The Shanghai Lectures 2019

HeronRobots *Pathfinder Lectures*

Natural and Artificial Intelligence in Embodied Physical Agents

HeronRobots

A+ | A | A-

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Inspired by nature,

we develop and implement advanced breakthrough solutions designed with a holistic approach.

Lecture 0

The Future of Robotics on a Hot Crowded Planet:

Today's Intelligent Robotics and
Next Generation Robotics Science and Technology Will Help Tackling Global Challenges in a Holistic Way

Fabio Bonsignorio[1,2,3,4,5,6…]

G2Net Stakeholder Link, Robotics Task Leader[1]
Coordinator The Shanghai Lectures[2]
SPARC TG Benchmarking and Competitions Coordinator[3]
IEEE RAS TC-PEBRAS[4]
Founding and Past Member SPARC Board of Directors[5]
Heron Robots[6]

www.heronrobots.com

Outline of the talk

- Global Challenges
- Robotics ‘waves’
- Industry 4.0
- I4.0 impact on the Circular Economy
- Other I4.0 side effects: impact on Agriculture and Construction Industry
- Open issues with current ‘paradigms’ and approaches, and the road ahead
- Societal impacts

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Department of Economic and Social Affairs

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World population projected to reach 9.7 billion by 2050

29 July 2015, New York

The current world population of 7.3 billion is expected to reach 8.5 billion by 2030, 9.7 billion in 2050 and 11.2 billion in 2100, according to a new UN DESA report, "World Population Prospects: The 2015 Revision", launched today.

"Understanding the demographic changes that are likely to unfold over the coming years, as well as the challenges and opportunities that they present for achieving sustainable development, is key to the design and implementation of the new development agenda," said Wu Hongbo, UN Under-Secretary-General for Economic and Social Affairs.

Most of the projected increase in the world's population can be attributed to a short list of high-fertility countrie mainly in Africa, or countries with already large populations. During 2015-2050, half of the world's population growth is expected to be concentrated in nine countries: India, Nigeria, Pakistan, Democratic Republic of the Congo, Ethiopia, United Republic of Tanzania, United States of America (USA), Indonesia and Uganda, listed according to the size of their contribution to the total growth.

NATIONAL GEOGRAPHIC

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MAGAZINE | JANUARY 2016

See for Yourself: How Arctic Ice Is Disappearing

Since satellites began regularl
declined sharply in extent and thic
is thin stuff that doesn't survive t
entire Arctic ecosystem, from pla
think that, by altering the jet stre
around the

Graphics and maps by **Lauren Ja**
Esteban,

UK world sport football opinion culture business lifestyle fashion environment tech

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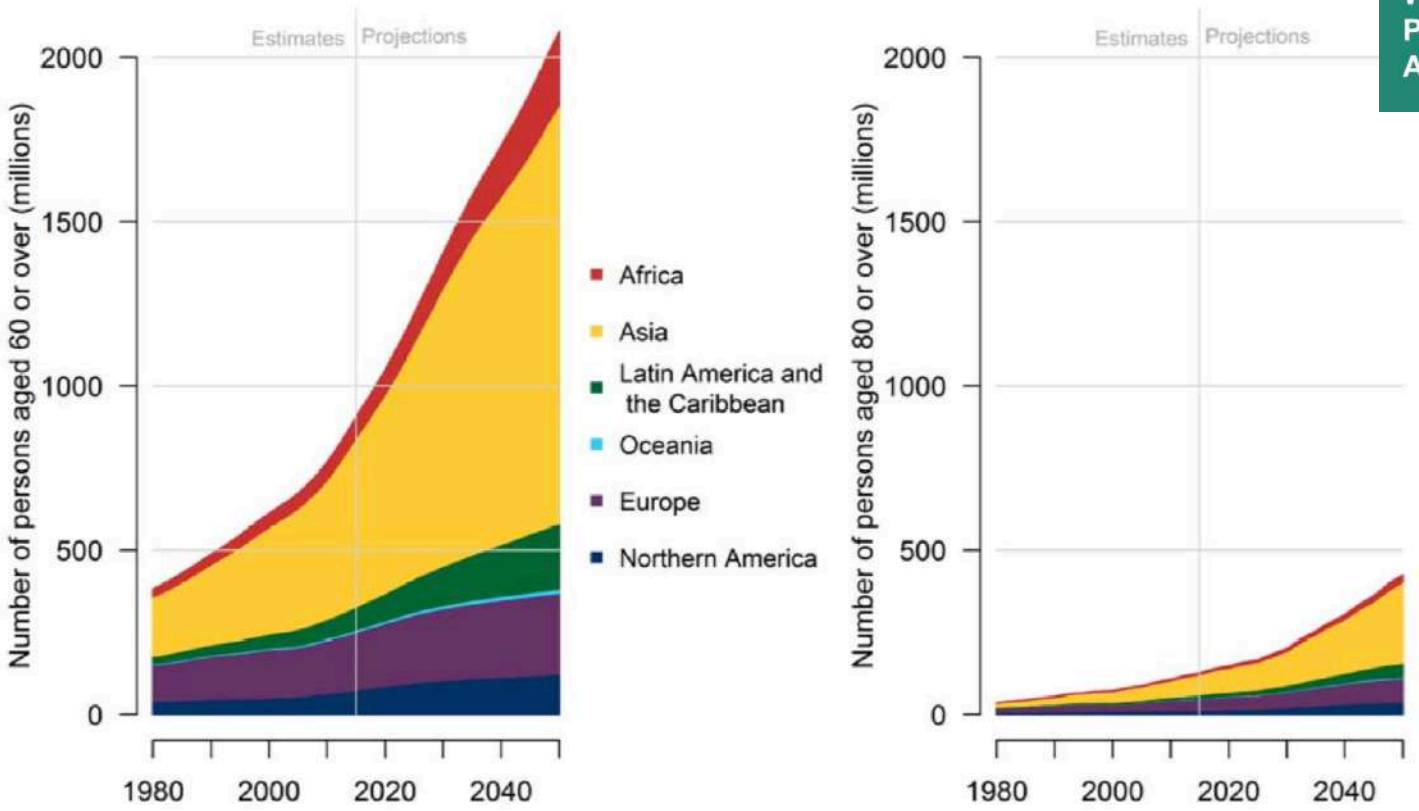
Sydney
Dispatch

Australia's new normal ... as city temperatures hit 47C people shelter from the deadly heat

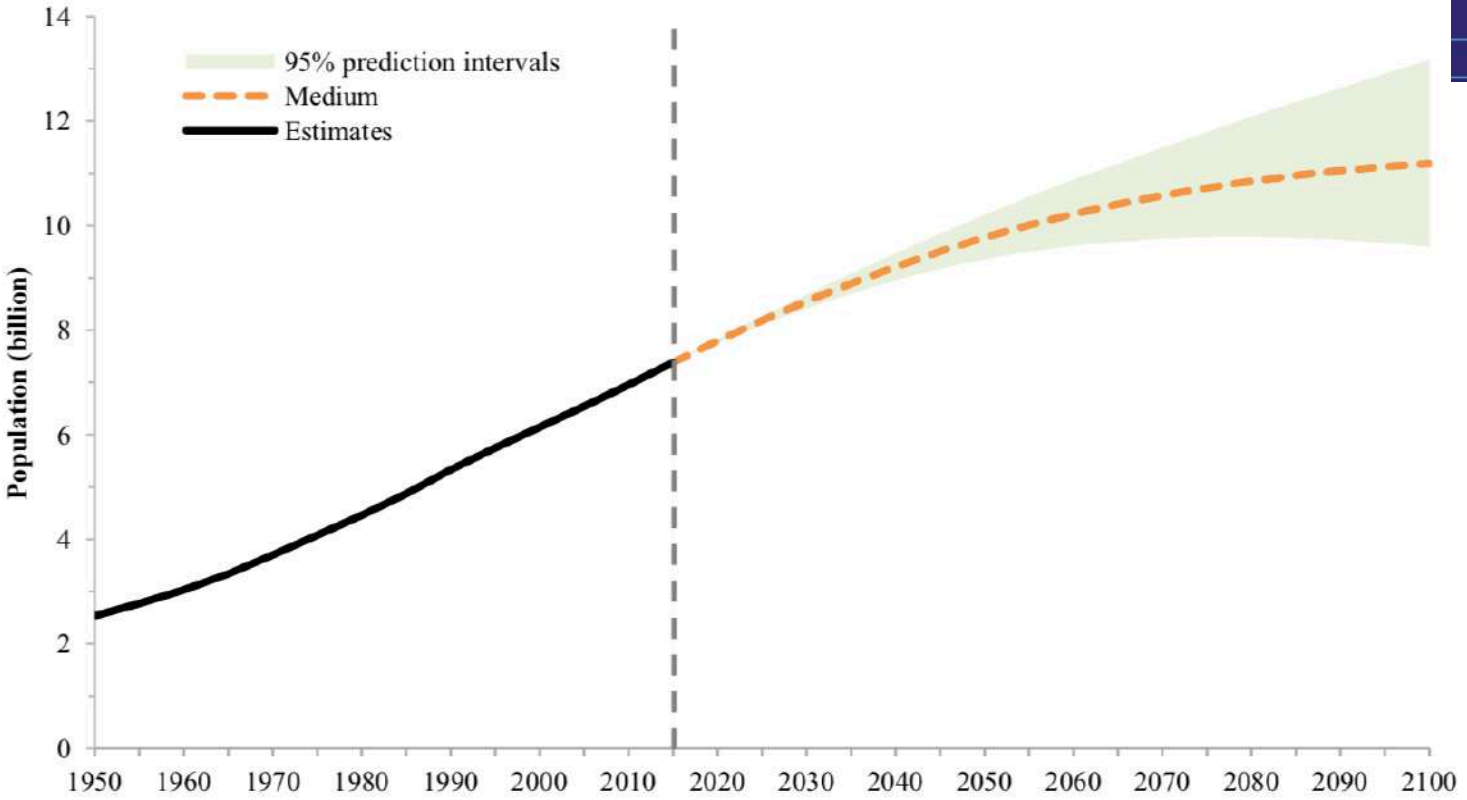
In Sydney's baking suburbs, fans have sold out – and fears about the effects of climate change are mounting

