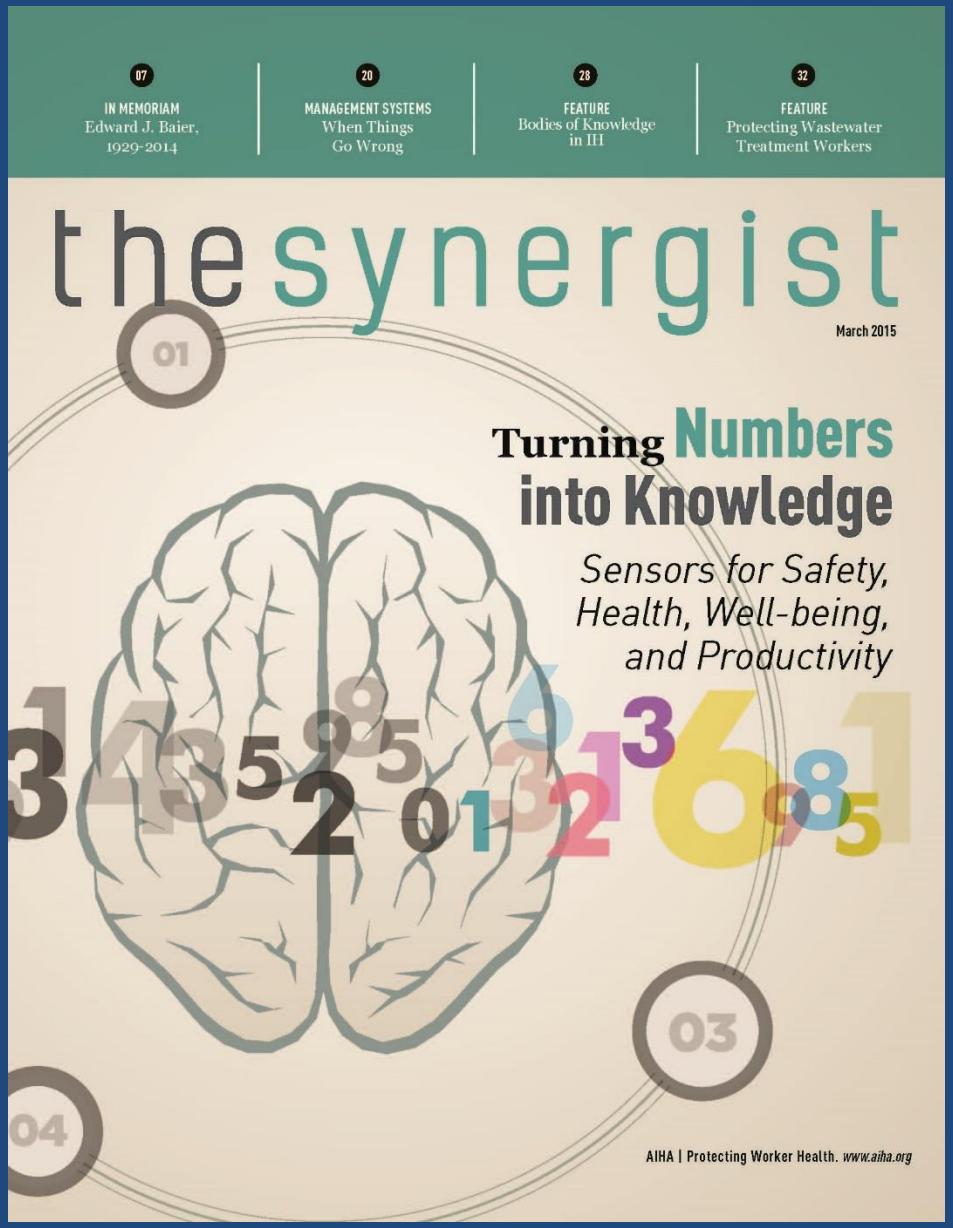
- Data scientist role is critical for organizations looking to extract insight from information assets for "big data" initiatives and requires a “broader” combination of skills than statistician or business intelligence analyst or safety professional:
  - Collaboration and teamwork is required for working with business stakeholders to understand business issues.
  - Analytical and decision modeling skills are required for discovering relationships within data and detecting patterns.
  - Data management skills are required to build the relevant dataset used for the analysis.

Data Scientists by Country: Low Share



What are the implications for safety and health professionals from BIG Data?





To Lag or To Lead—That is the Question

- Lagging safety indicators are like driving a car while looking backwards.

- Lots of interest by very smart people in business intelligence
  - Some interesting anecdotes in the safety field
  - Lots of trade publications have an interest
  - From IBM to start-up companies engaged in predictive analytics
  - Little rigorous empirical scholarship though

- Where are we at now in predictive safety analytics?
  - Probably not one, or two, or even three, such indicators
  - Indicators may be sector/establishment/activity based
  - Some doubt they are truly predictive

SAFER COMPANIES
ARE SAFER INVESTMENTS

Responsible Investing: Using Safety and Health Data

- Uploading injury and illness data to *Bloomberg Investors* is occurring
- Investors are increasingly using workplace safety and health measures to screen out underperforming stocks, and are showing stronger returns for doing so
- Gray, A. (2007). Good workplace health & safety good investment returns. *Goldman Sachs JBWere Investment Research.*
- *NSC (2013). Business Case for Safety: Guide for Executives. http://www.nsc.org/JSEWorkplaceDocuments/Journey-to-Safety-Excellence-Safety-Business-Case-Executives.pdf*

Is a Safer Company a Better Investment?

Recent Evidence

- Study aimed to assess the hypothesis that stock market performance of companies achieving high scores on either health or safety in the Corporate Health Achievement Award (CHAA) process will be superior to average index performance.

- 2016 study adds to the growing evidence that a healthy and safe workforce correlates with a company's performance and its ability to provide positive returns to shareholders.
  - Advances the idea that a proven set of health and safety metrics based on the CHAA evaluation process merits inclusion with existing measures for market valuation.

- Fabius, R. et al. (2016). Tracking the Market Performance of Companies That Integrate a Culture of Health and Safety: An Assessment of Corporate Health Achievement Award Applicants. *JOEM* 58(1):3-8.

Valuing Safety and Health as a Financial Performance Indicator

- Another 2016 study explores the link between companies investing in the health and well-being programs of their employees and stock market performance.

- Study supports prior and ongoing research demonstrating a higher market valuation—an affirmation of business success by Wall Street investors—of socially responsible companies that invest in the health and well-being of their workers when compared with other publicly traded firms.

  – Geotzel, R. et al. (2016). The Stock Performance of C. Everett Koop Award Winners Compared With the Standard & Poor's 500 Index. *JOEM 58(1)*: 9-15.


WHAT DO YOU SEE YOURSELF DOING IN 10 YEARS?
WORK THAT CAN'T BE DONE BY A ROBOT

Thank You!