SMART skills 4.0

Erasmus+

Transnational cooperation initiative fostering developing forward thinking skills of students, teachers and workforce in sustainability-relevant sectors posed by Business 4.0 trends through innovation in Business& Engineering education and training

Short-term Joint Staff Training (C1)

Education for future: designing learning curricula to meet complex skills posed by Business 4.0

20th - 24th September 2021

2020-1-RO01-KA203-080019

EDU4FUTURE

designing learning curricula to meet complex skills posed by Business 4.0 and beyond

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FUTURE

To the person who does not know where he wants to go there is no favorable wind...

Seneca
Roman philosopher, 1st century BC

Lucius Annaeus Seneca the Younger

THE ENVIRONMENT

IS CHANGING

THE ENVIRONMENT

Science and Technology

FORECASTING EMERGING TECHNOLOGIES' IMPACT ON WORK

IN THE NEXT ERA OF HUMAN-MACHINE PARTNERSHIPS

THE FUTURE OF OPEN FABRICATION

TRENDS RELATED TO 3D PRINTING
- ADDITIVE MANUFACTURING -

REINVENTING ENERGY FUTURE

FOUR VISIONS

BEYOND ORGANIZATIONS

NEW MODELS FOR GETTING THINGS DONE

KNOWLEDGE TOOLS OF THE FUTURE

The Knowledge Driven Global Economy

SKILLS FOR THE FUTURE

-

A report on the reports on the FUTURE

- Based on content developed by the Institute for the Future https://www.iftf.org/home/

Link site	Link document			Categ	SubCat	Change in
https://www.iftf.org/motd2020-2030/	Map of the decade	1	1	Environment	All	All
https://www.iftf.org/our-work/people-technology/technology-horizons/the-future-of-science/	A future of science	1	2	Environment	Science	Science
https://www.iftf.org/realizing2030-futureofwork/	Technologies and Shifts that Will Profoundly Change How Humans Work in 2030	1	3	Environment	Work-Tech	Work
https://www.iftf.org/uploads/media/SR-1390_FutureOfOpenFab.FINAL_sm.pdf	The Future of Open Fabrication	1	4	Environment	Fabrication	Fabrication
https://www.iftf.org/uploads/media/SR-1414A_Reinventing_Energy_Futures.pdf	Reinventing energy futures: four visions	1	5	Environment	Energy	Energy
https://www.iftf.org/fileadmin/user_upload/downloads/ourwork/InstitutefortheFuture_GoogleCloud_Beyond_Organizations_map_Reader_031319_01.pdf	Beyond Organizations - new models for getting things done	1	6	Environment	Organizations	Organizations
https://www.iftf.org/uploads/media/SR-1179_FutKnow.pdf	Knowledge Tools of the Future	2	1	Subject	Knowledge	Knowledge
https://www.iftf.org/fileadmin/user_upload/downloads/wfi/ACTF_IFTF_FutureSkills-report.pdf	FUTURE SKILLS Update and Literature Review	2	2	Subject	Skills	Future skills Report
https://www.iftf.org/fileadmin/user_upload/downloads/work-learn/IFTF_FutureSkills_Map_2021.pdf	Future Skills GET FIT FOR WHAT'S NEXT	2	2	Subject	Skills	Future skills Report
https://www.iftf.org/fileadmin/user_upload/downloads/work-learn/IFTF_Futures_Skills_for_Enterprise.pdf	Future skills enterprise - getting fit for a new kind of workforce	2	2	Subject	Skills	Future skills Report
https://www.iftf.org/uploads/media/IFTF_FutureWorkSkillsSummary_01.gif	Future Work Skills 2020	2	2	Subject	Skills	Future skills Report
https://www.iftf.org/fileadmin/user_upload/downloads/wfi/ACTF_IFTF_FutureSkills-infographic.pdf	The Future of Working and Learning	3	1	Process	Work, Learn	Work, Learn
https://www.iftf.org/learningisearning/	LEARNING IS EARNING in the national learning economy	3	1	Process	Work, Learn	Work, Learn
https://www.iftf.org/aiforces/	AI Forces Shaping Work & Learning in 2030	3	1	Process	Work, Learn	Work, Learn
https://www.iftf.org/our-work/global-landscape/learning/creating-the-future-of-learning/	2020 Forecast: Creating the Future of Learning	3	2	Process	Learn	Learn
https://www.iftf.org/uploads/media/SR-1580-IFTF_Future_of_Learning_01.pdf	FROM EDUCATIONAL INSTITUTIONS to learning flows	3	3	Process	Education	Education
	FROM EDUCATIONAL INSTITUTIONS to learning flows Infographic	3	3	Process	Education	Education

IFTF – THE INSTITUTE FOR THE FUTURE

- The main source for this analysis

"Who We Are
Institute for the Future is the world's leading foresight education and futures organization.

Among our staff are experienced forecasters representing a range of disciplines from the social sciences, public policy, and technical domains. They are joined by creative designers who render our research in accessible and innovative print and digital formats.

Our network extends to include affiliates, bringing a diversity of perspectives and experiences to research and events. From university professors to independent thought leaders and hands-on innovators, they help us work at the forefront of new ideas and practices worldwide."


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THE ENVIRONMENT

IS CHANGING

Where Does the Future Come From?

The digital transformation that remade our global systems will continue to

- disrupt,
- mature, and
- accelerate—

a process being kickstarted by the demands of adapting to COVID-19.

But technical change won't just come from digital technologies—it will also be driven by combination of advances in

- biology,
- energy, and
- materials science,

which will

- open new frontiers in
  - innovation and
  - organizational strategy as well
- present profound risks to
  - civic society and
  - Earth's natural systems.

Where Does the Future Come From?

Risks in our approaches:

- Short-term competition erodes organizational abilities to
  - Look ahead
  - Build leadership
  - Prepare for challenges:
    - IT systems were developed to fast and are vulnerable to cyberattacks
    - Inequality has reached levels leading to wars and political-social disruption
    - Data-privacy is a huge issue in an open-threatened society
    - Incremental improvements are not enough considering science and technology changes
    - Strategic resource intensive materials are rare
    - Technologies may be able to shape in a customized manner matter down to molecular and cellular level
    - Human-machine collaboration will have to evolve / be reinvented
    - Long term resilienc evs short-term growth / profit

signs


REINVENTING
ORGANIZATIONAL
CAPACITIES
with science
and technology

Organizations must be redesigned

- Resilience to face shocks including risks and opportunities
- Readiness for future
- Anticipate, plan and decide
  - On longer term strategic and technical questions and think over multiple time horizons
  - By using IT for anticipating short-term changes
  - By using Predictive analytics methods (some of which not yet invented) for longer term
  - By using models for the complex systems on which anticipation, planning and decision must take place
- Rebalance logistics between efficiency and resilience: slack provides resilience
  - Higher stocks
  - Better coordination
  - A more flexible production
  - More adaptive supply chains
- Innovation in reinventing production:
  - Manipulating substance at molecular and genetic levels
  - Better scientific simulation
  - Better cross-disciplinary analytics
  - Better bio-informatics
  - Higher pace in generating novelty
  - Better capabilities to avoid dead-ends in innovation

signs

SIMULATING FUTURE CONSEQUENCES OF TODAY'S ACTIONS

The combination of machine learning, context awareness, and increasingly powerful simulations will lead to new tools for examining alternative possibilities across multiple scales, from narrow organizational forecasts to systemic analyses of business ecosystems. These tools will strengthen organizational resilience by illuminating potential consequences of current choices, including latent risks and previously obscured opportunities.

Getty Images

Simulating Security Risks to Improve IoT Reliability

Jitsuin, a company focusing on risk management and transparency for industrial IoT, addresses security issues with "Digital Security Twins" that use big data and regulatory policies to secure trust and transparency across operations.

Emerson

VR Digital Twins Enable Simulation Based Training

Emerson has created a software called Mimic Field 3D that converts existing 3D models of industrial plants and facilities into a digital twin, which is then used to train workers on safety and other work-related scenarios in immersive virtual reality environments.

TARGETING INVISIBLE INTERVENTION POINTS

New simulation and systems analysis tools will give stakeholders a higher resolution view of long-term costs and benefits. For example, substantial research indicates that human performance is greatly diminished by the lack of a healthy environment, poverty, and other factors. Decision-making tools that take this into account could identify new intervention points to create more optimal work environments for organizational resilience.

Invisible Women by Caroline Criado Perez

Mining Data to Improve Equity

In her book *Invisible Women: Data Bias in a World Designed For Men*, Caroline Criado Perez highlights the myriad ways that a "gender data gap" adversely impacts women, with potent examples of how to reduce discrimination while improving public health and saving money in the process.

Twitter

Late Night Twitter Use Hinders Job Performance

Researchers combined two public datasets—basketball box scores and public behavior on Twitter—to analyze whether late night social media use made professional basketball players perform more poorly. The results showed that staying up late had adverse impacts on shooting percentage, points scored, and rebounds.

PLANNING AND DECISION-MAKING

RECALIBRATING ANTICIPATION

signs

LOGISTICS

REBALANCING EFFICIENCY AND RESILIENCE

EXPANDING DISTRIBUTION WITH AUTOMATED SUPPLY CHAINS

While transportation and warehousing are already poised for automation, smart manufacturing will leverage breakthroughs in robotics and artificial intelligence to transform supply chains, making them fully automated in many cases, and often much shorter. Some automation processes requiring human supervision today will become fully automatable within the decade. Autonomous delivery drones will make substantial gains and become particularly useful in previously hard-to-reach areas. Fully automated businesses such as grocery stores, restaurants, and perhaps even medical clinics will likely be viable in a decade, greatly expanding organizations' ability to reach previously difficult-to-serve populations.

Amazon Go

Unmanned, Autonomous Retail Enables Broader Reach

Amazon has launched Amazon Go, a series of retail stores that replace registers with sensors and computer vision. Customers check in at the store's entrance with an app, pick the items they want, and carry them out the door.

Nuro

Special-Purpose Autonomous Delivery Vehicles Automate the Last Mile

Nuro is an autonomous delivery vehicle for last mile deliveries of groceries and pizza on fixed routes. Rather than bolting autonomous features onto a standard vehicle, the Nuro is "half as wide as a compact sedan," according to the *Wall Street Journal*, in order to be more maneuverable and reduce damage in the event of an accident.

SOURCING FOR FLEXIBILITY

Advances in smart manufacturing tech could revolutionize the production chain. For example, 3D-printing and computer-controlled milling in automated microfactories will enable geographically remote businesses to efficiently produce locally tailored parts and products with fewer dependencies. Standardizing and minimizing required base materials could reduce or eliminate the costs of warehousing and the fragility of just-in-time production. Ultimately, the greater sourcing flexibility afforded by this kind of system would allow more distributed logistics, making single points of failure problems less likely.

Robotics & Automation News

Software-Defined Microfactory Enables Local Sourcing

Bright Machines integrates artificial intelligence into every phase of the manufacturing cycle—machine learning, computer vision, and adaptive robotics in an automation platform—for product assembly and inspection in what it calls a modular microfactory cell.

3D-Printing Replacement Parts for Ventilators Adds Capacity to Supply Chain

During the 2020 COVID-19 pandemic, an Italian hospital had respirators with damaged or failing valves. The operator of the Milan FabLab brought in a 3D printer to fabricate the valves in situ, allowing ten additional respirators to be brought online.

signs

R&D AND INNOVATION

REINVENTING PRODUCTION

VALUES-DRIVEN RESOURCE INNOVATION

Advances in material and biological sciences, coupled with increasing political and environmental instability, will drive the search for new materials, resources and processes in production chains. The demand for more flexible, sustainable, and ethical sourcing will push organizations to find or create fundamental materials and goods—from lab-grown substitutes for cattle and palm oil, which devastate the environment, to alternatives for cobalt, palladium, and tantalum, which often rely on toxic production methods including child slavery. Not all impacts will be immediately good: resource substitution could lead to the economic collapse of developing countries who depend on these exports today.

WooDoo

"Augmented Wood" Turns Low-Grade Wood into Premium Building Materials

Materials science company WooDoo describes this as "augmented wood," which can be used as an alternative to heavier, more expensive building materials. This kind of effort—augmenting basic natural resources—will drive new efforts to expand the range of useful building materials.

Self-Healing Concrete Reduces Resource Demand

Dutch biotech company Green Basilisk has developed a self-healing concrete by using bacteria. The bacteria helps heal cracks and other damage in a similar manner to how our human skin heals, requiring less maintenance and putting less pressure on resources.

DESIGNING FOR REINCARNATION

Advances in our functional understanding of biology, ecosystems, and evolution will catalyze "design for reincarnation," in which products' components are readily disassembled with minimal waste and become reusable—not just as replacement parts, but across a spectrum of products, even if those new uses are not yet known. The fashion industry, with its emphasis on brand narratives over price, offers early champions of this approach. Increased resource and energy pressures, combined with improved capacity for identifying and tracing individual parts over their lifecycle, will make this model attractive for organizations of all kinds.

GearJunkie

"Worn Wear" Clothing Stores

Patagonia is opening its first permanent worn wear clothing store in Boulder, Colorado. The idea of the worn wear store is to upcycle old clothes that can no longer be worn and redesign them into something new. The upcycle process and movement points to a future beyond recycling, and towards a more sustainable reuse of materials.

Ikea Charts Path Toward Circular Economy Furniture

Furniture giant Ikea has put in place a ten-year plan to remake its entire product line as a circular economy business. In addition to reducing carbon and financial costs, Ikea believes a circular product line will improve its brand identity with consumers.

Organizations must be redesigned

- Re-thought boundaries for collaboration:
  - Digital assistants in consumer devices move to
  - Enterprise and organizational contexts
  - New and profound integration of digital technologies in the way teams work
  - Devices and products will increasingly
    - Learn,
    - Grow and
    - Collaborate with end-users
- Systemic issues such as
  - climate change to
  - regulation of new biotechnologies

  will oblige organizations to position themselves and their Visions and Missions and consider larger/wider scales for collaboration and value creation

signs

COLLABORATION
RETHINKING BOUNDARIES

DEPLOYING DIGITAL AGENTS IN THE WORKPLACE

Advances in context awareness, machine learning, and data analytics will make digital agents robust enough to become pervasive in our organizations. We're likely to see the widespread use of organizational agents—bots with an image, voice, and persona that represent some aspect of the organization. In some cases, these agents will be digital doubles of workers who can extend their presence by attending low-stakes meetings and answering questions on their behalf. The way these bots will be trained and used created new questions around what defines labor, IP, and privacy—and future-ready organizations will have to be proactive in how they respond.

Andrew Yang

Former Presidential Candidate Developed Hologram to Appear on His Behalf

Former United States Presidential Candidate Andrew Yang developed a prototype hologram that would enable him to appear to be in multiple locations at once. Their plan, never executed, was to take the hologram technology on a truck to different locations for campaign rallies.

CNN

AI News Anchor Points Toward Enterprise Uses for Synthetic People

China's state-run press agency Xinhua has created "AI anchors" modeled on the looks and voices of real reporters to deliver the news on TV in alternative languages. These kinds of synthetic humans will become increasingly practical to deploy for enterprise use.

EXTENDING REACH THROUGH ROBOTICS

By 2030, serverless supercomputing will enable sophisticated telepresence robots to perform mundane tasks in the workplace and at home. Remote-controlled robots capable of tasks like searching cupboards, then identifying and opening a container, will likely be commonplace—initially with human oversight. These robots may bring organizations and their workers into our homes in the same way Alexa and Ring did for Amazon. Making effective use of robotic telepresence will require forethought about the implications for security, liability, labor rights, and privacy.


Mira Robotics

Remote-Controlled Domestic Workers

Mira Robotics has created a remote-controlled domestic helper robot that is capable of folding laundry and doing other household chores—at the direction of a trained operator who controls multiple robots at the same time.


Emerald Cloud Lab

Cloud Laboratory Democratizes Access to Lab Equipment

Emerald Cloud Lab rents remote access to its automated laboratory, containing robots that scientists can instruct to conduct life sciences experiments from afar. Emerald's robots are capable of conducting experiments much faster and more precisely than humans.

Organizations must be redesigned

- Organizational stakeholders influence will continue to increase
- Greater scrutiny on organizational outcomes and impacts
- Redesign organizational performance (creating, capturing and measuring performance).
- Leaps instead of incremental improvements based on science and technology
- Take into accounts the challenges:
  - climate crisis,
  - economic inequality,
  - human health,
  - environmental protection

signs

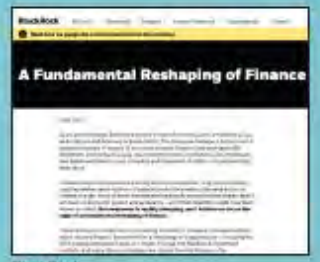
Oriented Operations

The Long-Term Stock Exchange (LTSE) has recently gained approval from the SEC to operate as a listing exchange. Companies on the LTSE have agreed to develop operational policies that comply with the exchange's Five Long-Term Principles, including longer-term success metrics, compensation structures, and stakeholder engagement plans.

Long-Term Stock Exchange

BlackRock CEO Anticipates Rapid "Reallocation of Capital"

Larry Fink, CEO of BlackRock, the largest asset manager in the world, focused his annual letter on how climate risk has become a priority for their clients, and announced plans to integrate sustainability into their risk analysis and develop new investment products that avoid fossil fuels.



BlackRock

Amazon Carbon Accounting System Forms Back-End for Carbon Reduction

Amazon has built a "comprehensive" carbon accounting system using a complex combination of sensing, massive-scale computation, data aggregation, and analytics. As the leading logistics company in the world, Amazon has an ability to set standards—and perhaps be able to sell compliance as a service in the future.


Amazon

Monitoring Systems for Stewardship and Sustainability

A project from NOAA and the Alaska Fisheries Science Center uses computer vision to automatically document fish as they are caught to create real time accounting and enforcement of catch limits, addressing a long-standing tragedy-of-the-commons issue.

DEFINING VALUE FOR THE LONG-TERM

Today, we're starting to recognize the environmental and social trade-offs of short-term financial metrics and incentives. Going forward, the same technologies that allow us to take a systems perspective and simulate outcomes will power new ways of measuring value beyond financial performance, including organizations' direct and indirect impacts on the social, economic, and environmental health of their workers, their communities, and their larger worlds. As such metrics continue to mature and become mainstream, organizations will be able to assess policies based not just on their perceived ethical value, but on how they sustain the operating environment and, ultimately, the bottom-line.

ENABLING CONTINUOUS IMPACT ACCOUNTING

Over the next decade, we'll see the proliferation of tools for monitoring and assessing organizations' social and environmental impacts, including new forms of tech-enabled enforcement. For example, many governments today use data analytics to identify tax evaders, and a number of citizen projects leverage arrays of sensors to monitor environmental pollution. These technologies will be combined with simulation and systems analysis tools to push beyond simply catching law-breakers, empowering organizations to demonstrate positive impact on the planet and communities.