Figure II.2.
Number of persons aged 60 years or over and aged 80 years or over for regions, 1980-2050



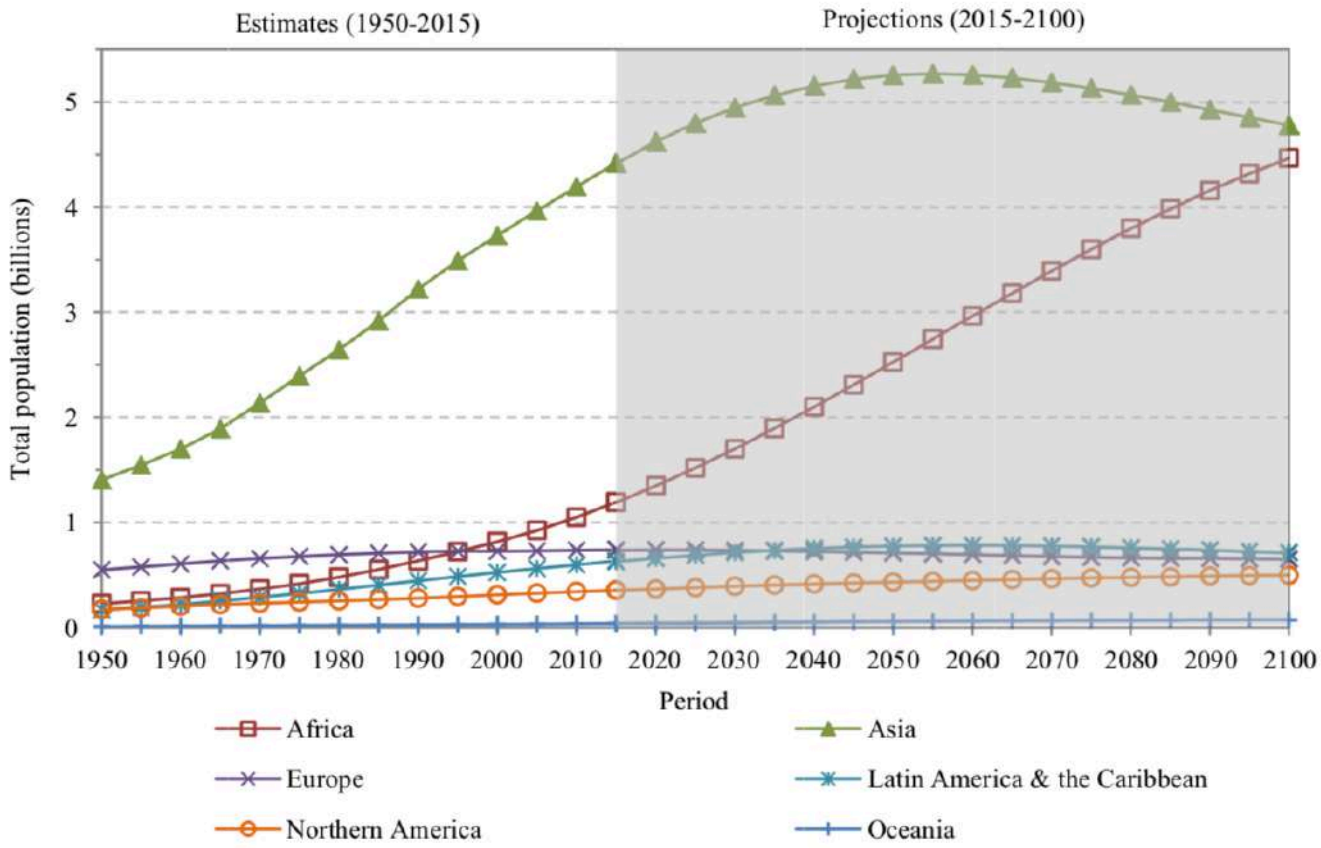
Data source: United Nations (2017). *World Population Prospects: The 2017 Revision*.

Figure 2. Population of the world: estimates, 1950-2015, and medium-variant projection with 95 per cent prediction intervals, 2015-2100



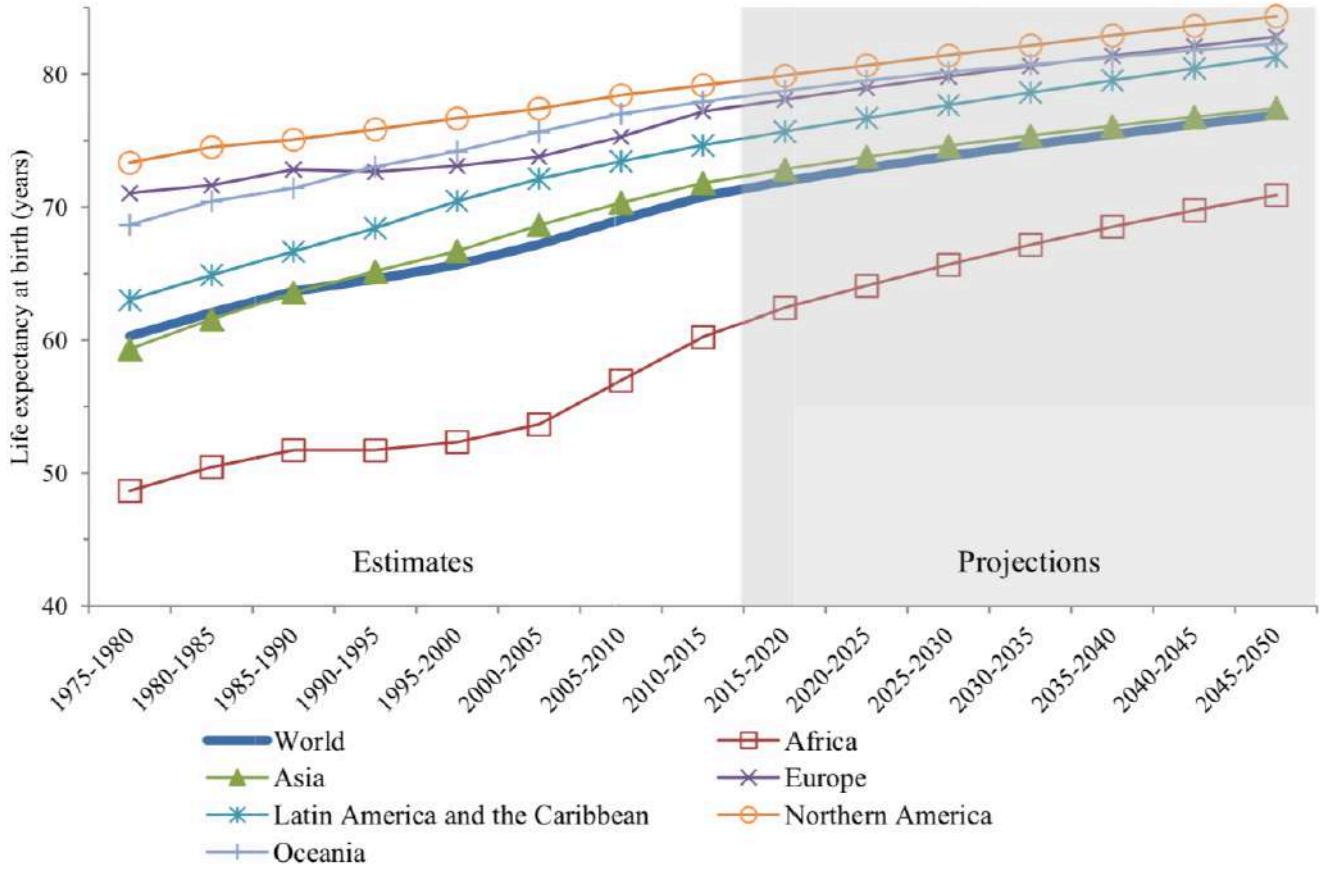
Source: United Nations, Department of Economic and Social Affairs, Population Division (2017). *World Population Prospects: The 2017 Revision*. New York: United Nations.