PERFORMANCE
REIMAGINING
VALUE

SCIENCE AND TECHNOLOGY

- Breakthroughs expected >
  - Energy
  - Materials sciences
  - Biology
  - Information technology

  from labs into organizations

- IT: Supercomputing at every node
- Materials: Atoms are the new building blocks
- Biology: An emerging biotech stack (just like we build in IT)
- Energy: Climate-Driven Evolution

IT: Supercomputing at every node

- Biggest story of the 21st century
- The new horizon> Advances in AI
- Low-latency, high speed networks
- Pervasive supercomputing – central to what we do

- Key roles in future organizations:
  - Machine learning
  - Purpose-driven AI
  - Big data use
  - Simulation to improve business processes

- Augmented individual workers:
  - Cobots
  - Digital twins
  - Virtual agents

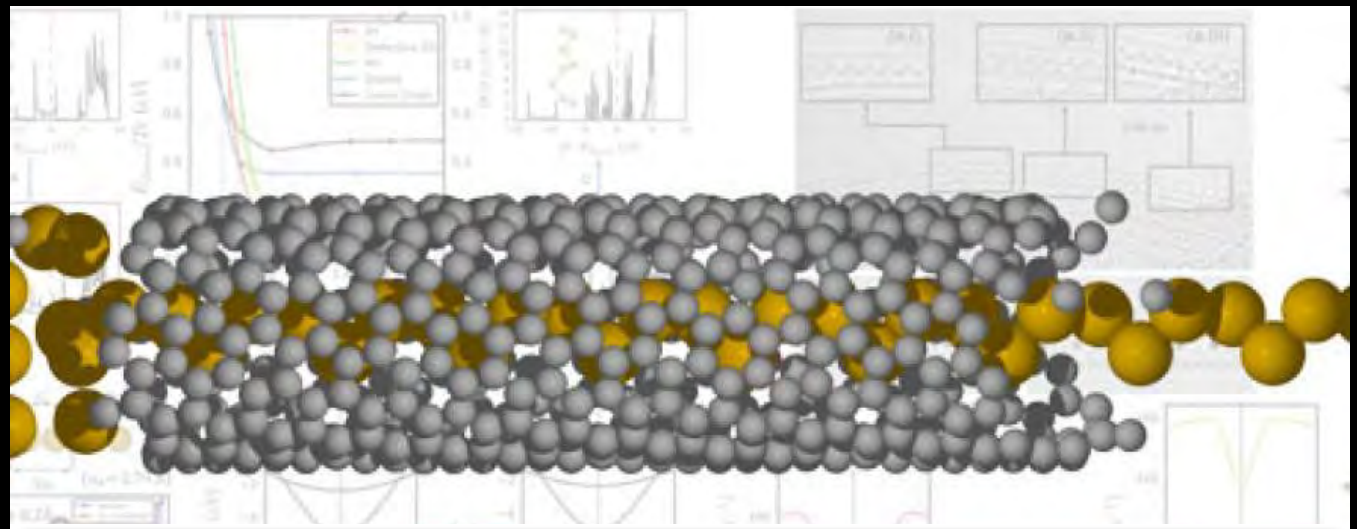
- Extended Reality Workplaces:
  - AR + VR = seamless multisensory operating environments
  - Intelligent, reactive and proactive work environments with enhanced human-machine collaboration and value creation

- Cyber-Resilience –
  - Breaches of sensitive databases
  - Intellectual property theft
  - Critical infrastructure vulnerabilities
  - Resilient IT systems

Materials: Atoms are the new building blocks

- Novel materials -> Novel products -> Novel processes
- One-dimension materials
- Two-dimension materials
- Programmable matter
- Custom-properties on-demand

- Clean fuels
- Inexpensive means to store energy
- Reduced energy building materials



Researchers have developed the world's thinnest metallic nanowire, which could be used to miniaturise many of the electronic components we use every day.

The researchers, from the Universities of Cambridge and Warwick, have developed a wire made from a single string of tellurium atoms, making it a true one-dimensional material. These one-dimensional wires are produced inside extremely thin carbon nanotubes (CNTs) – hollow cylinders made of carbon atoms. The finished 'extreme nanowires' are less than a billionth of a metre in diameter – 10,000 times thinner than a human hair.

> *"We're just starting to understand the physics and chemistry of these systems."*
>
> *— Paulo Medeiros*

Materials: Atoms are the new building blocks

- New frontiers for materials
- China owns the highest rare-earth materials
- Entrepreneurs look to explore ocean floor and outer space
- Looking for new laboratory techniques

- Matter merges with data> discovering material properties and new molecular structures that allow programmable properties – a more fluid matter
- Programmable materials have applications in
  - Energy
  - Fertilizer
  - Drugs
  - Building materials
  - Communications
  - Computation
  - ...

Materials: Atoms are the new building blocks

- New materials to face Climate change
  - Capture and reuse CO2 from atmosphere
  - Materials built with less energy
  - Building a clean economy

Biology: An emerging biotech stack (just like we build in IT)

- Tech-stack – combination of OS, programming languages, other layers and frameworks to create new applications
- It's similar in biology: you need a systems stack – advances in data analysis and computing to understand biological systems and develop new ways to work

- Bio-prospecting – 3D printing, gene editing, producing biopolymers, biofuels – new opportunities for many industries

- Eco-genomics = Ecology + biology – designing biological organisms and being able to correctly forecast impact on the entire ecological system. New literacy, new metrics needed.

- Need for new systems to manage risks in genomics. CRISPR and other genome editing techniques create huge risks.

Energy: Climate-Driven Evolution

- From carbon-intensive fossil fuel power systems to zero-carbon and renewable energy
- Disruptions in the local, regional and national power grids
- New energy storage and production systems

- Fragile grid – initial assumptions not true anymore:
  - Predictable use of the power
  - One-way power flow

- New Storage Technologies – looking for autonomous, decentralized ways to store energy locally.

- Shift to renewables – move towards cleaner fuels – as a global push – manage climate change while keeping the energy flow aligned with the needs – reinventing the global energy markets.

ORGANIZING FOR FUTURE READINESS: INDUSTRY FORECASTS

- PLANNING AND DECISION-MAKING RECALIBRATING ANTICIPATION

  - Food: Production Becomes a Climate Solution
  - Health: the permanent health data collection and interpretation
  - Health: targeting the deep, root causes to improve outcomes
  - Mobility: Logistics become more flexible
  - Communications: Objects and Supply Chains communicate their needs
  - Shopping: fashion, sports, furniture > real time, highly personalized on-demand products
  - Food: designing products with the Circular Systems in mind
  - Collaboration: Humans and Machines have to learn to work together
  - Finance: financing the new ways to create value> from neighborhood value creation to planetary scale
  - Retail: hyper-personalization, on-demand supply chains, automated customer journeys: mixed reality, holographic displays and smart things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THE ENVIRONMENT

Science and Technology

Decrypting the Brain

modeling the complex mind

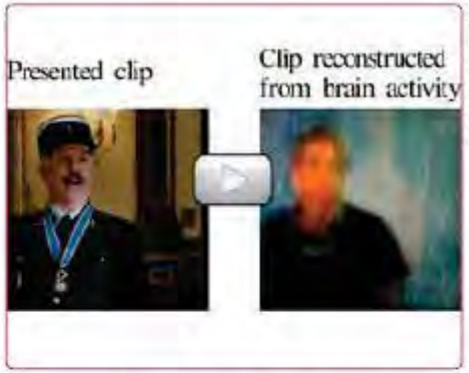
At the intersection of neuroscience, molecular biology, and computer science, researchers are making slow but sure strides to reverse-engineer the human brain. New imaging technologies enable us to scan brains at unprecedented resolutions. Informed by that data, a combination of optical and genetic techniques will allow for precision control of specific neural circuits almost as easily as flipping on and off light switches. As we finally uncover the mysteries of how the brain works, the next step will be to build systems that mimic our own cognitive abilities. That will not only lead to profound shifts in the way we think about machines, but will also transform our own sense of self.

- Machine learning melds with cognitive science
- Quantum physics helps explain consciousness
- Gene jockeys build a brain atlas
- Brain scans record "mind movies"
- Optogenetics leads to a neural switchboard

SIGNALS

syntheticneurobiology.org

Synthetic Neurobiology: Method for controlling the brain with pulses of light

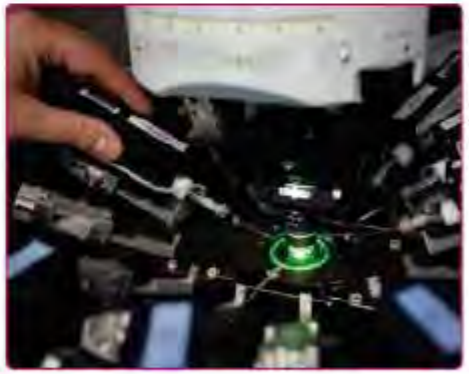


gallantlab.org

"Mind Movies": Technique to record visual experiences from brain scans

alleninstitute.org

Allen Human Brain Atlas: 3D map of gene expression in the brain



bluebrain.epfl.ch

Bluebrain: Computer that simulates a rat's brain

Hacking Space

public and private access spurs a new space age

Even as NASA has been subjected to relentless budget cuts, and the Space Shuttle program has come to its long-delayed end, new means for engaging with the "final frontier" are emerging. The role of governmental organizations is changing from obligatory sponsors of orbital projects funded by taxpayers to secondary supporters and customers of entrepreneurial ventures around medicine, manufacturing, and surveillance funded by private industry. These commercial efforts will increasingly be complemented by an array of citizen science projects, informed by a do-it-yourself mindset, and harnessing the curiosity and passion of a public enchanted by the wonder of space and eager to help us understand our place in the cosmos.

- Regulatory hurdles drive open standards and "coopetition"
- Discovery of extraterrestrial life
- Personal satellite for $1000
- Zero-G biology accelerates drug discovery
- Orbital manufacturing becomes practical

SIGNALS

spacehack.org

Spacehack: Directory of ways for citizen scientists to participate in space exploration

googlelunarxprize.org

Google Lunar X Prize: Millions of dollars for the first privately funded teams to land a robot on the moon

virgingalactic.com

Virgin Galactic: Commercial "spaceline" for tourism and private space science

makezine.com

***MAKE:*'s DIY Space Issue:** How to put your own satellite in orbit, launch a stratosphere balloon probe, and analyze galaxies with a $20 spectrograph

Massively Multiplayer Data

human-data interaction emerges as a core discipline

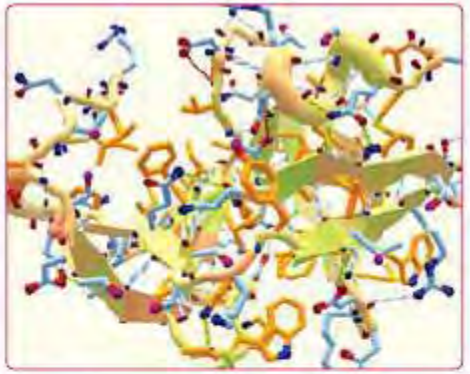
SIGNALS

Sensor networks, pervasive computing, and a host of other new technologies are translating our world into high-resolution data streams that can be analyzed, manipulated, and used to inform advanced simulations. Indeed, science has always been driven by data but now the sheer complexity and amount of information is demanding new practices and methods to translate the bits into knowledge. To that end, science will seek contributions from the networked public to tag raw data and make connections, seek patterns, and draw links between datasets. The speed of scientific discovery will be proportional to the availability of cross-disciplinary engagement with relevant data. Eventually, some discovery science will become automated as software analyzes experimental data to make new hypotheses and test them in simulations.

- Science is gameified
- Scientific papers are executable as code
- A Wikipedia of science models is created
- Data-intensive science spawns new disciplines
- Massively linked data becomes a public utility

galaxyzoo.org

Galaxy Zoo: Public effort to process NASA Hubble Space Telescope data



fold.it

Foldit: Online gamers solve protein folding puzzles, like the structure of an AIDS-related enzyme

hipacc.ucsc.edu

Bolshoi: The most accurate computer simulation of the entire universe

okfn.org

Open Data Commons: Provides legal frameworks for open data-base licensing

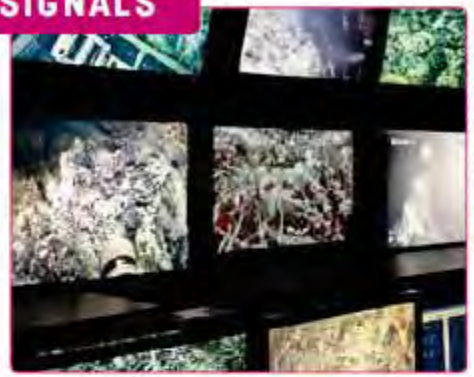
Sea the Future

oceans become the new frontier for energy, ecology, and engineering

The oceans, covering more than 70% of the Earth's surface, are our life-support system, supplying half the planet's oxygen and also harboring more than half the life on Earth. Over the next decade, deep-sea explorers will apply the tools of genomics in our oceans to learn about the millions of species living beneath the waves. Scientists will look to the sea as a renewable energy source while studying the complex interactions of the Earth, the ocean, and the atmosphere at the smallest scale. Of course, the oceans are also a leading indicator of climate change, regulating the climate by absorbing heat and carbon dioxide. As a result, the big blue will be a focal point for geoengineering efforts to counter the effects of global warming.

- Seawater fuels fusion
- Humans plumb ocean depths
- The ocean's top millimeter is mapped
- The majority of ocean species are inventoried

SIGNALS



oceanobservatories.org

Ocean Observatories Initiative: Global sensor network for studying the ocean and sea floor

mindandocean.org

BlueMind: Conference that looks at the ocean through the neuro-science lens

coml.org

Census of Marine Life: Ten-year international effort to inventory the oceans' life, from microbes to whales

dash.harvard.edu, flickr user ex.libris

Bright Water: Theory that pumping the sea with "microbubbles" will lower ocean temperatures

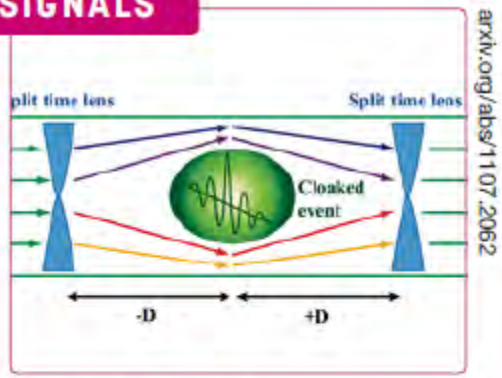
Strange Matter

unnatural materials reshape our world

Arthur C. Clarke once said that "any sufficiently advanced technology is indistinguishable from magic." He will most certainly be proven right by advances in materials science over the next decade, leading to such extraordinary possibilities as invisibility and even a space-time cloak that camouflages entire events. Meanwhile, the cross-disciplinary field of nanoscience will bear strange fruit in the form of useful microscopic machines made from DNA that folds itself up like origami, and metals whose properties can be altered with the push of a button. As we continue to learn more about the nature of matter at the smallest scales, and how to manipulate it, we will be on a better path to develop materials with less environmental impact at the macro level.

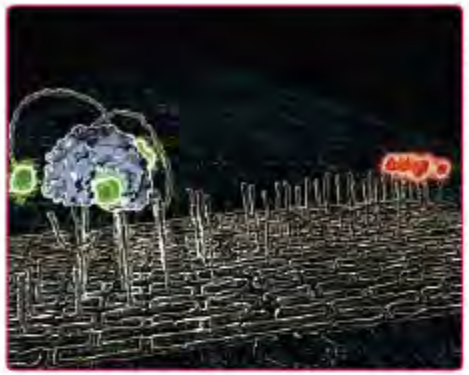
- Space-time cloaks conceal macro-world events
- DNA origami constructs useful nanodevices
- Teleportation scales up from atoms to molecules
- Metamaterials make invisibility real

SIGNALS



arxiv.org/abs/1107.2062

A Hole in Time: Events are masked by bending light around them



bit.ly/bacQLc

Molecular Robots: Nanobots traverse a DNA origami track

dionne.stanford.edu

Metamaterial Solar Cells: Infrared is harnessed to boost efficiency

bit.ly/pJruHx

Switchable Metals: Materials that change from brittle to ductile and back

Engineered Evolution

manipulating biology from the bottom up

For 3.6 billion years, evolution has governed biology on this planet. But now, Mother Nature has a collaborator. Inexpensive tools to read and rewrite the genetic code of life will bootstrap our ability to manipulate biology from the bottom up. The more we learn about the physics of biological processes and the intricacies of the genome and the biome, the better we will be able to tweak our own biology. We will not only genetically reengineer existing life but actually create new lifeforms with purpose. Along the way, we will apply new techniques for rewinding and fast-forwarding evolution *in vitro* and *in silico* to understand how life came to be.

- The human microbiome is mapped
- Quantum biology reveals the physics of life
- Epigenetics informs real-time genome tweaking
- Organisms become programmable
- New lifeforms created from scratch

SIGNALS

jcvi.org

Toward *Mycoplasma laboratorium*: Gene jockeys build the first self-replicating synthetic bacterial cell

commonfund.nih.gov/hmp

Human Microbiome Project: Effort to characterize the microbe community living within our bodies

amyris.com

Synthetic Biology: Engineered microbes convert sugarcane into renewable fuels

bit.ly/mgUR00

Chickenosaurus: Reversing a chicken's evolution to build a dinosaur

New social ways to develop Science and Technology

amplified collaboration

Unprecedented endeavors demand new skills and communities-of-practice.

peer review and peer pressure

New social and crowdsourced systems emerge for knowledge-sharing and evaluation.

recycle, reuse, research

Obsolete tools are hacked, modded, and shared for new purposes.

reshuffling the global deck

Innovation increasingly comes from beyond the Americas and Europe.

public patronage

Community funding and microgrants support scientific efforts.

citizens of science

The public is awakened as active contributors to scientific endeavors.


THE ENVIRONMENT
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THE ENVIRONMENT
Science and Technology
FORECASTING EMERGING TECHNOLOGIES' IMPACT ON WORK
IN THE NEXT ERA OF HUMAN-MACHINE PARTNERSHIPS
THE FUTURE OF OPEN FABRICATION
TRENDS RELATED TO 3D PRINTING
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-

FORECASTING EMERGING TECHNOLOGIES' IMPACT ON WORK

IN THE NEXT ERA OF HUMAN-MACHINE PARTNERSHIPS

Technology impact on work

- How will
  - collaborative AI,
  - Multimodal interfaces,
  - extended reality (XR), and
  - secure distributed ledgers

  intersect with evolving
  - social and
  - economic

  forces to shape how we prepare for, find and work in 2030 ?.

Technology impact on work

- New industries
- New jobs
- New places of work
- New working patterns

- 4 technologies considered:
  - Collaborative AI
  - Multimodal interfaces
  - Extended reality (XR) and
  - Secured distributed ledgers (~ blockchain)

Collaborative AI

- Is AI a menace to our jobs?

It’s rather a partnership in which complementary strengths meet.

How?

Collaborative AI

SIGNAL OF CHANGE

The Allen Institute for Artificial Intelligence aims to build common sense into machine systems so that they can be better collaborative partners for humans.[ii] Recently, its computer vision research team Perceptual Reasoning and Interactive Research (PRIOR) released a collaborative game in which the AI system uses its ability to reason and make inferences to communicate with a human partner. In the game, the AI and its human partner trade off illustrating scenes to try to understand what the other has drawn. Rather than looking to outperform a human (such as in a chess match), the researchers at PRIOR are building machine systems that can better communicate and interact with human partners.