Figure 3. Population by region: estimates, 1950-2015, and medium-variant projection, 2015-2100



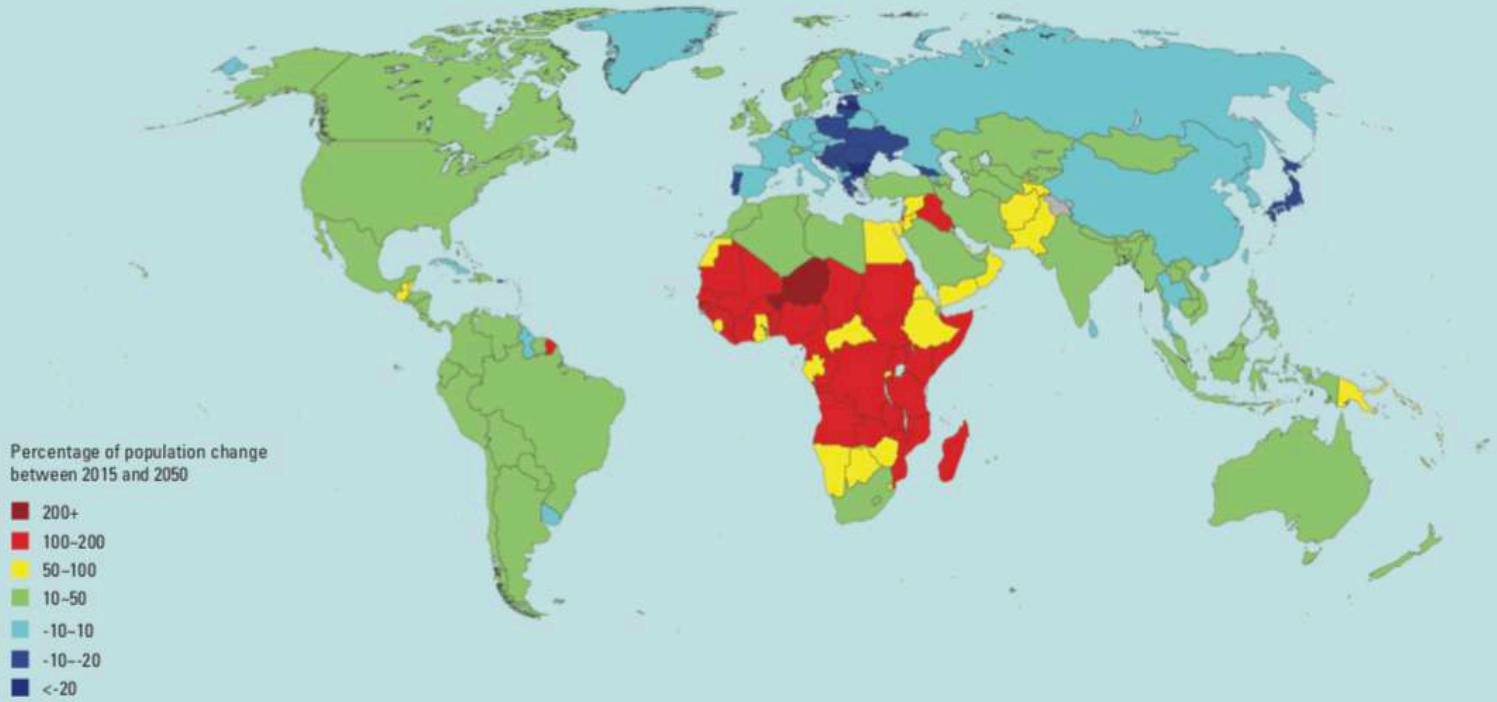
Source: United Nations, Department of Economic and Social Affairs, Population Division (2017). *World Population Prospects: The 2017 Revision*. New York: United Nations.

Figure 6. Life expectancy at birth (years) by region: estimates 1975-2015 and projections 2015-2050



Source: United Nations, Department of Economic and Social Affairs, Population Division (2017). *World Population Prospects: The 2017 Revision*. New York: United Nations.

Projected population growth, 2015-2050



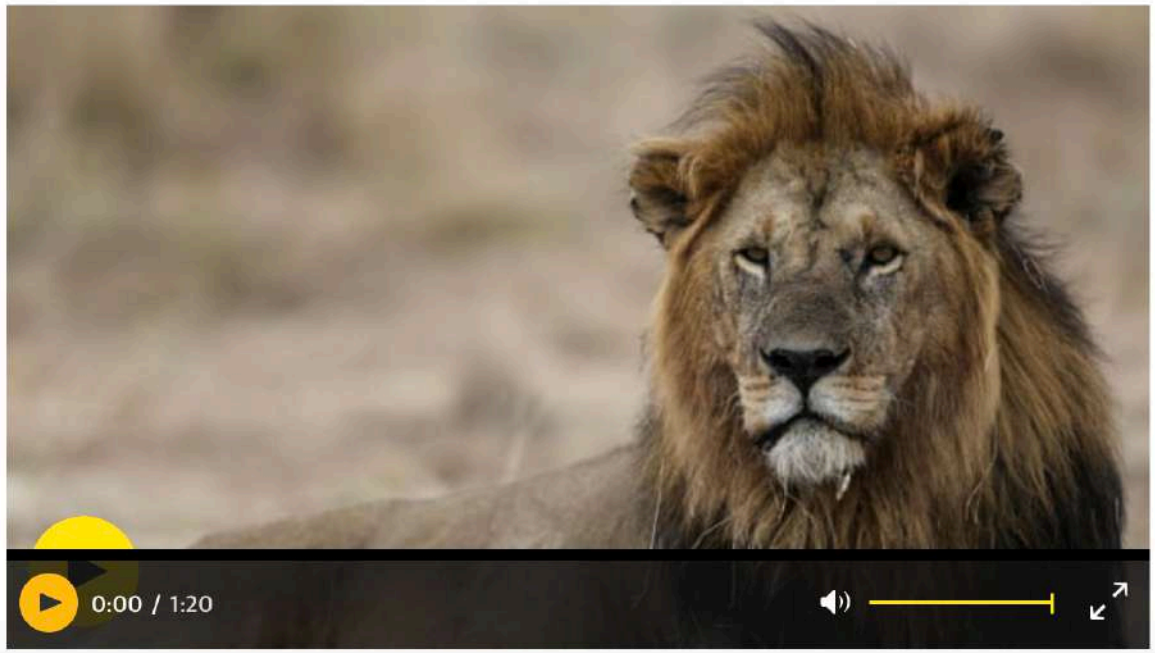
Data source: World Population Prospects: The 2017 Revision.
The designations employed and the presentation of material on this map do not imply the expression of any opinion whatsoever on the part of the Secretariat of the United Nations concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers of boundaries. Dotted line represents approximately the Line of Control in Jammu and Kashmir agreed upon by India and Pakistan. The final status of Jammy and Kashmir has not yet been agreed upon by the parties. Final boundary between the Republic of Sudan and the Republic of South Sudan has not yet been determined. A dispute exists between the Governments of Argentina and the United Kingdom of Great Britain and Northern Ireland concerning sovereignty over the Falkland Islands (Malvinas).

Endangered species

Earth's sixth mass extinction event under way, scientists warn

Researchers talk of 'biological annihilation' as study reveals billions of populations of animals have been lost in recent decades

Opinion: You don't need a scientist to know what's causing the sixth mass extinction



Damian Carrington
Environment editor

@dpcarrington

Mon 10 Jul 2017
20.00 BST

102k 2,892

This article is over 1 year old

Biological annihilation via the ongoing sixth mass extinction signaled by vertebrate population losses and declines

Gerardo Ceballos, Paul R. Ehrlich, and Rodolfo Dirzo

PNAS July 25, 2017 114 (30) E6089-E6096; published ahead of print July 10, 2017
https://doi.org/10.1073/pnas.1704949114

Contributed by Paul R. Ehrlich, May 23, 2017 (sent for review March 28, 2017; reviewed by Thomas E. Lovejoy and Peter H. Raven)

Stephen Hawking: We have LESS than 100 YEARS to save the human race

THE human race is entering the most dangerous 100 years in its history and faces a looming existential battle, Stephen Hawking has warned.

By SEAN MARTIN

PUBLISHED: 10:58, Tue, Jan 19, 2016 | UPDATED: 13:14, Tue, Jan 19, 2016

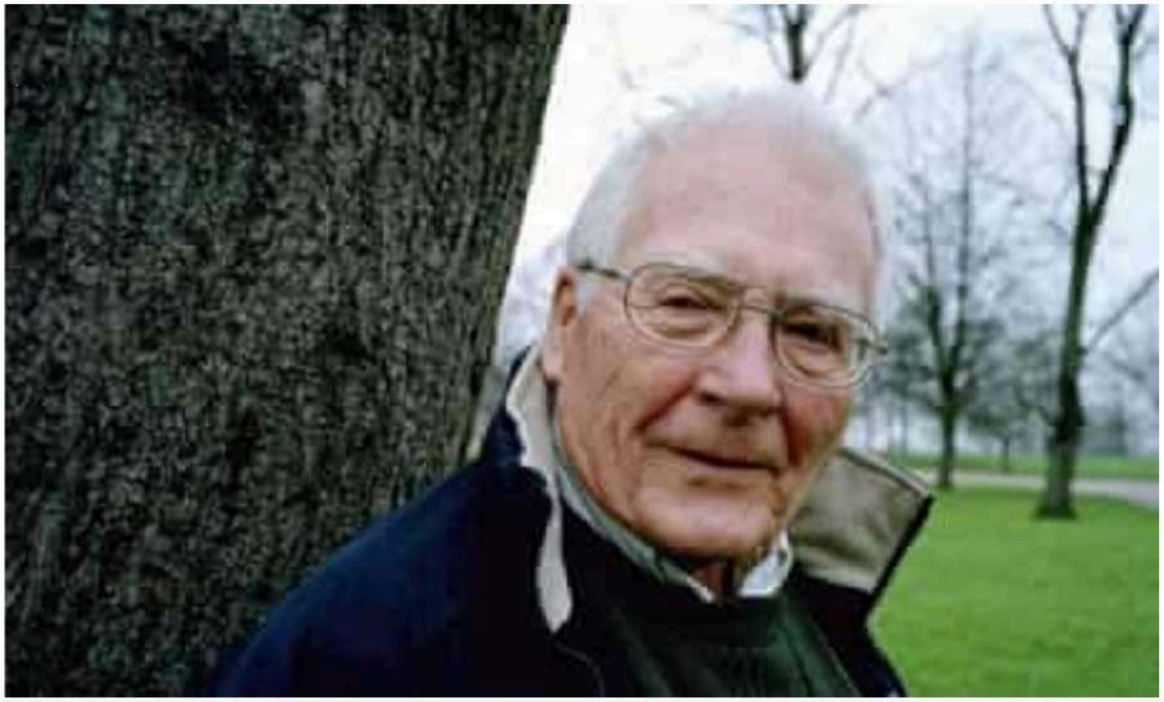
Climate change

James Lovelock: 'enjoy life while you can: in 20 years global warming will hit the fan'