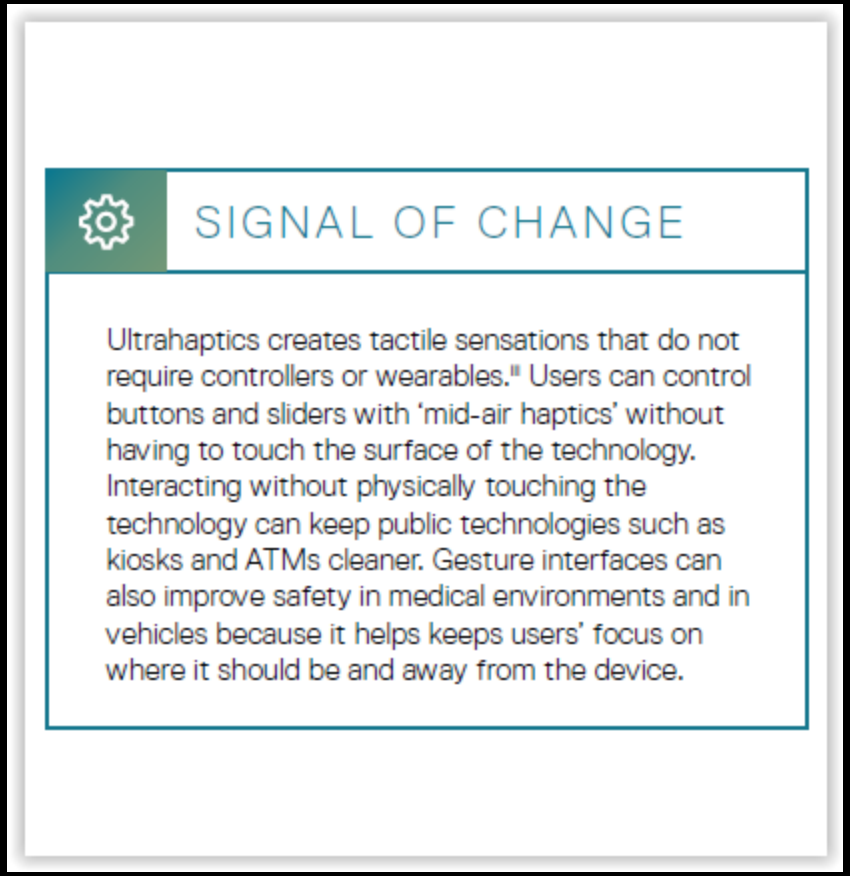
Multimodal interfaces

- Several ways to interface:
  - Seeing
  - Hearing
  - Touching

  - Gesture recognition
  - Smell
  - Electrodes

  - Sometime – smell may be integrated in VR interfaces

Multimodal interfaces

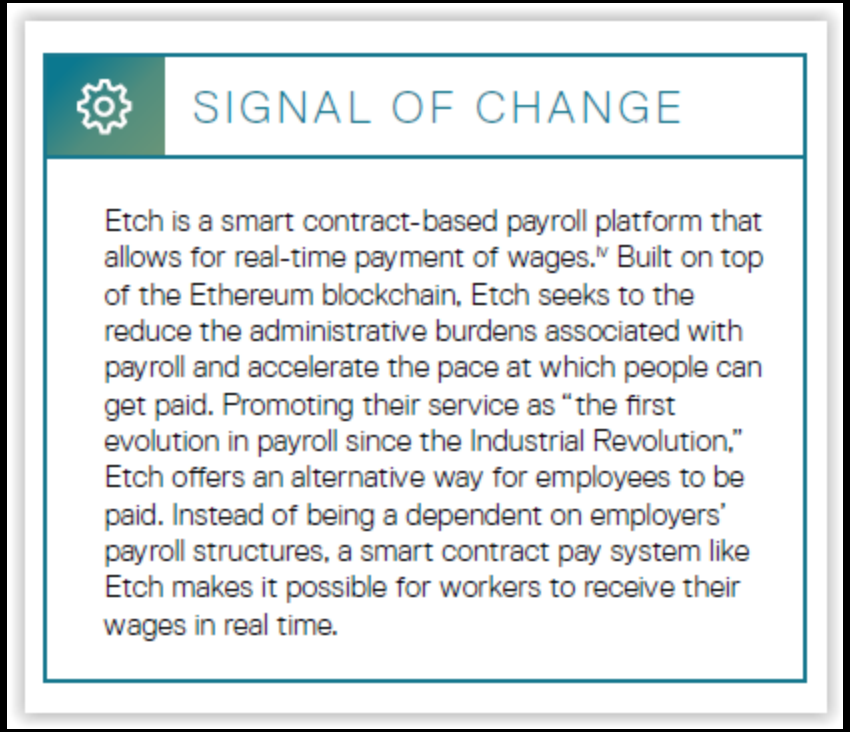


Secure Distributed Ledgers

- Blockchain is an example of distributed ledgers.
- They are
  - a highly protected,
  - transparent data storage mechanisms
  - to perform transactions

- Opportunity to automate a whole host of activities – contracts – payments – accounts management, etc.

Secure Distributed Ledgers

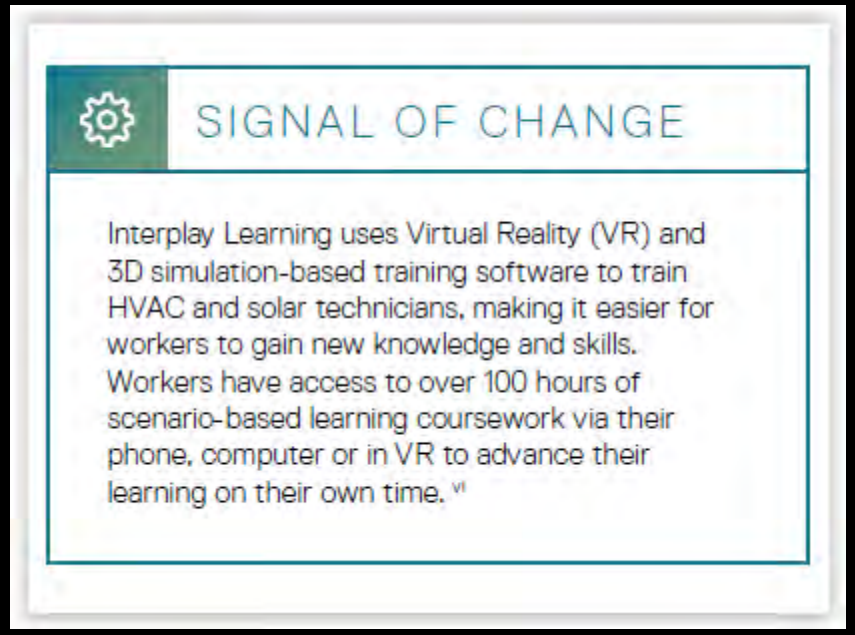


Extended Reality (XR)

- Blending the physical and digital worlds

- XR includes:
  - AR – augmented reality
  - VR – virtual reality
  - MR – mixed reality
  - Human-machine interaction generated by computer techhnology and wearable technology

Extended Reality (XR)



IN THE NEXT ERA OF HUMAN-MACHINE PARTNERSHIPS

Three shifts that could change the working environment:

- Inclusive talent
- Empowered workers
- AI Fluency

Inclusive talent

"For hiring manager Lydia Kim, a new employee's first day is often the first time she sees the person she has hired.

She knows they are competent; the AI system her company uses to spot and recruit talent has an admirable track record in finding people ready and prepared to contribute on day 1.

She knows their personality; she has interviewed them in a social VR space and observed them working with others from the organization in virtual simulations.

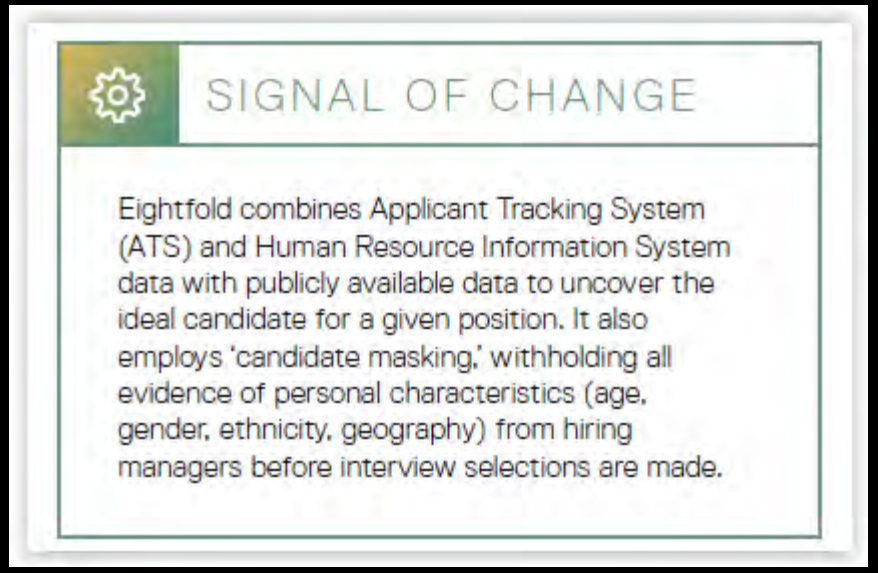
But how the potential hire has chosen to present herself in these virtual locations is up to her. So, what she often doesn't know when she offers them a job is their

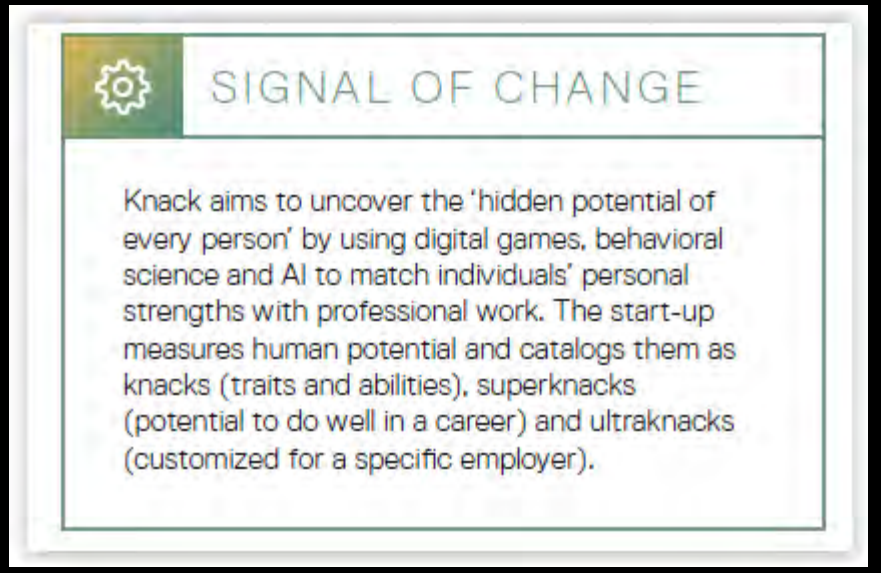
- age,
- gender and, unless required for the job, their
- geographic location.

With the benefit of an AI system that can evaluate an individual's ability based on their competencies and assess their potential as well, Lydia and her team have overhauled their hiring process. Their new way of finding people has expanded their pool of potential talent and helped the organization meet their stated goals around diversity and inclusion."

Generally speaking: pattern recognition

- Recognizing patterns of
  - High-performance / fit employees
  - Illnesses and correctly diagnose patients
  - Equipment defects and correctly diagnoze the technical incident
  - Correctly identify situations described by parameters and allow appropriate decisions





How do NN work?

Dangers in using NN

- Underlearning
- Overlearning
- Not really knowing what the decision criteria are

Traditional Programming

If <condition> then <sequence> else <sequence>

Empowered workers

"A Day in the Life – 2030. Beijing. China. The burgeoning field of genomic medicine is built on collaboration. Most scientists and clinicians engaged in understanding and treating people with genetically defined diseases operate under no false pretense that their scientific discovery or successful treatment is the sole result of their individual effort, or even the work of a small team.

Metabolic Geneticist Li Min, like almost all of her colleagues entering the field of genomic medicine in the late 2020s, was trained to be networked scientist, and to conduct distributed research in realtime. The collaborative platforms she uses (often multimodal and XR) first gained popularity in the gaming world but are now routinely integrated into her research practices.

Incentives have evolved to reflect the norms and practices in genomic research. Publishing first—that is, being listed as the first author in peer-reviewed biomedical journals—is not as highly valued as before. Credit for any advancement in the scientific community's understanding is automatically tracked and attributed to the people and AI systems involved in the work.

The complexity and scope of the scientific challenges being tackled in 2030 require a coordinated approach by thousands if not millions of humans and machines. Dr. Min and her contemporaries are leading the way in re-organizing research labs and clinical practices to support this new way of networked working."

Empowered workers

Collaboration platforms such as Slack, Discord and Github offer clues to the social norms, cultural practices and workers' expectations that will inform how work is completed a decade from now. For teams that are geographically distributed, these tools help facilitate constant connection and coherent, team-based actions.

AI Fluency

"Buenos Aires. Argentina. After two years working as a systems programmer for a large hospitality chain, Laura invests more of her personal time in virtual learning courses on positive psychology and behavior change.

Before taking a full-time role, Laura had concentrated most of her course work on intelligent agent design, learning the ins and outs of robotics AI programming. Now, with a couple of years of work experience, Laura has figured out that her technical expertise is less valuable than her ability to work with the company's AI systems. She is part of the cohort of AI natives who have joined the workforce over the last few years.

Unlike digital natives, millennials and other more experienced workers at her organization, she grew up navigating her coursework and personal life with her infallible AI assistant at her side. Working in partnership with an AI assistant is second nature to her, but Laura has noticed that many of her colleagues who didn't grow up with AI struggle to integrate it into their workflows.

So, instead of re-programming the company's AI systems, most of her time at work is now spent helping her colleagues partner more smoothly with those systems. Laura doesn't know if some of her Gen X colleagues will ever stop writing their own emails, but, the mentoring by AI natives like herself is a step in the right direction."

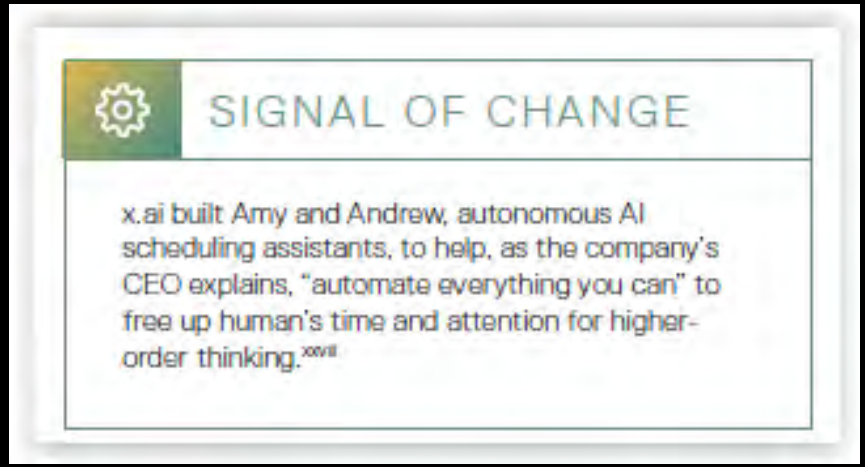
AI Fluency

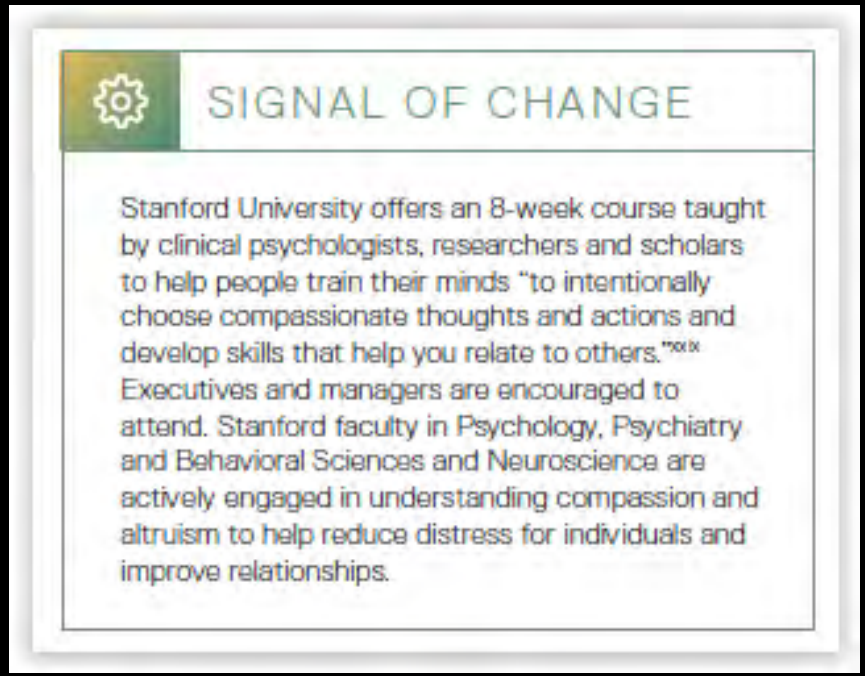
- Educate the youth
- Upskill existing workforce to stay relevant

- This is not about coding or other technical skills.
- It's about
  - understanding what AI can do and cannot do
  - Understanding complementarities with AI – how to combine their strengths with human strengths

A 2017 study published by MIT Sloan Management Review identified three categories of AI-driven business and technology jobs: "trainers, explainers and sustainers.".

According to study authors James Wilson, Paul Daugherty and Nicola Morini-Bianzino, AI trainers will be needed to develop AI personalities and train them to convey empathy; AI explainers will be enlisted to elucidate algorithmic decision-making; and AI sustainers will seek to prevent AI from doing harm.



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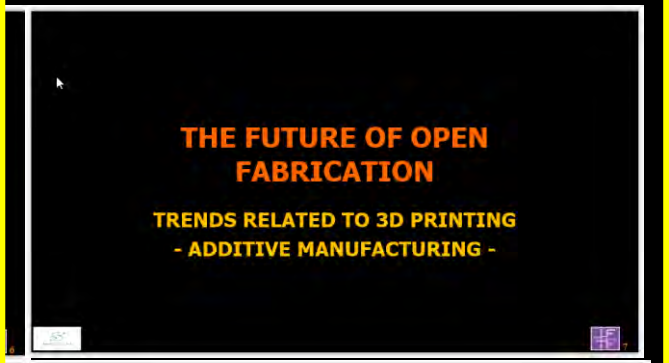
THE FUTURE OF OPEN FABRICATION
TRENDS RELATED TO 3D PRINTING
- ADDITIVE MANUFACTURING -


REINVENTING ENERGY FUTURE
FOUR VISIONS


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SKILLS FOR THE FUTURE
-

THE FUTURE OF OPEN FABRICATION

TRENDS RELATED TO 3D PRINTING
- ADDITIVE MANUFACTURING -

The Key Principles of Open Fabrication

- Stay flexible – explore the flexibility of cheap and accessible desktop manufacturing

- Leverage Web scale –
  - Standards
  - Knowledge repositories
  - Web Communities

- Be open – share intellectual property –
  - object designs,
  - code,
  - process innovations,
  - acceleration of learning

Open manufacturing
From Wikipedia, the free encyclopedia

Open manufacturing, also known as open production, maker manufacturing, and with the slogan "Design Global, Manufacture Local" is a new model of socioeconomic production in which physical objects are produced in an open, collaborative and distributed manner[1] [2] and based on open design and open source principles.