The climate science maverick believes catastrophe is inevitable, carbon offsetting is a joke and ethical living a scam. So what would he do? By Decca Aitkenhead

Decca Aitkenhead

Sat 1 Mar 2008
10.35 GMT



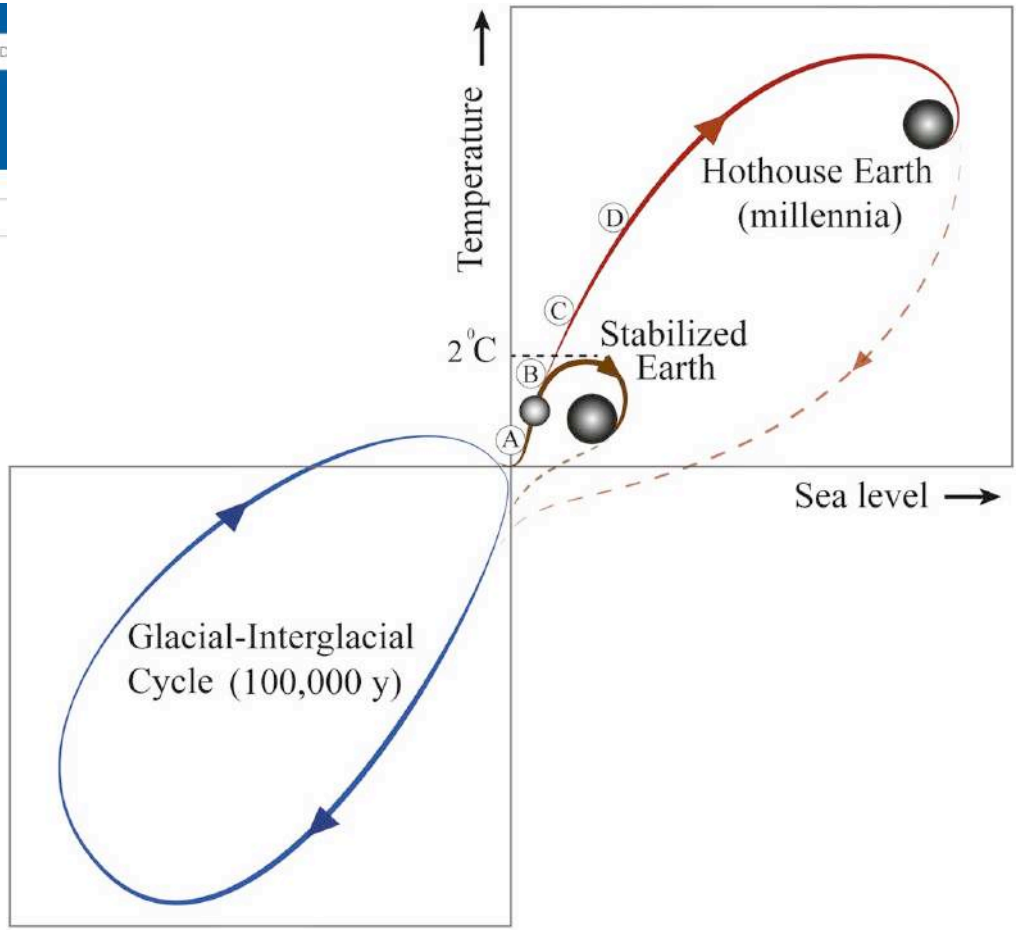
PNAS
Proceedings of the National Academy of Sciences of the United States of America

Trajectories of the Earth System in the Anthropocene

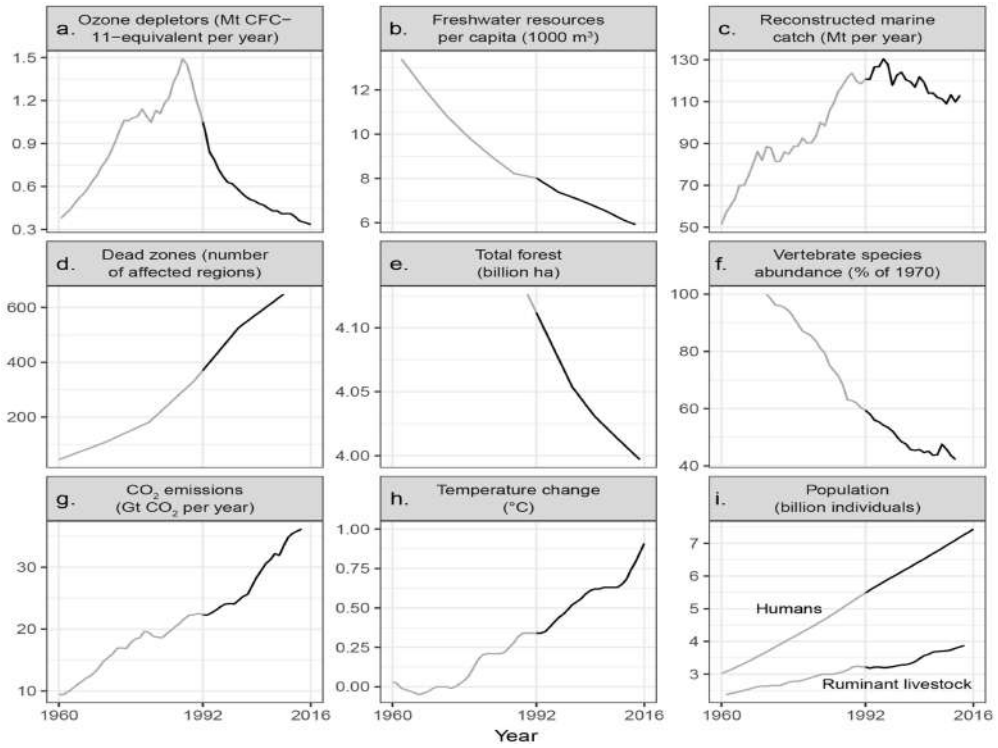
Will Steffen, Johan Rockström, Katherine Richardson, Timothy M. Lenton, Carl Folke, Diana Liverman, Colin P. Summerhayes, Anthony D. Barnosky, Sarah E. Cornell, Michel Crucifix, Jonathan F. Donges, Ingo Fetzer, Steven J. Lade, Marten Scheffer, Ricarda Winkelmann, and Hans Joachim Schellnhuber

PNAS August 14, 2018 115 (33) 8252-8259; published ahead of print August 6, 2018 https://doi.org/10.1073/pnas.1810141115

Edited by William C. Clark, Harvard University, Cambridge, MA, and approved July 6, 2018 (received for review June 19, 2018)



What has already happened



From: World Scientists' Warning to Humanity: A Second Notice

BioScience. Published online November 13, 2017. doi:10.1093/biosci/bix125

* William J. Ripple Christopher Wolf Thomas M. Newsome Mauro Galetti Mohammed Alamgir Eileen Crist Mahmoud I. Mahmoud William F. Laurance 15,364 scientist signatories from 184 countries

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Older and newer attempts

Juanelo Torriano alias Gianello della Torre, (XVI century) a craftsman from Cremona, built for Emperor Charles V a mechanical young lady who was able to walk and play music by picking the strings of a real lute.

Hiroshi Ishiguro, early XXI century

Director of the Intelligent Robotics Laboratory, part of the Department of Adaptive Machine Systems at Osaka University, Japan

Old ideas

“If every tool, when ordered, or even of its own accord, could do the work that befits it, just as the creations of Daedalus moved of themselves . . . If the weavers' shuttles were to weave of themselves, then there would be no need either of apprentices for the master workers or of slaves for the lords.”