Open manufacturing combines the following elements of a production process:

- new open production tools and methods (such as 3D printers),
- new value-based movements (such as the maker movement),
- new institutions and networks for manufacturing and production (such as FabLabs), and
- open source methods, software and protocols.[3] [4]

Open manufacturing may also include digital modeling and fabrication and computer numeric control (CNC) of the machines used for production through open source software and open source hardware.

The philosophy of open manufacturing is close to the open-source movement, but aims at the development of physical products rather than software.[5] The term is linked to the notion of democratizing technology[6] as embodied in the maker culture, the DIY ethic, the open source appropriate technology movement, the Fablab-network and other rooms for grassroot innovation such as hackerspaces.

3D PRINTING TECHNOLOGIES EVOLVED

As they exist today, most 3D printing technologies might more readily be classified as sophisticated sculpting techniques than as mature manufacturing technologies. However, this will begin to change over the coming decade.

Fused deposition modeling prints by depositing layers of material.

Source: shapeways.com

THE LIMITS

- What are the limits of the resolution in printing:
  - Depends on materials
  - Depends on the layer generation techniques
  - Ideally – we should develop the ability to print atom layer by atom layer

Moving from

- production lines to
- manufacturing web and further to
- fabrication in the cloud

EVOLUTION IN MANUFACTURING

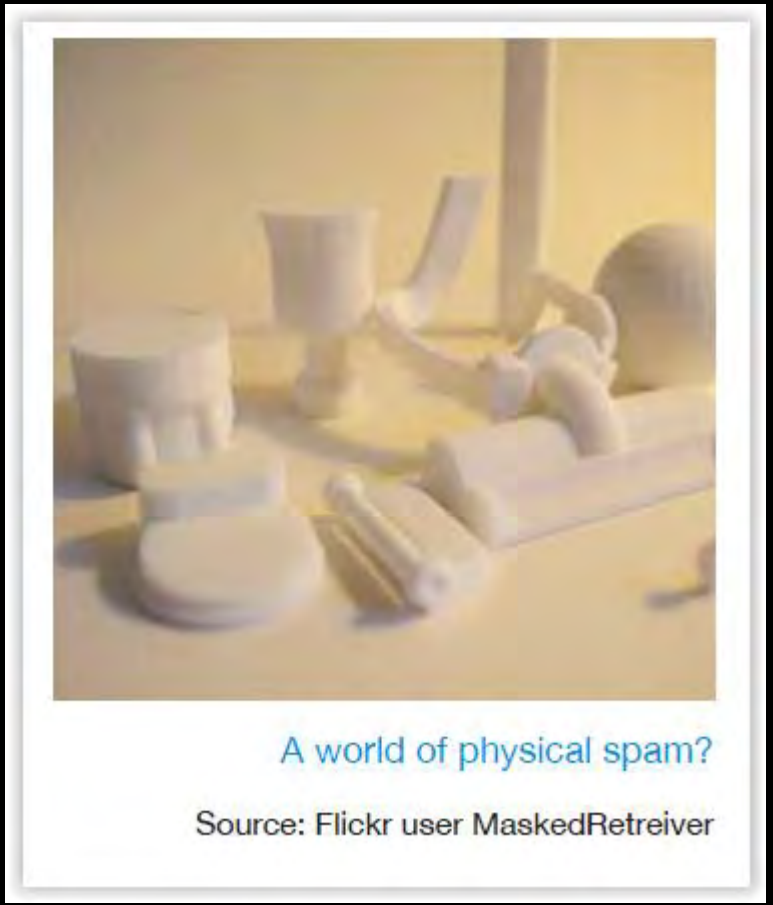
Evolution in manufacturing

	Production Line	Manufacturing Web	Fabrication Cloud
Machinery	Manually-operated machine tools	Computerized numerical control machine tools (CNC)	Rapid prototyping/ additive manufacturing
Labor's Added Value	Skilled machine operators	Programmers	Designers
Materials	Metal, wood, rubber	Metal, wood, plastic, foam	Plastic, low melting-point metals, powdered materials, cells, binders
Distribution	Wholesalers	Retailers, direct to consumers	Fabricate-on-demand, fabricate on-site
Recycling/ Use of Products	None	Select components	Entire objects

Source: IFTF

DANGERS

- A world of CRAPJECTS
- Unwanted waste
  - Created by unskilled designers
  - Fabricated using inferior materials
  - Poor surface resolution



A world of physical spam?

Source: Flickr user MaskedRetreiver

OPPORTUNITIES

- 3D printing and open design also present us with the opportunity to break down the standardization and uniformity that's been enforced by mass production for a century.

- In its place, we will see an explosion of personalized objects, introducing for the first time artisanal characteristics to manufactured products.

- These objects may incorporate features based on sensory or scanned data from individuals, such as "Be Your Own Souvenir," a hack that combined 3D scanning with a RepRap 3D printer to allow tourists to create personal figurines of themselves.

CHANGES

- From centralized factories to distributed, mobile fabs
  - Move production close to consumption place
  - Smaller / changed Supply Chains
  - Printers are more standardized than computer-controlled machine tools
  - Only 2 things to supply:
    - Electric power
    - A limited set of feedstocks
  - New manufacturing business models based on short-run, site- and event specific / ad hoc production runs

CHANGES

- From fixed to mobile machines brought on site
  - E.g. 3D printing of houses by bringing the 3D printer on-site to print the building
  - Instead of producing building materials somewhere else and bring them on-site to be assembled into a house

CHANGES

- Moving from large factories to small production – non-industrial – facilities
- Being able to print complex new shapes for aircraft assemblies - nearly impossible to manufacture by traditional techniques.
- Printing from 10 units to 10000 units – costs of small-scale production go down significantly
- The cottage industrialist – forming the cloud network of small, highly personalized products capability manufacturers

THE NEW OPEN WAYS

- Initiated by the open-source software movement – huge impact on the IT industry over the last two decades

- Emerging technologies promise a similar move:
  1. democratizing the availability of necessary information
  2. in order to allow anyone to produce complex goods at very low costs anywhere

The process has developed distinct advantages for many projects involving low production runs, unique or complex design, shipping constraints, and time limitations.

However, fundamental limitations in process, software, and materials remain to be addressed.

ADVANTAGES

- More cost-effective design> simple process:
  shape -> slicing -> printing slice by slice
- Mass customization
- Rendering “impossible” forms
- Haptic design interfaces

SUSTAINABILITY

- Reusable feedstocks – fully recyclable printed objects
- New materials should allow on-the-spot recycling instead of long recycling trajectory
- Openness of the architecture of the machines themselves
- Biological feedstocks – biological applications in manufacturing – tissue based materials – organic forms being printed form live organ stem cells

EXAMPLES – SIGNALS OF THE FUTURE

- Printed electronics
- Grown meat
- Printed organs
- Printed components / spare parts
- Printed buildings

OPEN FABRICATION COMMUNITIES

- Once a design developed – it's reusable – huge source of efficiency
- Objects are first digital before they become real by printing
- Regulation regarding information ownership and knowledge sharing
- Shanzhai manufacturing : Like the bandits of yore, they live by their own code, steal from the rich, and provide to the poor. An estimated 10% of the global mobile phone market belongs to them.

SHANZHAI RULES

Here are the rules the shanzhai live by:

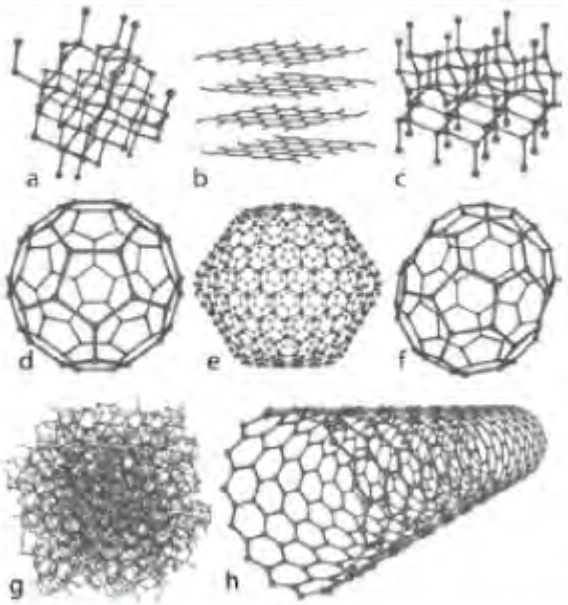
- Do nothing from scratch; build on the best of what others have already done.
- Innovate process ceaselessly at small scales for speed and cost savings.
- Share as much as you can to make it easy for others to see your value and to add value to your process.
- Sell it before you make it.
- Act responsibly within the supply chain to preserve your reputation.

- FROM SCHANZHAI TO LEGITIMATE BUSINESS ?

DEMOCRATIZING INDUSTRIAL DESIGN

- Standardization of shape description (in files – electronic form knowledge)
- Collaborative design processes
- The next generation of CAD software will take into account the physical and molecular capabilities of objects used in printing.
- There are concerns regarding our ability to create the raw materials to be used for all these areas – STILL TO GO – slow pace of materials innovation

MULTIPURPOSE – SAFER MATERIALS



Eight allotropes of carbon: (a) diamond, (b) graphite, (c) Lonsdaleite, (d) C60 (Buckminsterfullerene or buckyball), (e) C540, (f) C70, (g) amorphous carbon, and (h) single-walled carbon nanotube or buckytube.

Source: Wikipedia

CONSEQUENCES

- Extreme customization
- See it, capture it, make it
- New blue-collar skills
  - a college education is no longer a guarantor of economic success, as automation and offshoring of many white-collar jobs reduces demand for college graduates
  - Blue collar new skills - open fabrication could be a powerful growth accelerant for a stable base of non-routine manufacturing jobs

10 to 10000 – the sweetspot for 3D printing

- Over 10000 it may be cheaper to produce with traditional production tools

THE WILD FUTURE

SELF REPLICATION OF OBJECTS

This is the explicit aim of the RepRap project, an open-source effort to produce a selfreplicating printer for home use.

While RepRap is likely a signal of the possibility here rather than a fulfillment of it, the implications are eye-opening. If successful, digital fabrication capabilities would naturally tend toward ubiquity, much as computing has.

Beyond this, the process of technological evolution that underlies the maturation of all technologies would be exponentially accelerated.

Within such a scenario, it is difficult to imagine that digital fabrication would not overtake traditional manufacturing in nearly every sphere of production.

KEY OBSTACLES

- Design tools remain too specialized
- Intellectual property frameworks favor big players
- A Gordian knot limits the applicability of 3D printing due to today's limits in raw-materials' development

KEY OPPORTUNITIES

- Open fabrication will extend the life and value of a product over time.
- A world of open fabrication will transform the role of the retailer.
- Open fabrication will enable extreme customization
- Open fabrication offers new development opportunities for manufacturers and designers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REINVENTING ENERGY FUTURE

FOUR VISIONS

1 THE RISING TIDE : GROWTH

- Market full of major players
- Renewable energy vs fossil fuels – highly profitable
- When will the shifting point be (from fossil to reusable)? 2024 ? – 2030 ?
- Still – even if fossil energy is not cheap anymore, it still is
  - Plentiful
  - Reliable
  - Profitable

2 SHARING THE LOAD : CONSTRAINT

- Oil spills
- Nuclear meltdown
- Massive profits for energy companies
- Accelerated climate change

- Direct government control over energy
  - Industry (grid, production, distribution)
  - Consumption (if a grid failure is predicted – government may order to reduce household consumption)

3 SHUT DOWN : COLLAPSE

- In the US – costs cuts in R&D – only maintenance for the power grid
- The effort to salvage the Power grid came too late and too little what once was a reliable power system
- The grid was thrown in what one may call nearly chaos
- A new line of services for disaster recovery was developed + microgrid

In 2025 carbon emissions are going to be well below 1990 levels, providing a glimmer of hope that thee worse predictions for global climate catastrophe will be avoided. Thermal inertia is still making the planet warmer but there are signs that this warming is slowing down.

4 A NEW DAWN

- There was never any energy shortage on Earth, only a shortage in the energy humans were able to harness and utilize.

- Using this abundance is to fundamentally change human civilization

Soviet astronomer Nikolai Kardashev created o scale for civilizational advancement based on the amount of energy available for use :
Type 1 – to harness the energy on the entire planet
Type 2 – to harness the energy in the solar system
Type 3 – to harness the energy in the entire galaxy

Still, we accelerate our capabilities – we may become a Type 1 civilization quite soon.
By 2033 – we could reach the 174 peta-watt mark (POWER (10, 15))

SIX ACTION DOMAINS

- Over the next 10-15 years:
  - Infrastructure: new ways to generate, transmit, store and consume
  - Resources: development in generation, new fuels, excessive heat into electricity, Solar Moore's law
  - Economy: new ways to value energy – supply and demand
  - Quality of life: the way we consume and relate to energy in our daily lives
  - Environment: Unintended impacts of shifting energy strategies
  - Governance: rethink energy responsibilities at national, regional, local and individual scales

CHANGES IN ENERGY - INFRASTRUCTURE

- Energy-generating buildings
- Energy islanding – increasing grid reliability – bringing together micro production with consumption
- Plugged-in mobility – fleet vehicles would be able to draw and provide energy to the grid – allowing greater control over the electricity flow – mobile power reserve
- Wireless infrastructure – power transfer
- Energy in the cloud – much better micro-control of local production and consumption – by using the data provided by the producer / consumer – and optimizing energy consumption.

CHANGES IN ENERGY - RESOURCES

- Practical fuel cells
- Recycling heat – e.g. in solar photovoltaic cells – heat even worsens efficiency
- There are prototypes of solar panels that use as well light and heat to produce electric energy
- Reuse of heat of engines – to produce electric energy
- Solar Moore's law: Photovoltaic energy doubled every two years – we would need only a couple of decades to replace the entire today's production capacities.
- Nuclear plants (not nuclear energy) are becoming more and more expensive
- Garbage in – energy out – household garbage into biofuel – new technologies available.

IN A NUTSHELL

GOVERNANCE

Q: How will we re-allocate control over energy in a world of new power politics?

FORECASTS

- Regional, not national, resilience
- Struggles over energy mandates
- Personhood rights for Earth
- New resources = new power brokers
- Locally owned energy

Source: bloomington.in.gov/peakoil

Source: Wikimedia Commons

Energy Soft Landings
Bloomington, Indiana has joined the Transition Towns movement, creating an "energy descent action plan" for a postpeak world.

New Legal Categories
Nations like Bolivia are part of a burgeoning movement to declare "personhood" for planet Earth, granting it the rights of any human citizen.

IN A NUTSHELL

ECONOMY

Q: How will we innovate strong jobs, services, and products based on the energy economy?

FORECASTS

- Rise of disaster economics
- Renewables reach the tipping point
- Extended producer responsibility: cradle-to-cradle
- Motivating high-tech workers with a new mission
- Peak energy use at the global level

Source: ghgprotocol.org

Source: fenixintl.com

Growth of Full-cost Metrics

Robust accounting systems such as the Greenhouse Gas Protocol are enabling companies to develop comprehensive and reliable inventories of their GHG emissions.

Agile Energy Products

Fenix International's ReadySet is a safe, rechargeable battery system for charging small devices when the grid is down or nonexistent.

IN A NUTSHELL

QUALITY OF LIFE

How will we build a new relationship to energy to support better lifestyles?

FORECASTS

- Religious organizations take on power
- Personal data systems become more vulnerable
- Persuasive technology drives behavior change
- Purchasing access, not ownership
- New energy retail

Source: vatican.va

Source: MeterRead

Vatican Highlights GHG
The Pontifical Academy of Sciences is one of a growing number of religious authorities bringing issues of climate change and environmental futures to worshippers around the world.

MeterRead
Mobile apps make behavior change easier. You can set up multiple meters to track your home, solar panels, or car, or to make personal projections of future usage patterns.

IN A NUTSHELL

FORECASTS

- Garbage in, energy out
- Wind, water, and solar for the win
- Recycling heat
- Costly nukes
- Solar Moore's Law

RESOURCES

Q: How will we redefine fuels and waste?

Source: BloomEnergy

Source: Enerkem

BloomEnergy's Fuel Cell Servers
BloomEnergy's fuel cell "servers," deployed in 2010 for customers including Google, eBay, and Walmart, are an early signal of reemerging commercial interest in fuel cell technologies.

Rethinking Waste
Enerkem will operate a plant slated to open in 2012 for industrial scale production of biofuels from municipal waste.

IN A NUTSHELL

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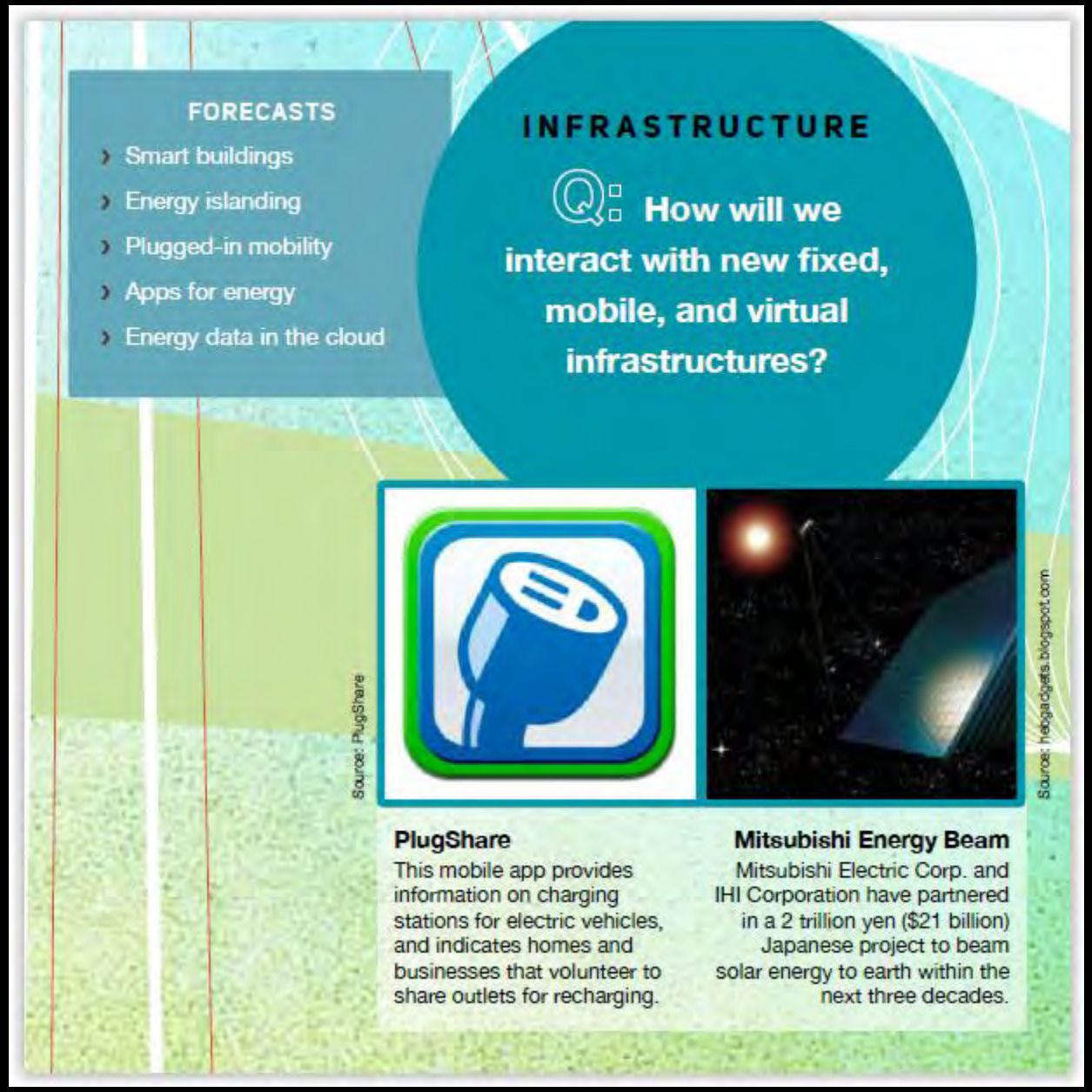


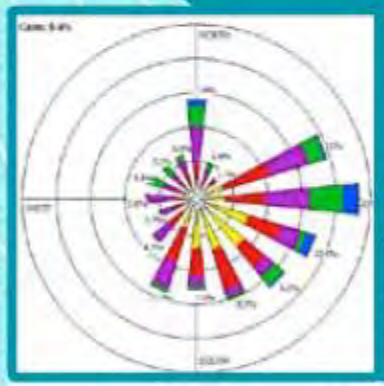
IN A NUTSHELL

FORECASTS

- Energy conscious food
- Growing scrutiny of water for energy production
- Temperatures on the rise
- Energy locavores
- Geo-engineering the climate

ENVIRONMENT

How will we reinvent our responses to accelerating environmental volatility?