Aristotle

(from Politics, Book 1, 1253b, 322 BC)

Old ideas

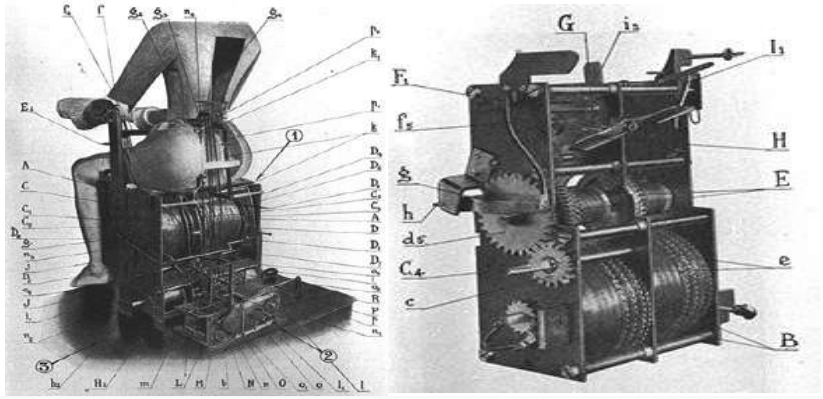
The part of the quote "or even of its own accord" is elsewhere translated as "or by seeing what to do in advance2

I think this is an important part of the quote, so it's good to go back to the original text:

Aristotle uses the word "προαισθανόμενον" – proaisthanomenon this means literaly: pro = before, aisthanomenon = perceiving, apprehending, understanding, learning (any of these meanings in this order of frequency) in my view it is clearly a word that is attributed to intelligent, living agents....i.e. ones with cognitive abilities (!)

personal communication, Dr. Katerina Pastra
Research Fellow
Language Technology Group
Institute for Language and Speech Processing
Athens, Greece

Old attempts



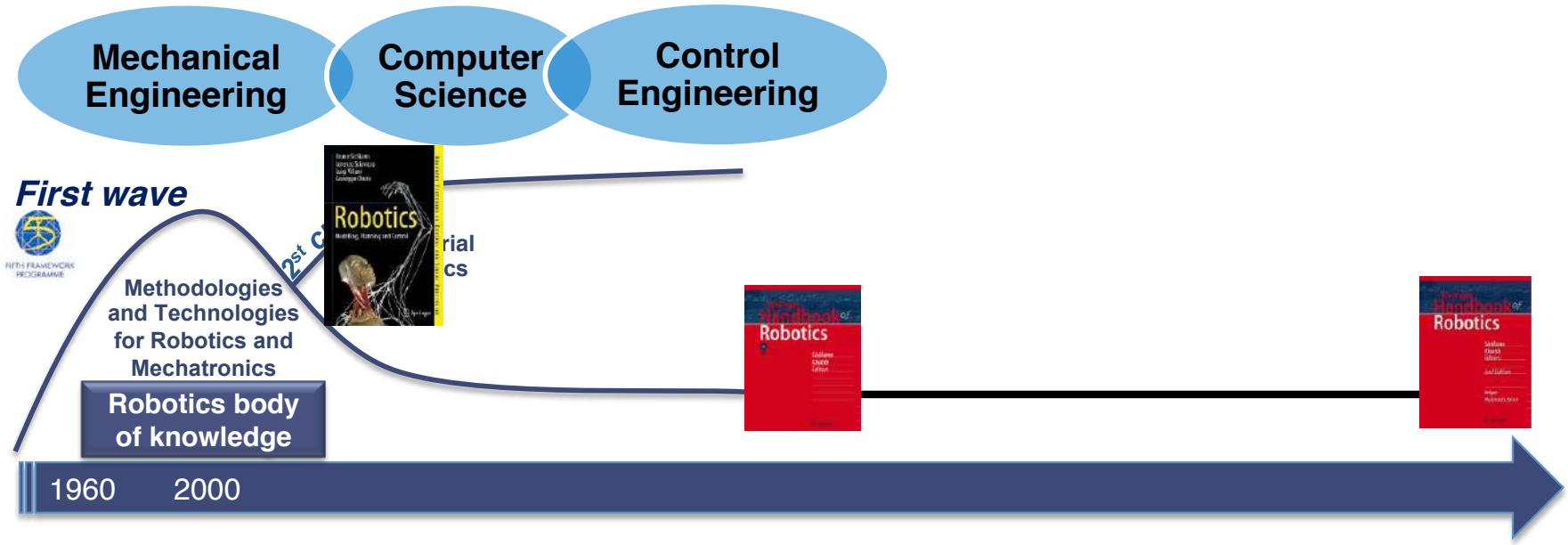
Jaquet-Droz Brothers (1720-1780)

Old attempts

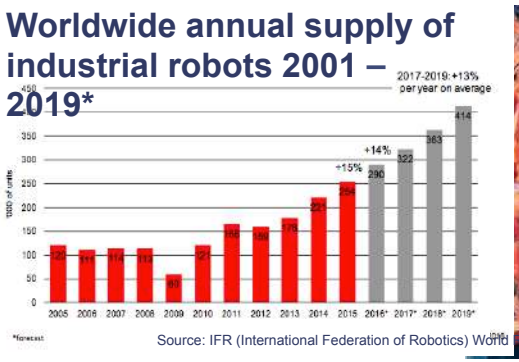
Karakuri Dolls

Chahakobi Ningyo (Tea Serving Doll) by SHOBEI Tamaya IX, and plan from 'Karakuri Zuii' ('Karakuri - An Illustrated Anthology') published in 1796.

Recent successes: the first wave



The first wave



Mechanical Engineering

Computer Science

Control Engineering

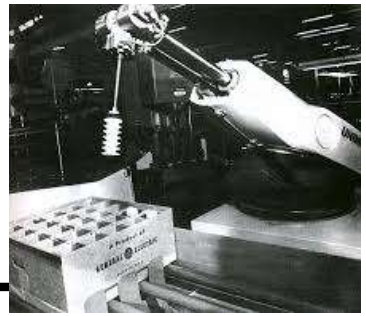
First wave

2st crest

Industrial robotics

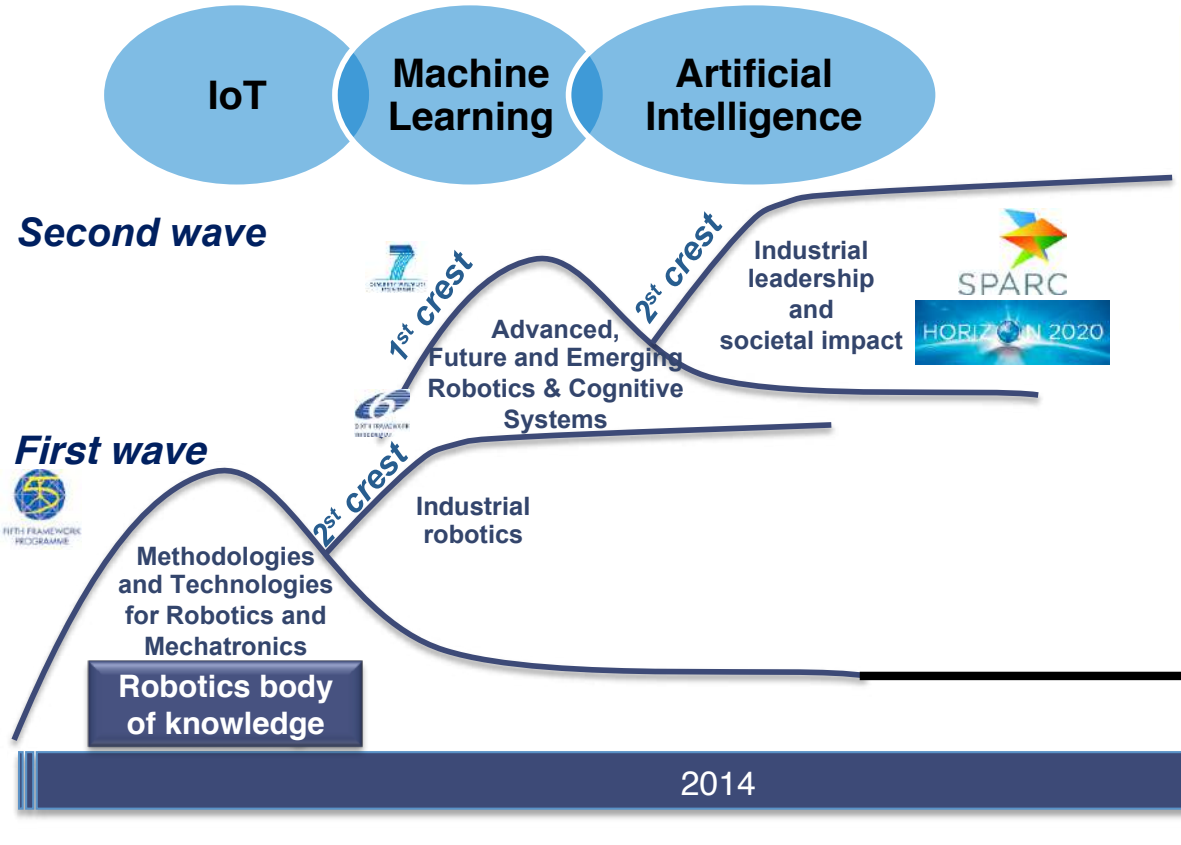
Methodologies and Technologies for Robotics and Mechatronics

Robotics body of knowledge



1960 2000

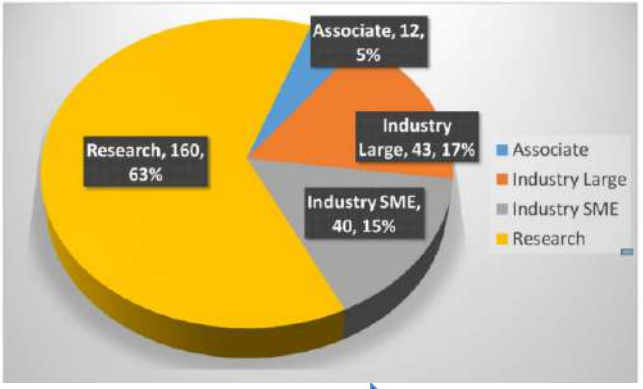
The second wave



Membership development

280 member organisations

Legend:
- Industry
- Research
- Associate
- euRobotics AISBL



The second wave

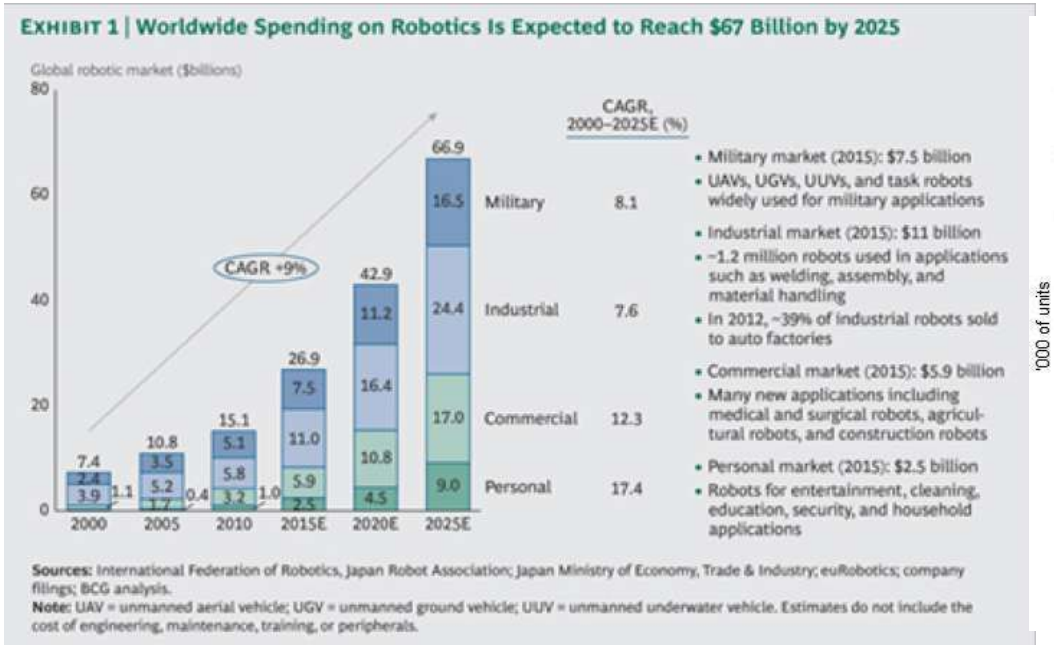
Data are very important, but they are not all in a digital economy. ACTIONS, MOBILITY and STRENGTH are also needed! **Robotics**: a great opportunity to **innovate, connect** and **transform. Robotics is technology and business, but it is also creativity and fun!**

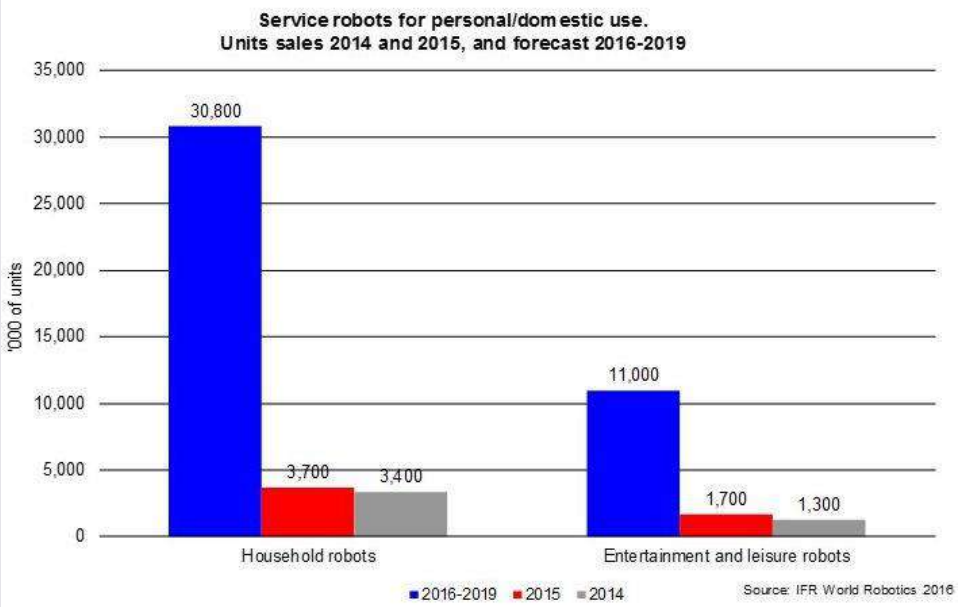
"[...] The size of the robotics market is projected to grow substantially to 2020s. This is a global market and Europe's traditional competitors are fully engaged in exploiting it. Europe has a 32% share of the industrial market. Growth in this market alone is estimated at 8%-9% per annum. Predictions of up to 25% annual growth are made for the service sector where Europe holds a 63% share of the non-military market. […]"

"[…] From today's €22bn worldwide revenues, robotics industries are set to achieve annual sales of between €50bn and €62bn by 2020. […]"

Robotics is one of the 12 disruptive technologies identified by McKinsey

The second wave





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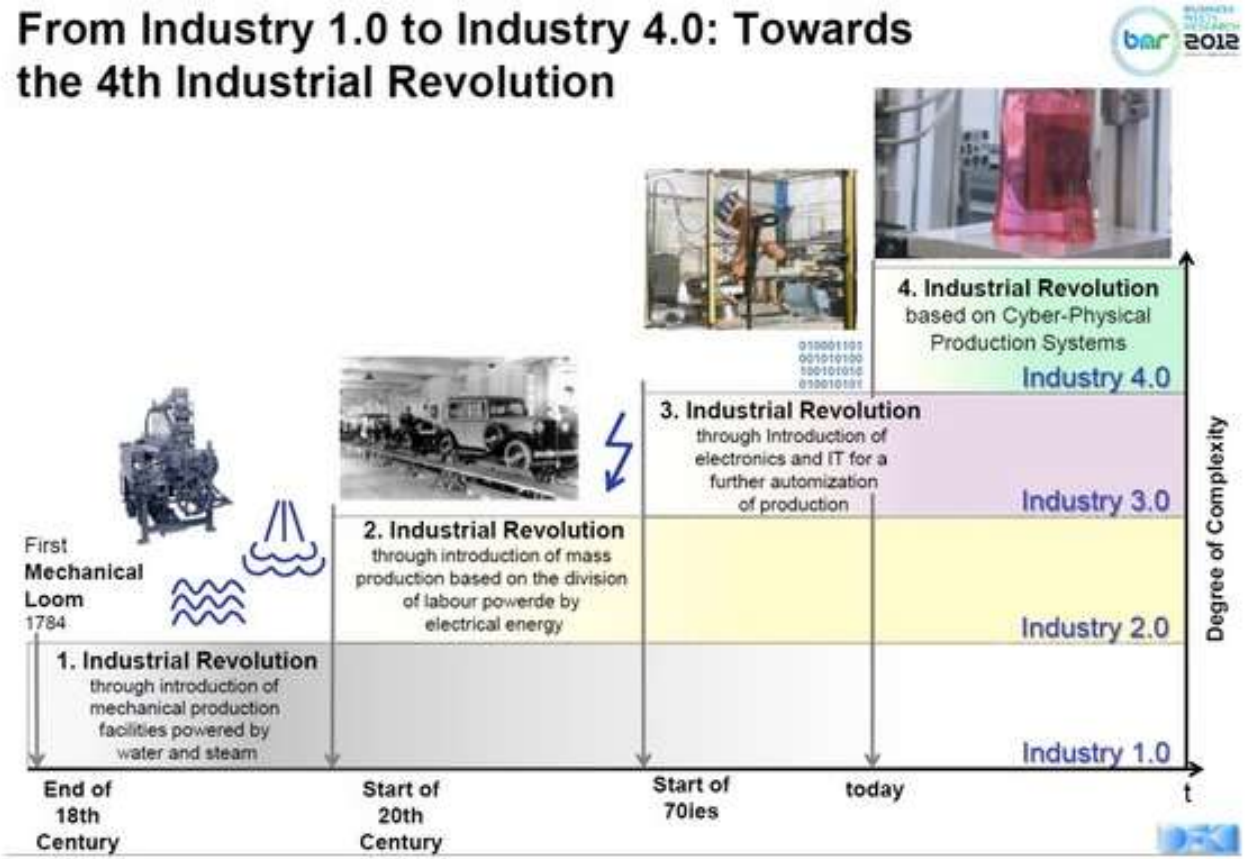
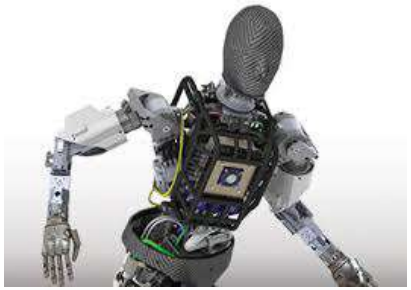
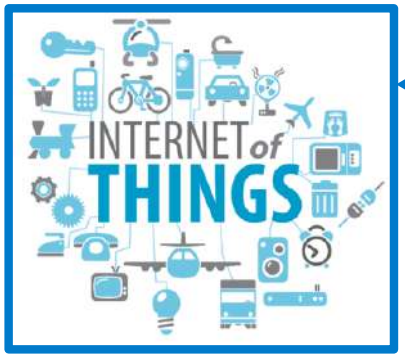
The second wave