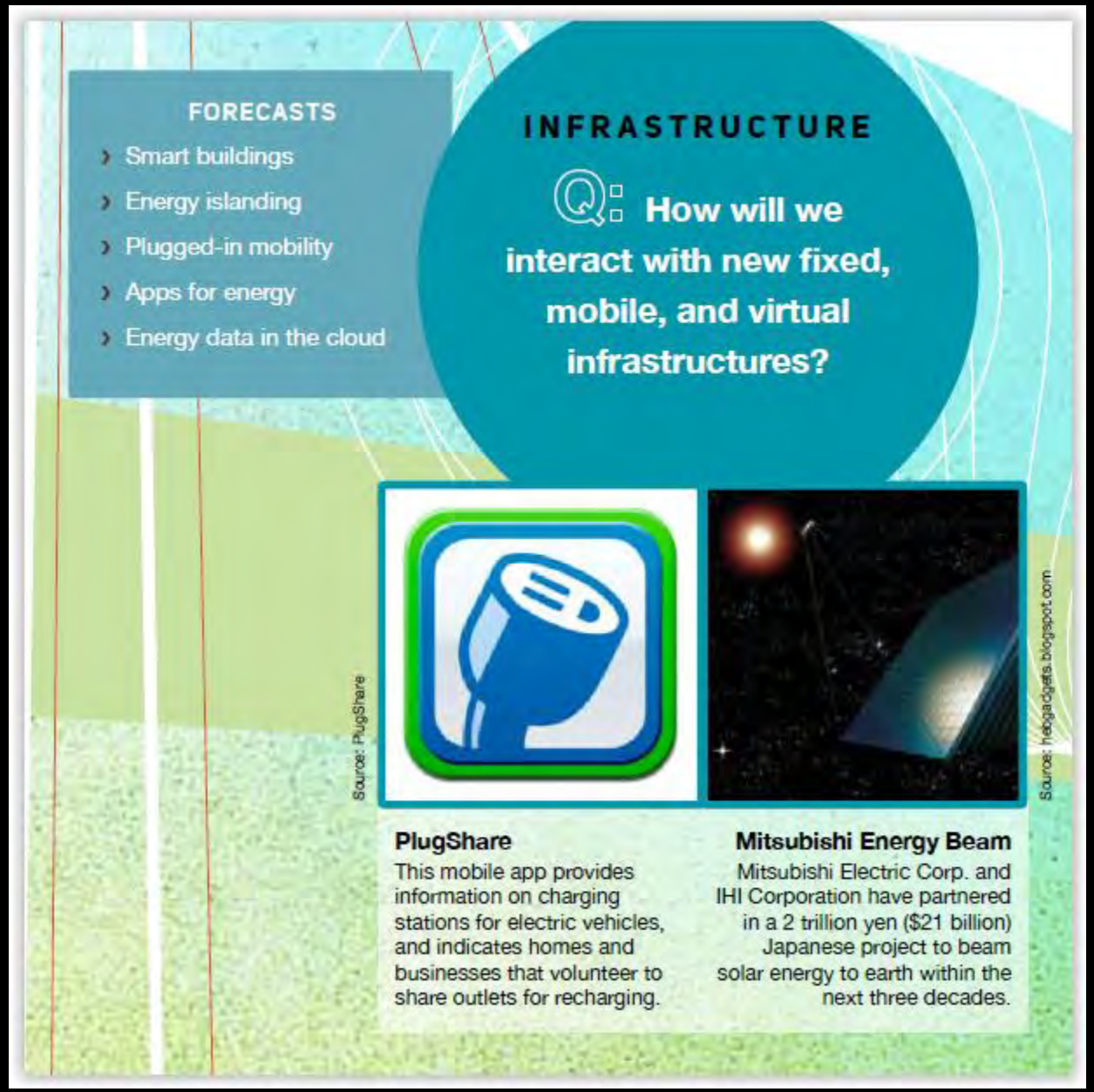
Source: vistadatavision.com

Source: indiegogo.com/VANISHING_WORLDS

Distribution Wind Rose
New professions and tools, such as graphs to plot the distribution of wind resources, are helping reframe land use at the local level.

Vanishing Worlds
This documentary tells the story of three families in Alaska, India, and China, whose lives are already being affected by changing climates.

IN A NUTSHELL

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-

Germany 4.0

BEYOND ORGANIZATIONS

NEW MODELS FOR GETTING THINGS DONE


BEYOND
ORGANIZATIONS
new models for getting things done

ORGANIZATIONS IN CHAPTERS

1. Drivers of Change : 3 major emerging technologies enabling new ways of organizing

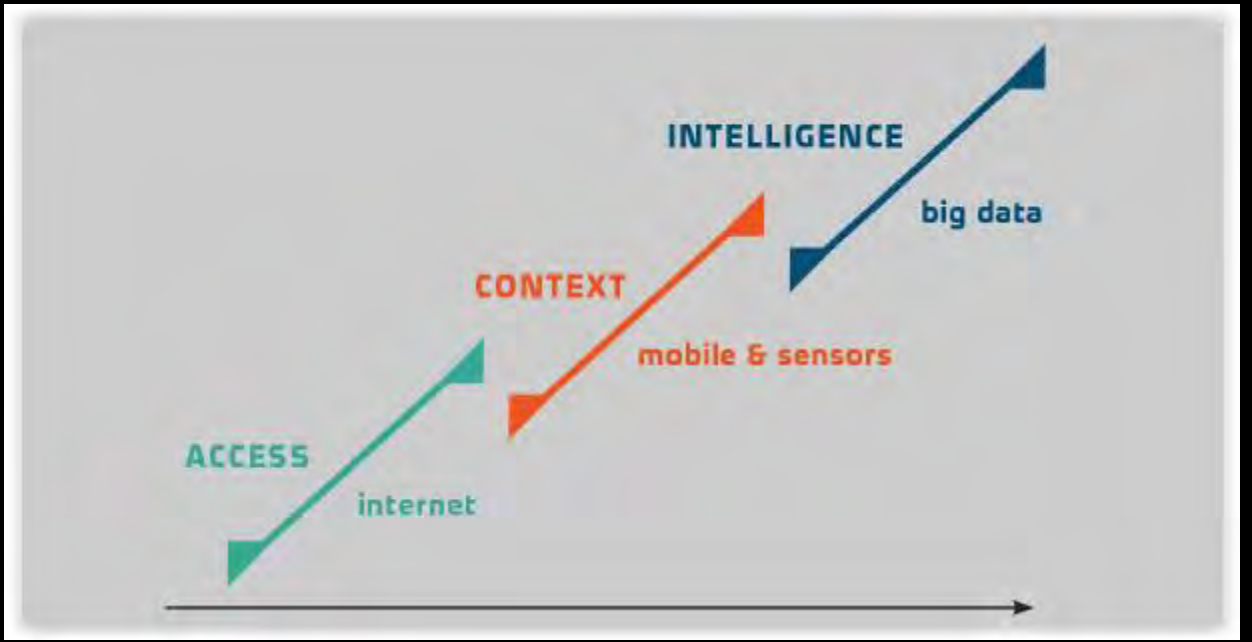
2. Getting things done: 7 powerful affordances of these new organizational functions

3. Future skills: 5 capacities individuals will need to thrive in future organizations

4. Transformational shifts and early signals: What's in store for organizations

5. Scenarios: 4 Different kinds of organizations in 2028

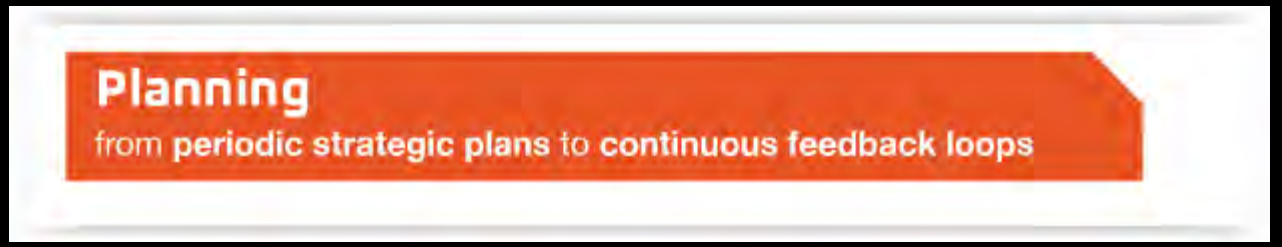
AS TIME GOES BY…



- How can we apply social technology of organizations for specific purposes?
- Where will it be most effective
- What will the 2nd and 3rd order effects from its application be?