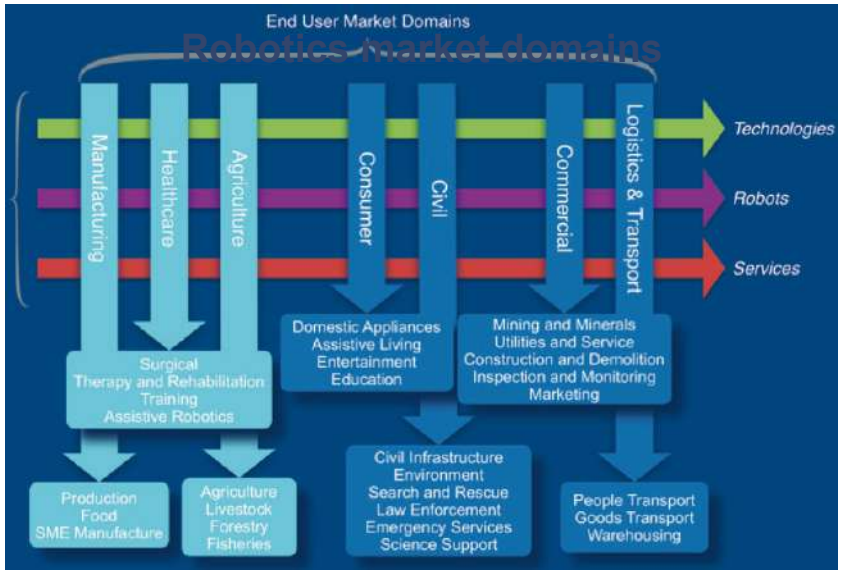


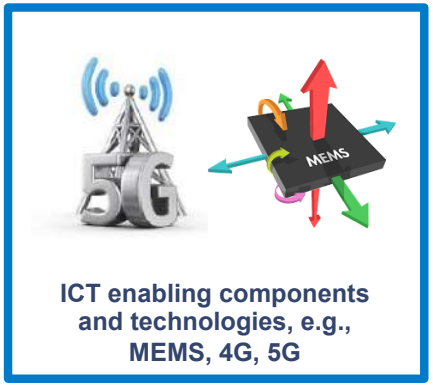


The second wave: Robotics: a great opportunity to innovate, connect and transform



- The web and IoT pull new robotic applications
- Robotics expands the boundaries of the Web and of IoT
- The Web is an 'infrastracture' of future robotics





ICT enabling components and technologies, e.g., MEMS, 4G, 5G

- Robotics integrates enabling ICT components
- Robotics will drive the development of new ICT components
- Robotics pulls the development of next generation communication networks

Robots and Jobs

- Creating **new jobs** in robotics
- Creating new industrial opportunities (and **jobs**)
- Taking advantage of robotics and automation to enable GDP growth

Why we need that? Today's markets are turbulent

Many market researches since many years (Zook et al., 2001, Ghemawat HBS Blog, 2007, Qin et al., 2008) show how the markets are becoming more and more 'turbulent': *the demand of products (shifting towards service-products) becomes more and more diversified as product mix and as product quantity variation versus time.*

Digitalization of European Industry EU Strategy

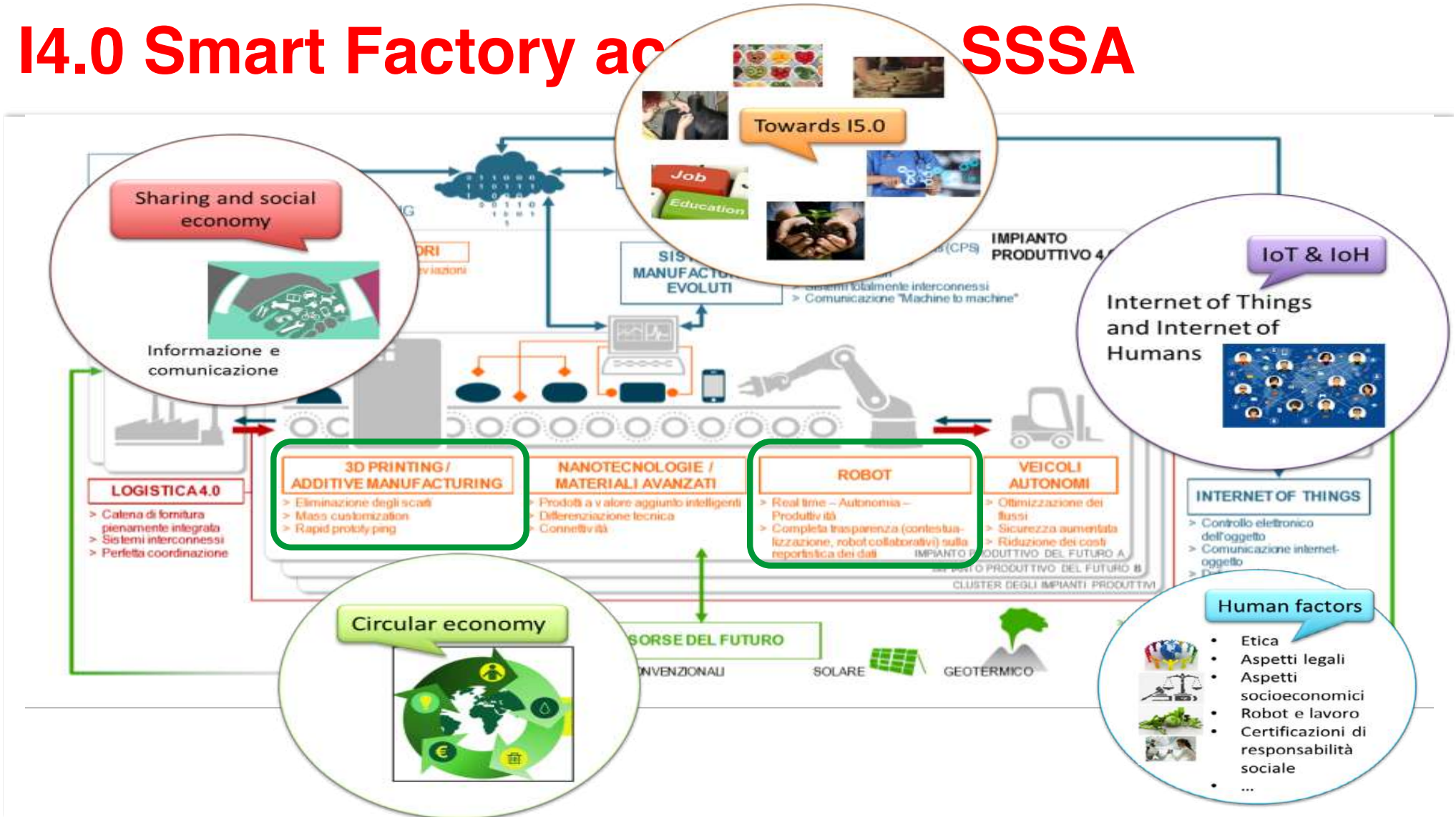
a. Digitalization of Products

b. Digitalization of Services

c. Digitalizzazione of Processes

50 G€ of investments by Bruxelles should generate benefits on industry and service sectors revenue for 110 G€/year

I4.0 Smart Factory ac SSSA



PIAGGIO

Regione Toscana

FAS
Fondo Aree
Sottoutilizzate
2007-2013

REPUBBLICA ITALIANA

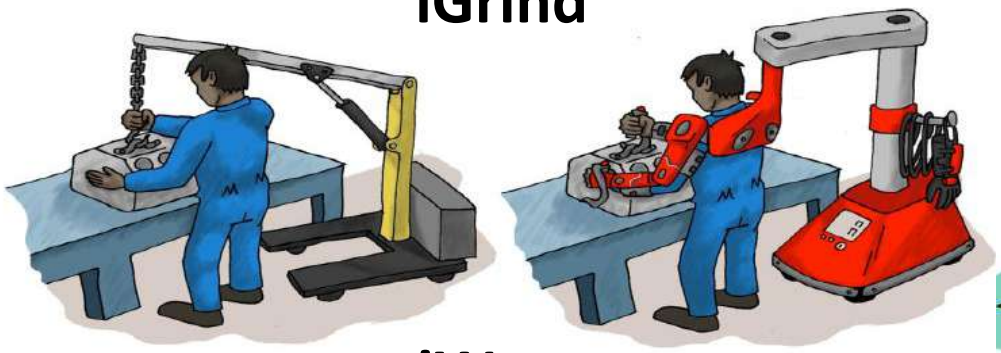
THE BIOROBOTICS INSTITUTE
Scuola Superiore Sant'Anna