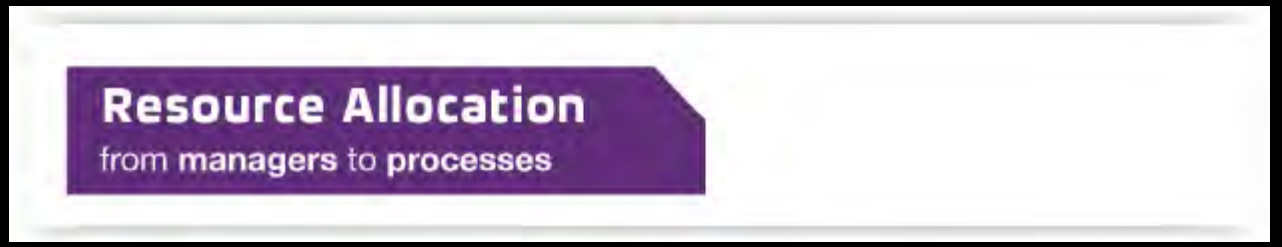
HERE ARE THE NEW FUNCTIONS

CHANGING FUNCTION 1



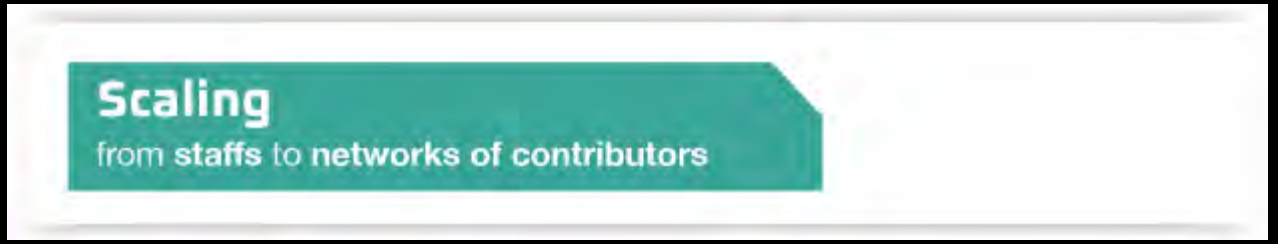
CHANGING FUNCTION 2

CHANGING FUNCTION 3



CHANGING FUNCTION 4

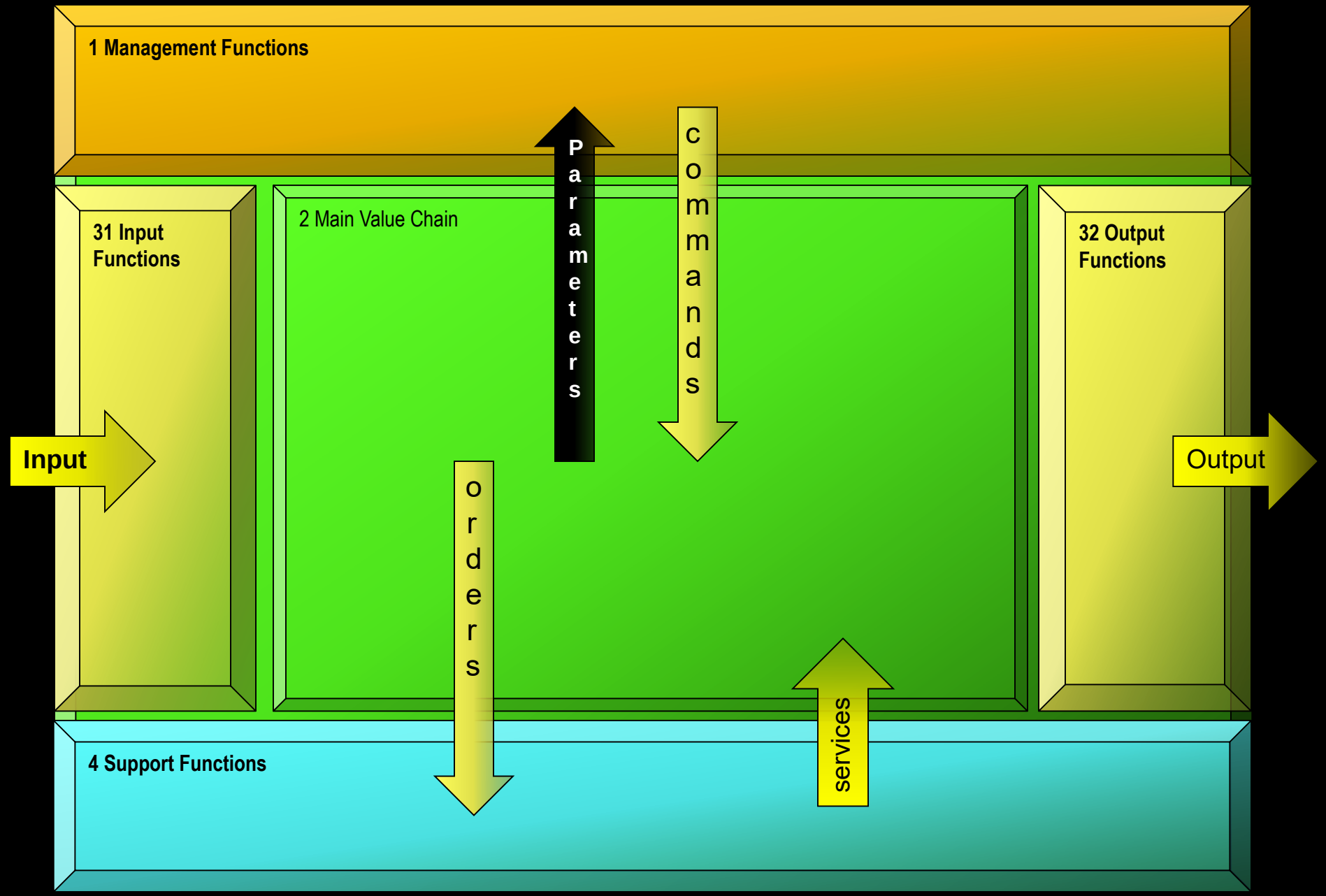
CHANGING FUNCTION 5



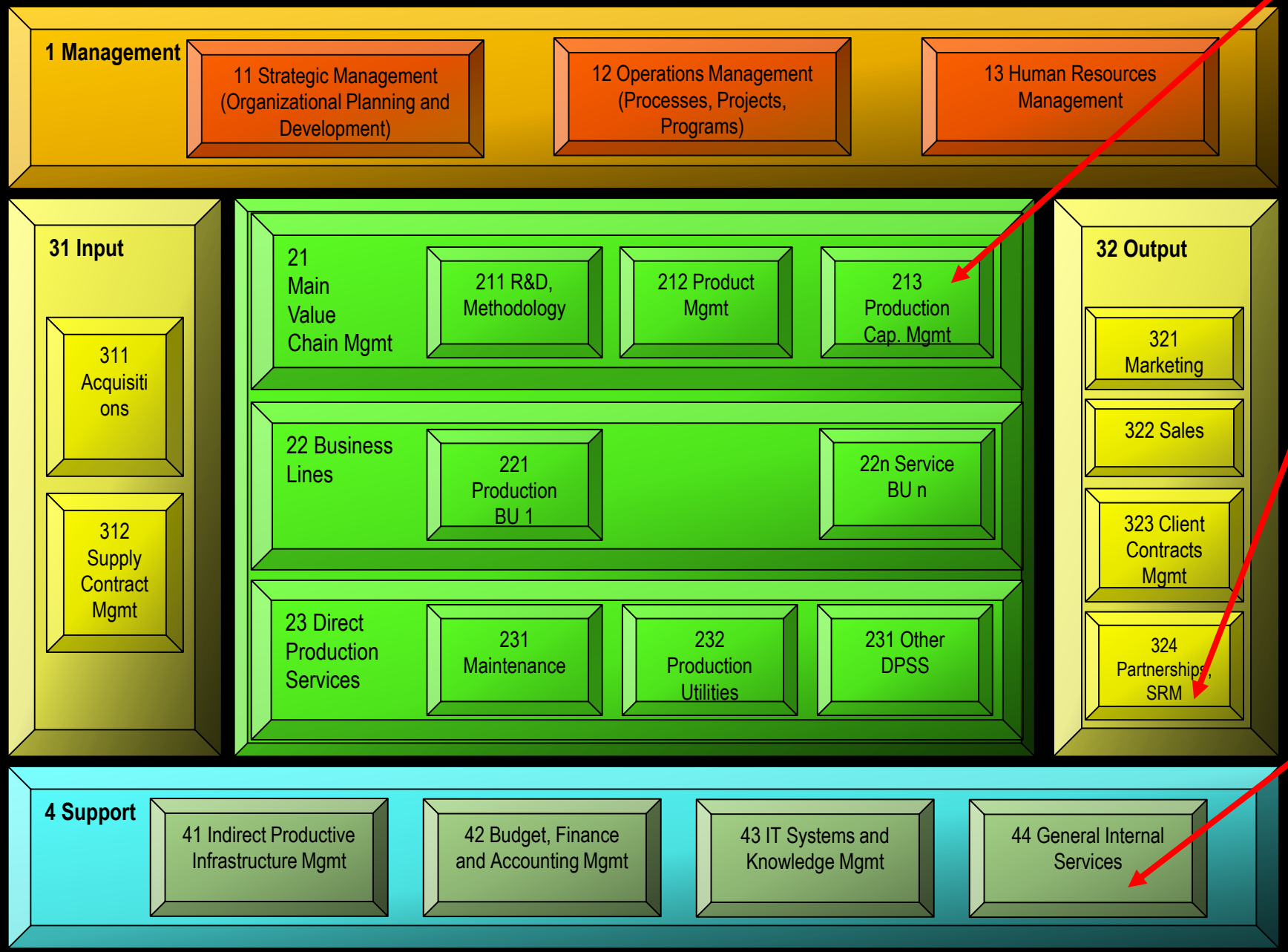
CHANGING FUNCTION 6

CHANGING FUNCTION 7

The Organization seen as a SYSTEM



The Functional Map - Companies

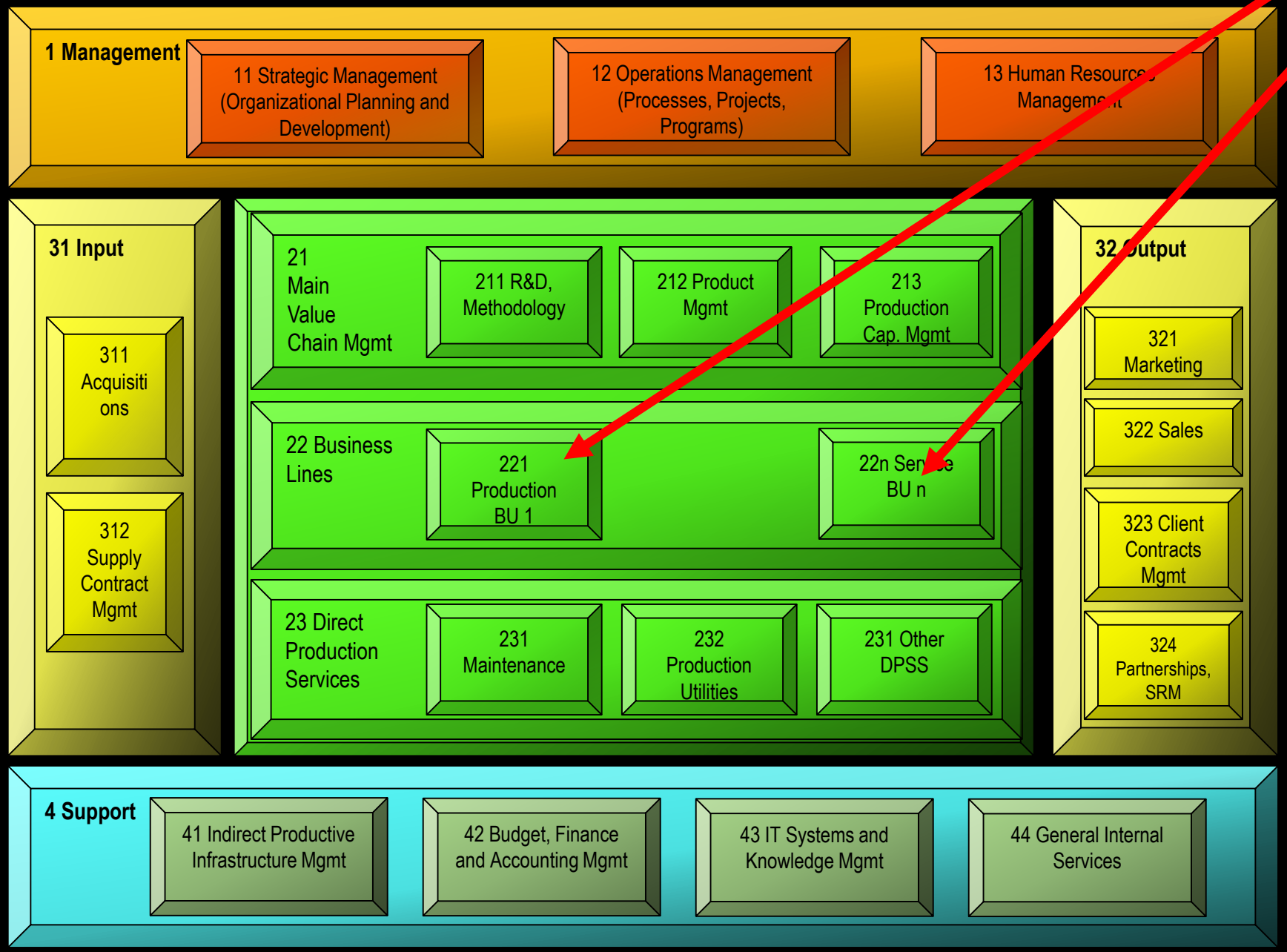


Production capacity renewal

Stakeholder relationship management

e.g. legal, security, etc.

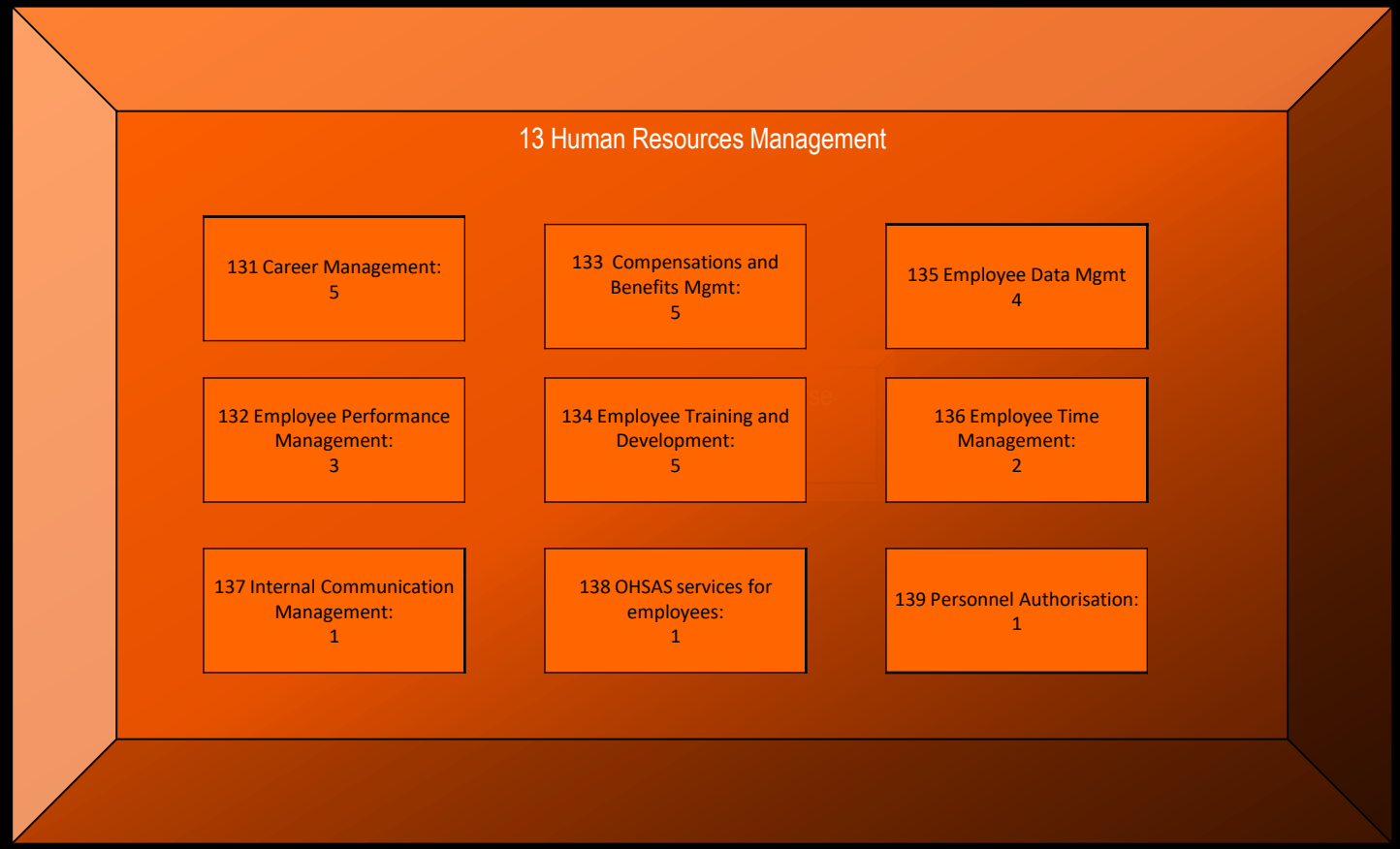
The Functional Map - Companies



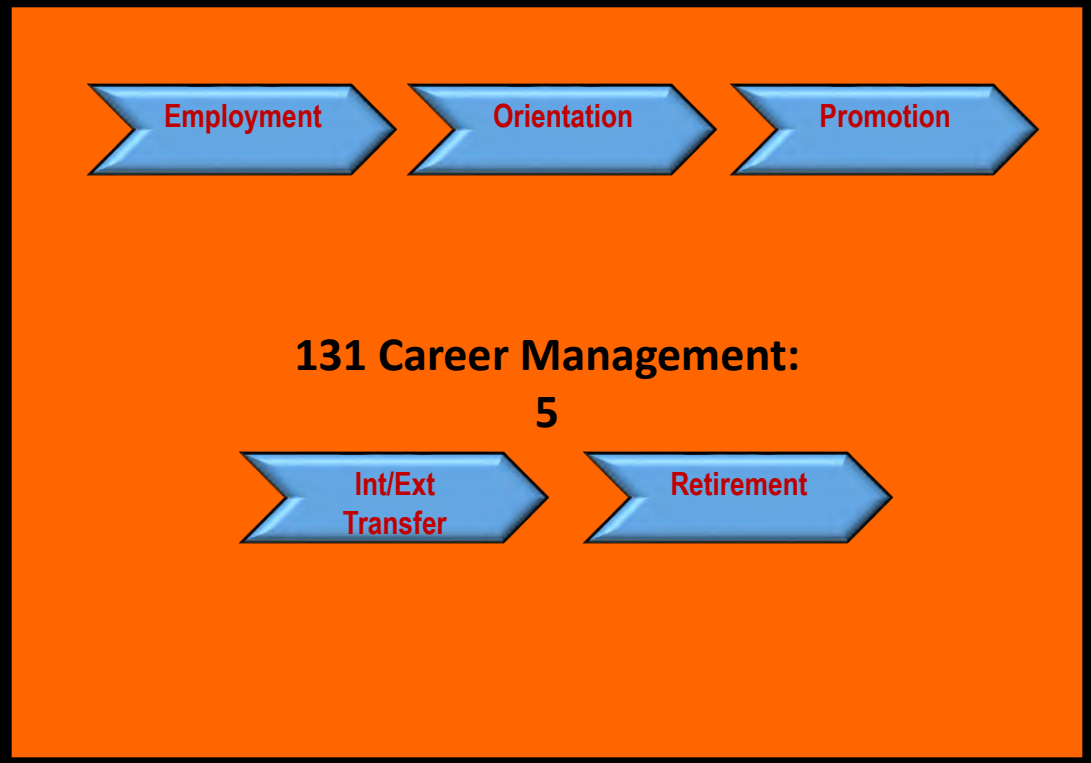
These are Profit Centers (measured on P&L)

All others are Cost Centers

Inside the functional boxes: processes
In this case, HR processes - detailed



The Career Management Process group (HR processes) – detailed at a process level



Creativity Scenario

- Makerspaces began as community workshops where makers shared the cost of tools, equipment, and working space. Providing access to 3D printers, laser cutters, and CNC mills was tremendously beneficial to makers, but everyone knew the most valuable resource in makerspaces is the other people there.

- Makers drew on one another's complementary skills to collaborate on complex technology projects. While makerspaces started as clubhouses for hobbyists, over time, many morphed into grassroots incubators and development labs, where people with similar interests self-organized into temporary teams to prototype commercial products, usually at a fraction of the price that traditional manufacturing companies paid for similar projects.

- By 2028, this trend had been adopted by companies wishing to optimize for creativity. In some cases, these companies formed partnerships with existing makerspaces, and in other cases they started their own makerspaces. The flat hierarchical structure and lack of formal titles in these organizations means that workers have the freedom to seek out and team up with others who share the same goals.

Learning Scenario

- In 2028 learning has become pegged to a kind of currency that ties together every aspect of our lives and is tracked and traded on a digital platform called the Ledger. It's a complete record of everything you've ever learned, everyone you've learned from, and everyone who's learned from you. The Ledger not only tracks what you know—it also tracks all of the projects, jobs, gigs, and challenges you've undertaken.

- As a public block-chain, the Ledger forms the basis of a teaching/mentor marketplace. You can pay down your student loan by teaching forward what you've learned. Employers use the Ledger to match you with projects and gigs that perfectly fit your current skill set.

- There's no need to finish school to have a thriving career. When you master a new skill at work, that goes on your learning record, too. You have a complete record of how much income each skill or lesson you've learned has helped you generate—so you know the exact value of every part of your education.

- Investors can even help pay for your education. In return, they get a percentage of your future earnings tied to the skills they paid you to learn. This fuels a new speculative economy as people invest in building a workforce for what they hope will be the most lucrative skills.

Sustainability Scenario

- In the early 2000s, scientists collected ocean floor samples and measurements in select places and at specific times. Inferences and projections were based on this spotty information. But by 2025 portions of the ocean floor were instrumented with tiny wireless interactive sensors that enabled scientists (and laypeople) to access continuous streams of physical, chemical, geological, biological, and other data about the ocean.

- These streams were fed to interactive models that allowed oceanographers to navigate a range of possible futures and test different scenarios: they could "take the pulse" of the ocean and literally experience the future, suggesting powerful interventions when needed.

- By 2028, the earth itself became blanketed with hundreds of billions of wireless sensors. Their real-time information flows, combined with AI-based data analytic software, allow anyone to create customized virtual instrument dashboards. There's no longer a need for quarterly and annual reports—they've been replaced with up-to-the-second snapshots of an organization's health and trajectory.

- As a result, strategic planning is no longer about reacting to stale data, but instead is an engaging, vibrant, future-facing, participatory, and continuous sense-making process that guides and helps organizations navigate and prepare for the future.

Well-being Scenario

- In the same way that healthy cells provide a foundation for a healthy organism, healthy organisms form the basis for a healthy organization.

- In 2028, you can choose to be continuously monitored by a menagerie of networked bio-scanners: sensors built into mobile phones collect your sweat samples and body temperature. Office chairs detect your weight. Laptop cameras measure your pulse and look for symptoms of precancerous skin on your face. Your toilet takes a census of your gut microbiome. Your watch measures galvanic skin response. Your bed tracks your sleep patterns.

- The data is transmitted to the cloud where AI and big data programs create and maintain a computational copy of your body. Through your phone and voice assistant, you receive up-to-the minute suggestions, nudges, and, if necessary, warnings to change your behavior to achieve peak physical and mental health. Your personal data is encrypted and stored on a block-chain, and you have sole access to the keys to unlock the data, and the ability to control who gets to see the data, how much of they can see, and how long they can see it.

- Organizations you work with will license this data from you and your colleagues to help them understand the overall health of the organization itself and develop policies to ensure a healthy, happy workforce.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KNOWLEDGE TOOLS OF THE FUTURE

The Knowledge Driven Global Economy

The new web functions of knowledge

- semantic Web functions,
- Micro-formats,
- Natural language searching,
- data-mining,
- machine learning, and
- recommendation mechanisms
- agents to provide a more productive and intuitive experience for the user.

- the new knowledge tools aren't meant to replace humans
- they are meant to enable humans to do what they do best—creativity and innovation—without having to do the heavy lifting of brute information processing

The new web functions of knowledge

Today's generation of knowledge tools—

- interrelational databases like Freebase and DBPedia,
- social networks like OpenSocial,
- information accessing tools like Snapshots—
- are flexible and relatively easy for individuals and groups to learn, and thus can serve as "outboard" brains.

The result is a kind of human–machine symbiosis in which processing-heavy tasks are offloaded onto software, leaving users to collaborate more freely with each other in search of insight, creativity, and experience.

Principles of social knowledge tools

- They’re **simple**, which makes them easy to use, and quick to evolve.
- They’re **sociable**, which allows them to be used by a diverse range of users and communities.
- They have **symbiotic** relationships with their users.

Intentional simplicity of KT

- Good enough and easy to use
  - Search engines
  - The page-rank algorithm
  - Amazon calculates correlations in-between purchases
  - Google translate

Sociability: Enabling Diversity and Encouraging Community

- Lightweight systems also integrate more easily into existing workflows and, perhaps most importantly, across different professional groups. SRI's NLS (oNLine System) required six months training to master. In some professions, familiarity with complex systems is obligatory. For lawyers, mastering Lexis-Nexis is part of the job; likewise, librarians must know the Online Computer Library Center (OCLC) and other electronic catalogs.

- For people in jobs that require bringing together multidisciplinary perspectives or working in diverse teams, however, it's not worth the time and resources it takes to learn the more complex systems. With lightweight systems, users carry the burden of figuring out how to integrate the tools into their daily work, but the payoff is greater flexibility and utility. Information tools are more likely to be used when they don't require people to redesign their lives around them.

Symbiosis: Changing the Definition of Machine–Human Cooperation

- Lightweight knowledge tools have another important feature that separates them from more complex tools: they work and evolve in symbiosis with their users.

- Lightweight knowledge systems and humans train each other. Probably the best-known symbiotic lightweight knowledge tools are collaborative filtering and recommendation systems.
- Developed in the early 1990s by MIT professor Pattie Maes, these systems aggregate user behavior (ratings, songs listened to, or purchases) across a service in order to build a model of relatedness between the items.

- Commercial services—Netflix, Amazon, and iTunes, among others—as well as knowledge management or social networking systems such as Last.fm, MyStrands, and Digg, all offer collaborative filtering.

- The Amazon recommendations system, for example, looks at users' purchases, and tells them about other items purchased by people who've ordered the same items. The more they're used, the more adept these systems become at making useful recommendations: experience makes them more adept at anticipating the tastes of their users.

Breaking Tradition
From Knowledge Chains to Knowledge Ecologies

- Information scientists and managers have traditionally thought of knowledge production as a chain made up of discrete links carried out by different groups:
  - creation,
  - publication,
  - organization,
  - filtering, and
  - consumption.

- Of course, these are all descriptions of idealized activities that usually aren't completely discrete, nor are they always carried out by different people.

Knowledge today

- Generated by many contributors (not by a regular chain process)
- Allowing reader's real-time feedback (content / (dis)approval / level of interest)
- Organized in a connected way in more than bodies (hyperlinked)
- Organized in hierarchies by weighting algorithms based on our interaction and expression of interest regarding the subject
- Easy to be found
- Easy to be searched through
- With search keys having pre-determined values (trying to guess what we want to search)
- Looking around for similar searches/results if there is not an exact match
- +SQL / similar capabilities

A Knowledge Ecology vs Knowledge Chain

CREATION AND PUBLICATION: Growth of Decentralized Peer Production

We have recently witnessed a surge in decentralized peer production online, which has been well documented in the mainstream media as the "rise of the amateur." The phrase "peer production" refers to content that is submitted and edited by a community of users, often outside traditional gatekeeping institutions like publishing houses, companies, and universities. It is important to recognize that many online communities are actually engaging in peer *aggregation*: that is, they are organizing knowledge that has already passed through more traditional processes.

Peer-produced and peer-aggregated knowledge has become a trusted source in the past decade. Regardless of what one thinks about the reliability of Wikipedia, Wikipedia pages frequently dominate the search results of Google queries. This high rank reflects not necessarily the accuracy of the content, but a democratic process in which Internet users are visiting and linking to Wikipedia more than other sites. Companies have also made use of this new model of knowledge production. Newspapers, magazines, and television stations are now offering spaces for their audiences to share relevant information by means of comments or customized user blogs and submission pages. Indeed, many companies have online knowledge bases that are solely populated by the contributions of their consumer/users.

These processes will not displace traditional forms of knowledge production but will add to the diversity of information, and to the amount of information that must be filtered and vetted. Kevin Kelly puts it this way in his book *Out of Control*[2]: "The hive mind produces the raw material that smart design can work on." This smart design includes knowing when and how to pluck relevant content from raw material, and dedicating human and computer resources to the task. We will see the disappearance of top-down editorial control; instead, editors will serve as filters that help to highlight peer-produced and peer-aggregated content for larger audiences.

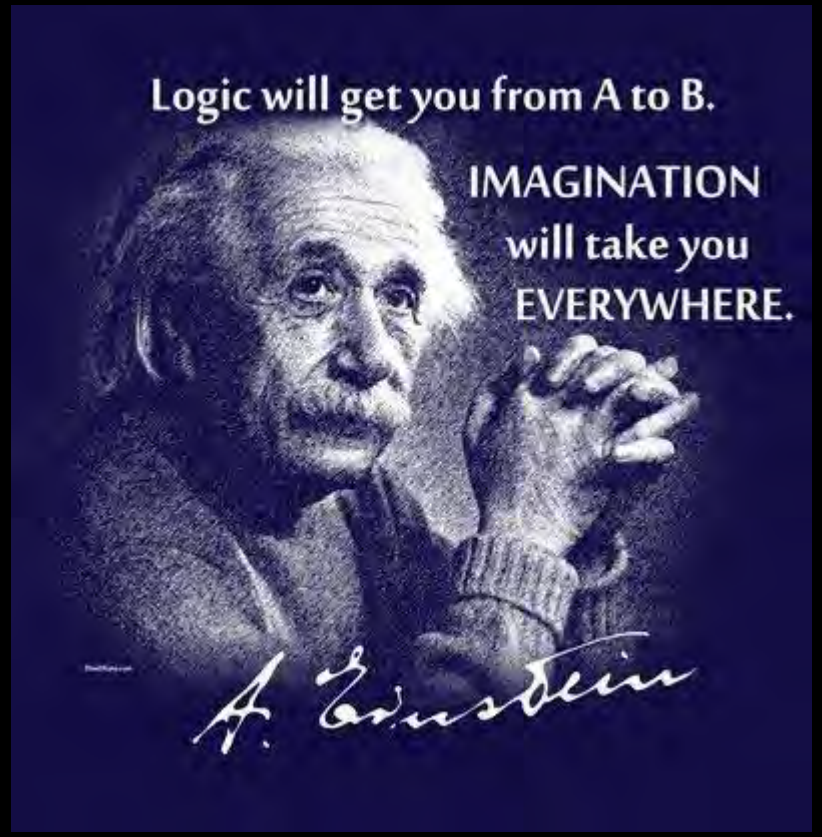
FROM KNOWLEDGE MANAGEMENT TO CREATIVITY

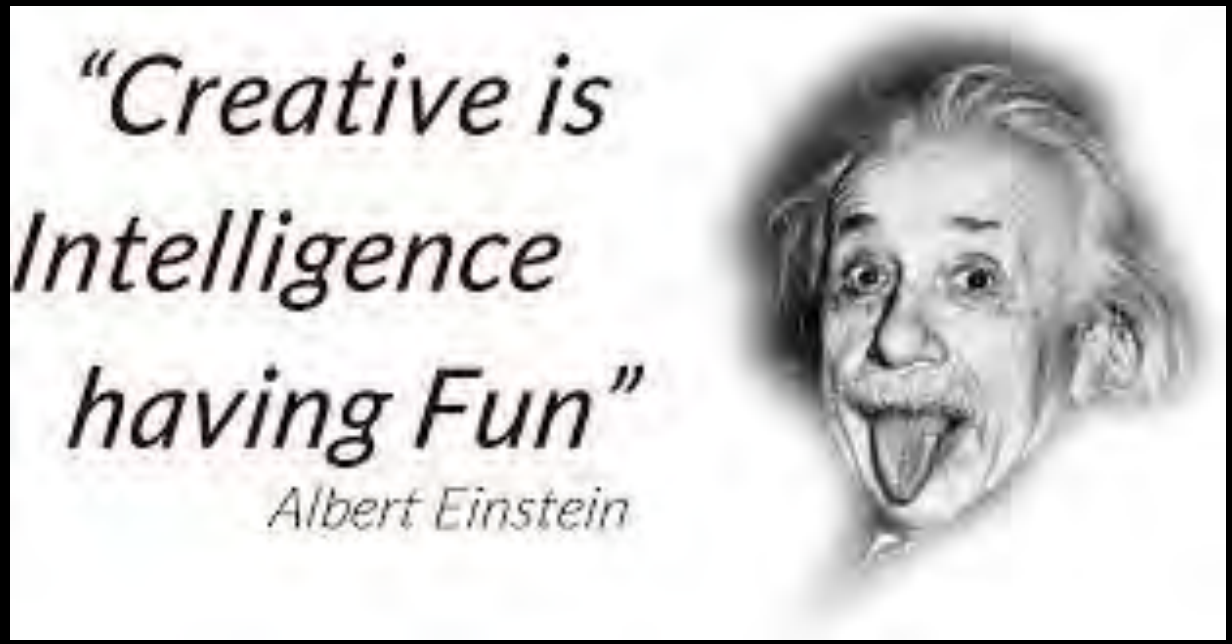
- The importance of creativity is growing
- The success formula becomes more and more:

SUCCESS = KNOLWEDGE + CREATIVITY

- Creative co-presence
- Co-cognition evolves allowing multiple contributions from informal, very large groups of experts

CREATIVITY


Logic will get you from A to B.
IMAGINATION
will take you
EVERYWHERE.
A. Einstein


"Creative is
Intelligence
having Fun"
Albert Einstein

ADAPTING ORGANIZATIONS TO THE NEW KT

- Map knowledge processes across the organization – where can you insert KT to increase productivity ?

- Learn which / how knowledge processes
  - Can be automated
  - Are best left to humans
  - Allow human analysis incorporation as feedback into automated processes

- Not too much automation in processes – it may kill creativity

ADAPTING ORGANIZATIONS TO THE NEW KT

- Develop processes for harnessing the ideas and knowledge of individuals
- Develop processes for engaging with ideas, attitudes and data-aggregation efforts from outside the company
- Recruit new hires experienced with the new knowledge ecology
- Use the lightweight knowledge tools available today

An (by far incomplete) Inventory of KT

Amazon Mechanical Turk	A marketplace for people to post or complete small tasks for small amounts of money; a crowdsource-enabling service.
DBPedia	DBPedia is an attempt by a community to make a publicly available database of all the structure-able information in Wikipedia; similar to Freebase (see below).
del.icio.us	A "folksonomy" that stores bookmarks for personal gain while contributing to a common good: an aggregate, evolving taxonomy for the Web.
Freebase	A product of the start-up Metaweb, Freebase aims to be a Wikipedia for free, structured data—a centralized, interrelational database with information about anything in the world.
Microformats	A Web-based, decentralized data formatting approach to allow regular people to embed information into their Web pages so that machines can read it.
Mozilla Weave	A Mozilla service to provide a continuous experience with the Internet across any computer. Currently stores bookmarks, history, saved form information, passwords. Could be mined for attention data. Could become the user's arbiter for all kinds of profile data.
OpenSocial	A set of common interfaces to social network data, developed by Google in 2007 and supported by sites such as Hi5. com, Viadeo, MySpace, Friendster, orkut, Yahoo!, LinkedIn, Salesforce, and more. Allows users to specify when and how their social network data can be shared between sites and companies.
OpenCalais	A free toolkit offered by Thomson Reuters to scrape semantic information from news stories, including topics, companies, countries, people, technologies, products, and more.
PageRank	The algorithm that helps Google rank search results. PageRank assesses the authority of a hyperlinked document by aggregating the authority of pages linking to it.
Powerset	A search company seeking to match the semantic meaning of search queries with the semantic meaning of sentences in Web documents, using natural language processing. Currently, Powerset only indexes Wikipedia.
Resource Description / Framework (RDF)	A W3C specification for modeling information as "subject : predicate : object"—for example, "The United States : has as a capital : Washington, D.C." RDF is used in many bottom-up data-creation efforts, including Creative
Commons, FOAF (friend of a friend), and MusicBrainz,	an open-source, community-contributed database for music metadata.
Snap Shots	A tool to overlay pop-up information over traditional links on a page. Rolling your mouse over an actor's name, for instance, could bring up a bio and picture from the Internet Movie Database. Rolling over a place name brings up a Google map.
TechMeme	A company that scrapes news sites and blogs. Clusters articles into story groups, which are ranked by importance and timeliness.
Twine	A product by start-up Radar Networks that helps users organize, share and discover information on the Web. Twine attempts to extract semantic information (for instance, people, places, and organizations) from documents that are saved by users. Users can share their stored information with colleagues or the public.
X2 and Signals	An integral part of IFTF's research methodology, signals are events, observations, or developments suggestive of a larger trend or shift. Researchers, experts, and public contributors can view, rate, combine, or hypothesize on the impact of signals on online platforms and in workshops. In the case of X2, members of the science community are invited to contribute signals related to the future of science.
Yahoo! SearchMonkey	A tool that simplifies creation of mashups of Yahoo search results with structured information or imagery from any source.

AUTOMATING CREATIVITY


THE ENVIRONMENT
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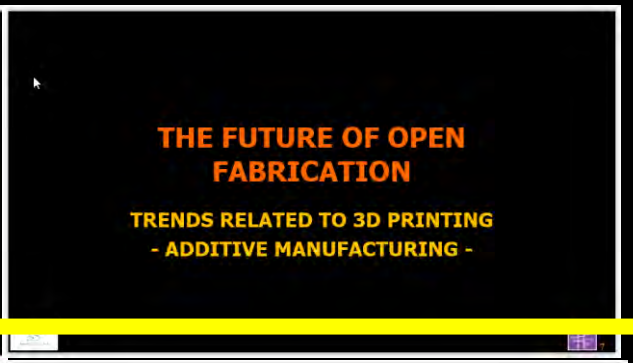
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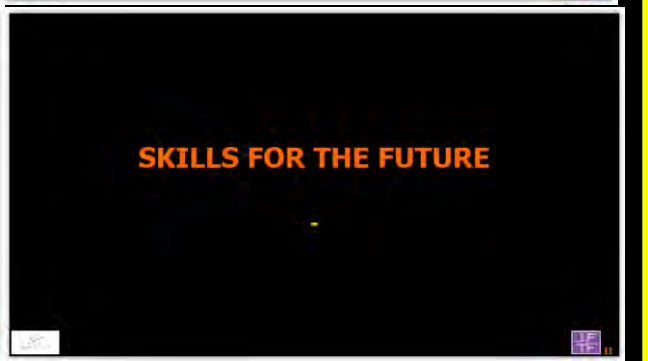
SKILLS FOR THE FUTURE
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SKILLS FOR THE FUTURE

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SKILLS FOR THE FUTURE

SOURCE 1

Make yourself known: your data, your brand

In the future, a person's entire life, digitally documented and accessible by anyone online, will serve as their entry to work and other opportunities. People will have to be skilled at building a reputation and finding ways to communicate it across contexts and cultures.

How can you give employees and contributors the ability to capture data about their accomplishments to build their reputations?

Build your tribe: pop-up communities

In loosely connected, distributed, and shape-shifting organizations, it is important for people and groups to have the ability to quickly scan the environment, identify necessary resources wherever they are, and tap into and organize them to achieve desired outcomes.

What platforms, tools, and skills does your organization need to build or give employees to enable flash organizing?

Befriend the machines: AI IQ

Success in the future will depend on how well a person works with various types of automated, algorithm-driven systems. People will need digital fluency, an ability to move from one algorithmic platform to another, and the critical faculty to know when to trust and when to test these digital platforms.

How can algorithmic reasoning be made transparent and adjustable for non-technical people who depend on them?

Make sense: big stories

With an over-abundance of data, it is more important than ever to be able to separate what is important from what isn't, and translate the salient signals into stories that can be clearly communicated to others.

How might your organization's technology teams lead the way in disseminating data literacy and analytics tools more widely?

Keep it going: shared risks/assets

In a task-based environment, it is easy to lose track of not only the ultimate purpose of the activity, but also the social, environmental, economic, and political effects. Ignoring this larger context can ultimately make the organization unsustainable.

How might processes that match people to tasks optimize for values and passion alignment, not just skills and availability?

SKILLS FOR THE FUTURE

SOURCE 2

Personal	Resilience
Team	Cross-Cultural Competency Social Intelligence Virtual Collaboration
Logic Analysis & Creativity	Novel And Adaptive Thinking Cognitive Load Management Sense-Making
Problem solving & Decision making	New Media Literacy Design Mindset Transdisciplinarity Computational thinking

SKILLS FOR THE FUTURE

SOURCE 3

WITH THE ART & SCIENCE OF REPUTATION MANAGEMENT

In the future, you will have to make yourself known in a digiverse of billions of people. You will need to build your own personal brand for your own personal economy. You can build fame—the kind that earns you viewers and dollars in online gaming venues like Twitch. You can build a reputation for knowing how things work with YouTube instruction videos. You can win contracts for tasks that take a few minutes to a few years. You can build trust, one payment at a time, with digital currencies like Bitcoin. But whatever you do, you will have to do it across many different cultures, on a global stage.

This is the starting place for your journey into the future—a future that begins with who you are and who you want to become.

SKILLS FOR THE FUTURE

SOURCE 3

TO MASTER HUMAN-MACHINE COLLABORATION

Machines have a language of their own, and if you want to work with them, you need to learn it. But working with machines isn't just about coding. The future will ask more of you—and them. You'll need to know how to assemble teams of humans, robots, and bots and get them all to work together. Your AI assistants will promise you convenience and efficiency, but you'll need to know how to tap their intelligence to do more, to accomplish things you could never do before.

This human+machine path will take you to new worlds—digital worlds where you'll mix learning, working, and playing to build any future you can imagine..

SKILLS FOR THE FUTURE

SOURCE 3

IN THE
MANY WORLDS
OF PEER PRODUCTION

The future you're headed for is always shapeshifting. You can't always count on familiar landmarks like schools, stores, corporate headquarters, the factory floor, the stadium, or city hall. But you can count on your network—and it's all about the trade. You'll need to master the many different kinds of trade: open, private, or public goods. Money, time, insight, skill, knowledge, strength. And with the world shifting shapes all the time, you'll need to think like a designer to make the shapes you want.

This is how you'll build communities from the ground up, how you'll get lost in a crowd-sourced world in order to find out who you really are.

SKILLS FOR THE FUTURE

SOURCE 3

OF LOOPY
COMPLEX SYSTEMS

Making the future is an exercise in connecting lots of dots to tell the stories that change the way you—and others—think about the world. It's an exercise in building flexible minds as well as flexible bodies, in thinking beyond the obvious, in coloring outside the lines. It takes imagination and creativity and a willingness to know that you don't know. It takes a long, careful look into the future and a readiness to act on what you find there.

There are no easy problems or right answers on this journey—only feedback loops, puzzles and mazes that pull you forward in your quest to discover what makes sense in your world.

SKILLS FOR THE FUTURE

SOURCE 3

BY BUILDING RESILIENCE IN EXTREME ENVIRONMENTS

The future is riskier than ever. Category 5 hurricanes and wildfire politics. Dwindling reserves of everything you depend on and hot debates about the substitutes. Cities and farmland alike, struggling to feed more and more people around the world while feeding their own. Body hacking to make sure the human form can survive in these extreme environments. This future needs more than tech solutions and artificial intelligence. It needs social intelligence, emotional intelligence, empathy, and clear strategies for we're-all-in-this-together.

This is where you commit and recommit to your learning journey, where you draw on hope and healing and caring to secure the future for everyone.

SKILLS FOR THE FUTURE

SOURCE 3

SKILLS FOR THE FUTURE

SOURCE 3

Learning on your own

Becoming your own boss

More and more, learning is leaving the classroom and escaping the familiar boundaries of disciplines and trades. Work is also abandoning fixed places like factory floors and office cubicles as well as fixed 9-to-5 schedules. This new freedom to find your teachers and be your own boss will require some new work+learn attitudes and behaviors:

- Disciplined curiosity
- Entrepreneurial imagination
- Passionate creativity
- Continuous flexibility
- Self-advocacy
- Willingness to fail
- An openness to awe

Learning together

Collaborating with others

In the work+learn future, everyone is in it together. So learning to learn means knowing how to help others with their work+learn journeys while you make your own progress. The people you meet along the way will be both your teachers and your students, both your bosses and your assistants. In this peer-to-peer world, you'll do best if you can master some basic abilities:

- Manage multiple identities
- Read people, machine intelligences, and contexts
- Communicate across media, including unexpected media
- Think across disciplines and contexts
- Manage the spectrum of knowledge from truth to opinion
- Translate across subtle differences in cultures
- Distinguish ethical principles from legal restrictions

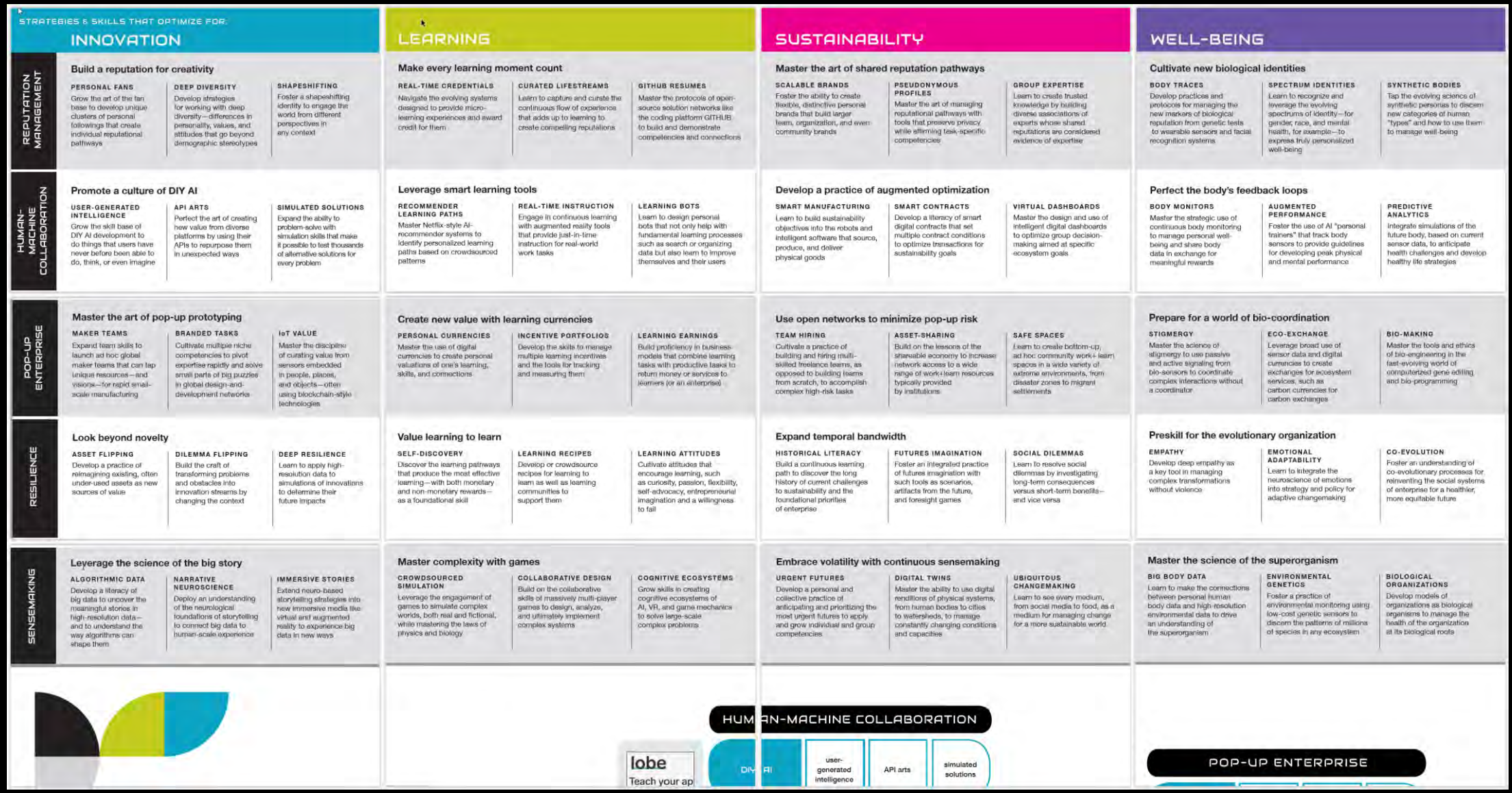
SKILLS FOR THE FUTURE

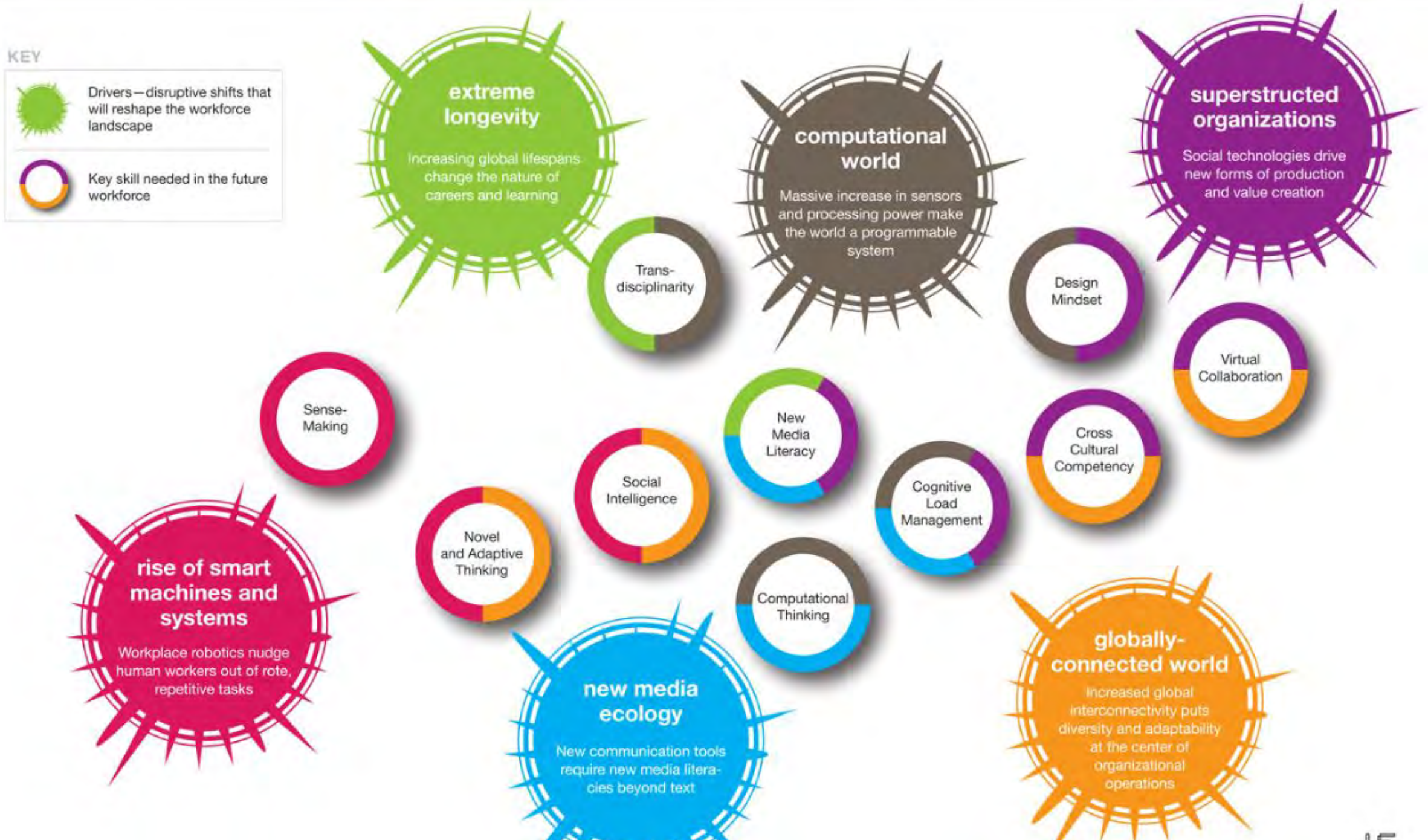
SOURCE 3

	INNOVATION	LEARNING	SUSTAINABILITY
REPUTATION MANAGEMENT	Build a reputation for creativity	Make every learning moment count	Master the art of shared reputation pathways
HUMAN MACHINE COLLABORATION	Promote a culture of DIY AI	Leverage smart learning tools	Develop a practice of augmented optimization
POP-UP ENTERPRISE	Master the art of pop-up prototyping	Create new value with learning	Use open networks to minimize pop-up risk
RESILIENCE	Look beyond novelty	Value learning to learn	Expand temporal bandwidth
SENSEMAKING	Leverage the science of the big story	Master complexity with games	Embrace volatility with continuous sensemaking

SKILLS FOR THE FUTURE

SOURCE 3




KEY
Drivers—disruptive shifts that will reshape the workforce landscape
Key skill needed in the future workforce
extreme longevity
Increasing global lifespans change the nature of careers and learning
computational world
Massive increase in sensors and processing power make the world a programmable system
superstructed organizations
Social technologies drive new forms of production and value creation
Trans-disciplinarity
Design Mindset
Virtual Collaboration
Sense-Making
New Media Literacy
Cross Cultural Competency
Social Intelligence
Cognitive Load Management
Novel and Adaptive Thinking
Computational Thinking
rise of smart machines and systems
Workplace robotics nudge human workers out of rote, repetitive tasks
new media ecology
New communication tools require new media literacies beyond text
globally-connected world
Increased global interconnectivity puts diversity and adaptability at the center of organizational operations

SKILLS FOR THE FUTURE

SOURCE 4

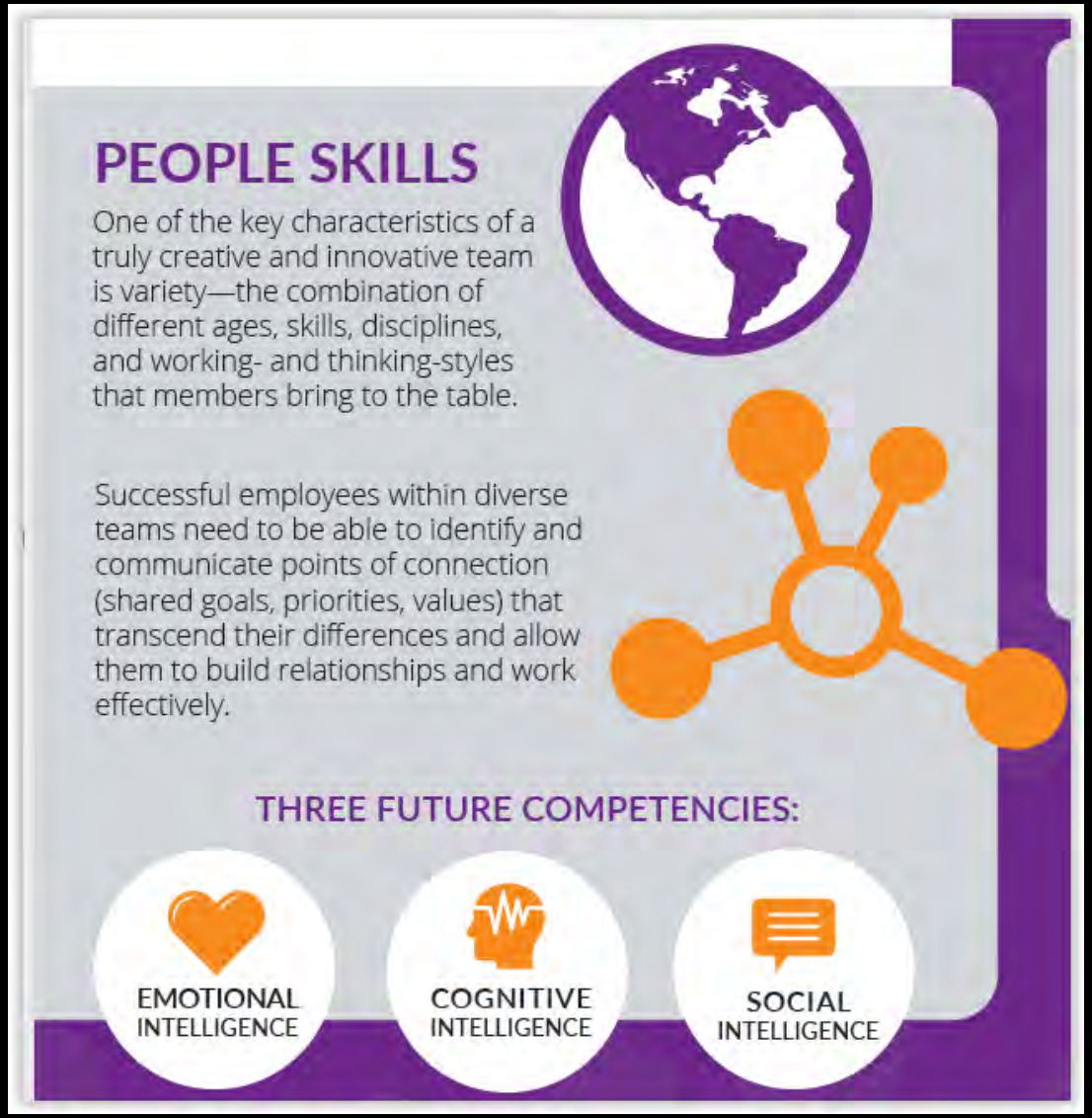
RESILIENCE

Thomas Edison failed **10,000** times before he invented the light bulb. The ability to competently overcome setbacks, challenges, and other obstacles is called "resilience."

Highly resilient individuals maintain positive emotions and, in some cases, can actually thrive in the face of crises. Resilient people also tend to demonstrate more flexibility with change, more stability in demanding situations, and less aversion to risk than their non-resilient counterparts.

SKILLS FOR THE FUTURE

SOURCE 4

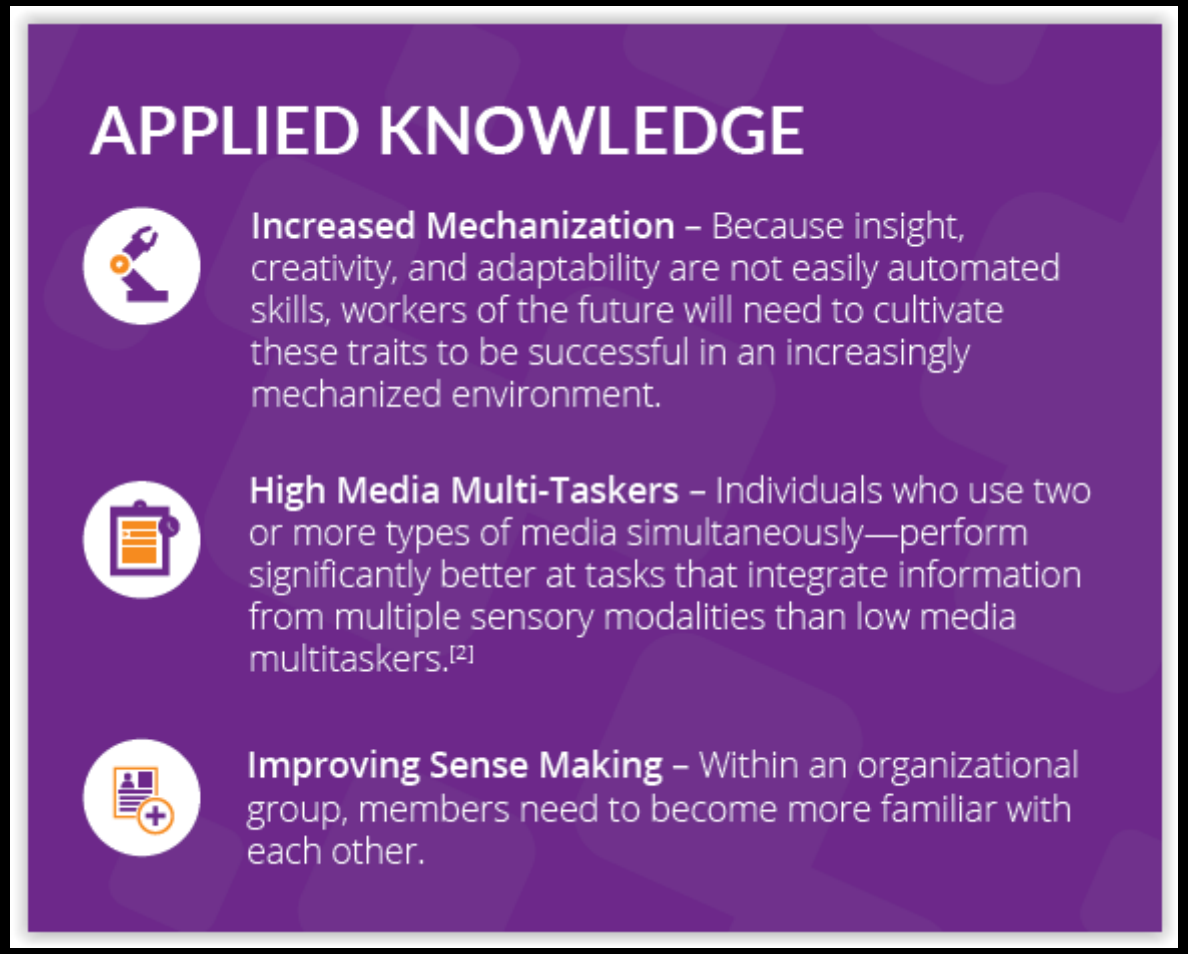


SKILLS FOR THE FUTURE

SOURCE 4

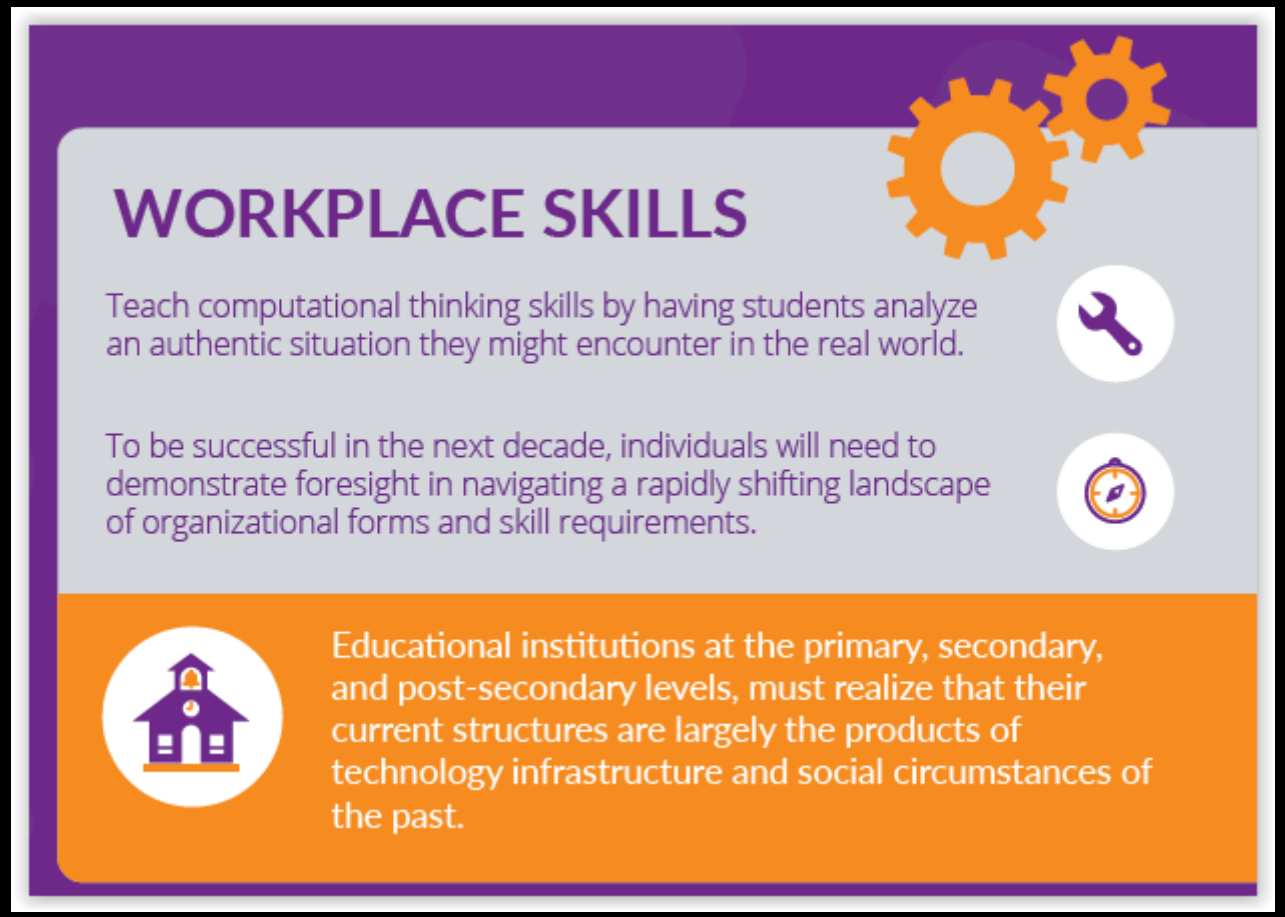
SKILLS FOR THE FUTURE

SOURCE 4



SKILLS FOR THE FUTURE

SOURCE 4



THANK YOU