FACTORY 4.0: 'CENTAURO' Project

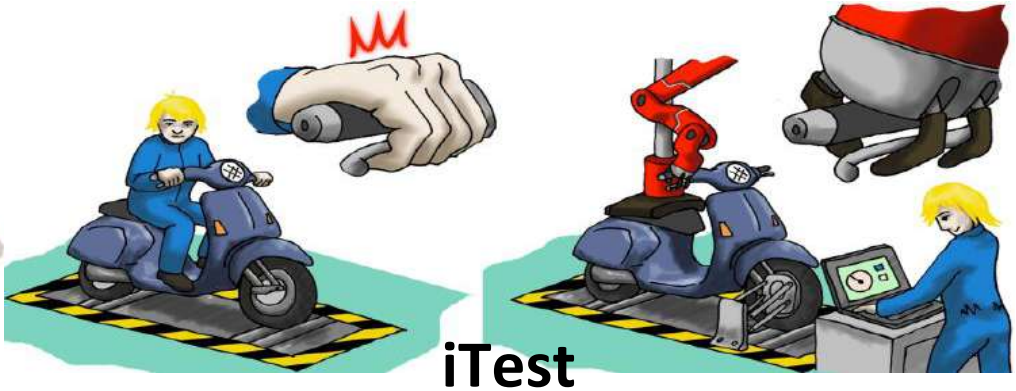
SCENARIOS

iGrind

iSort



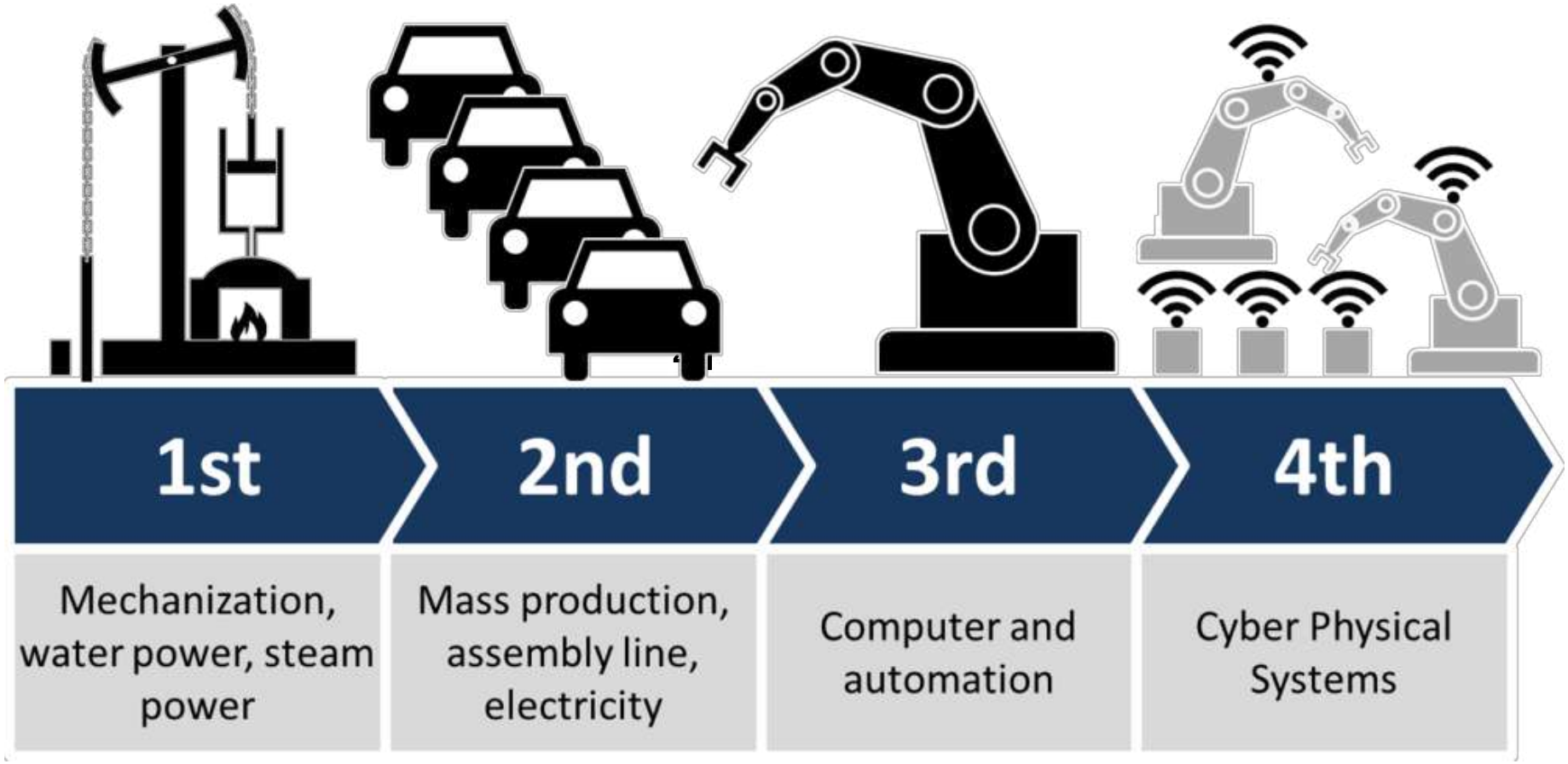
iWear



iTest

This is a dismantling scenario!

Industry 4.0


1st
2nd
3rd
4th
Mechanization, water power, steam power
Mass production, assembly line, electricity
Computer and automation
Cyber Physical Systems

Enabling scientific knowledge

- Internet of Things
- Machine Learning/Deep Learning
- ‘some’ AI (mainly Computer vision, Object recognition and Planning)

Textile industry

the first cotton mill at Cromford, Derbyshire, UK, is usually considered the first example of a modern factory

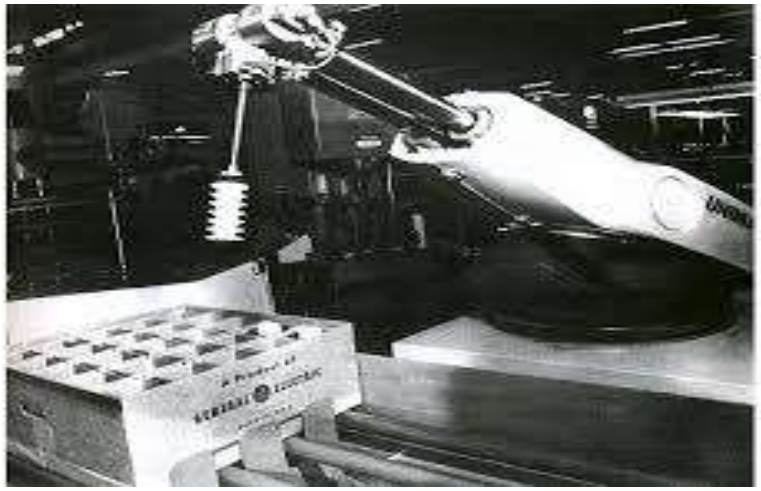
the spinning jenny is considered one of the first modern industrial machines

<u>the level of automation reached in this field of manufacturing engineering is not complete.</u>

Textile industry

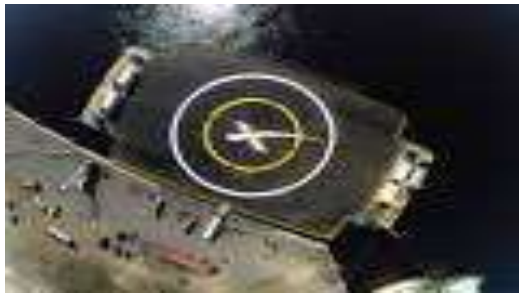
this is the current situation

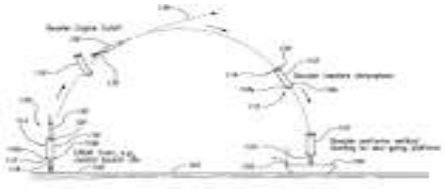
GOF Robots



New Industrial Robots

Also…New Robots





New Robots

New Robots

Your robot(s)?
Unleash your imagination!

There have been few moments in history like this one

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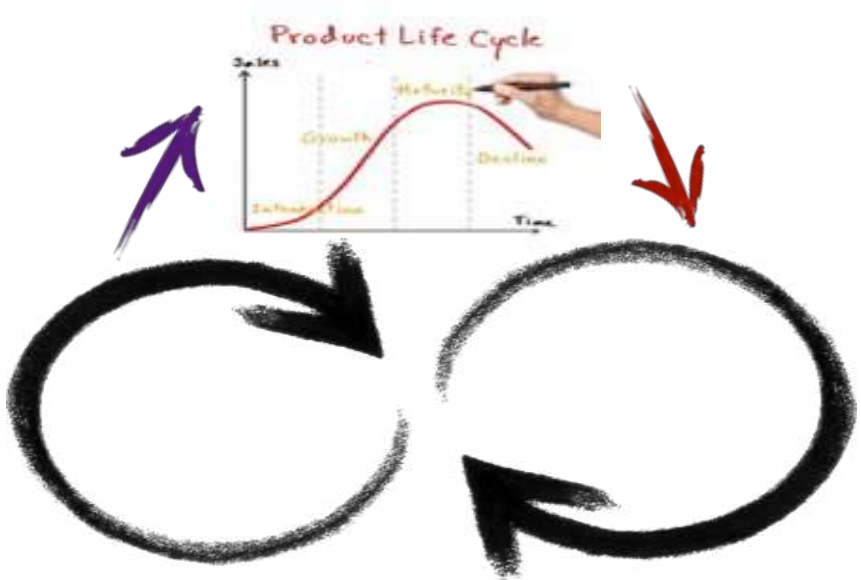
Bio-Automation: Deep Human-Robot cooperation (and workspace sharing) is needed for dismantling (and for lot of 1 artisan quality)

Assembly



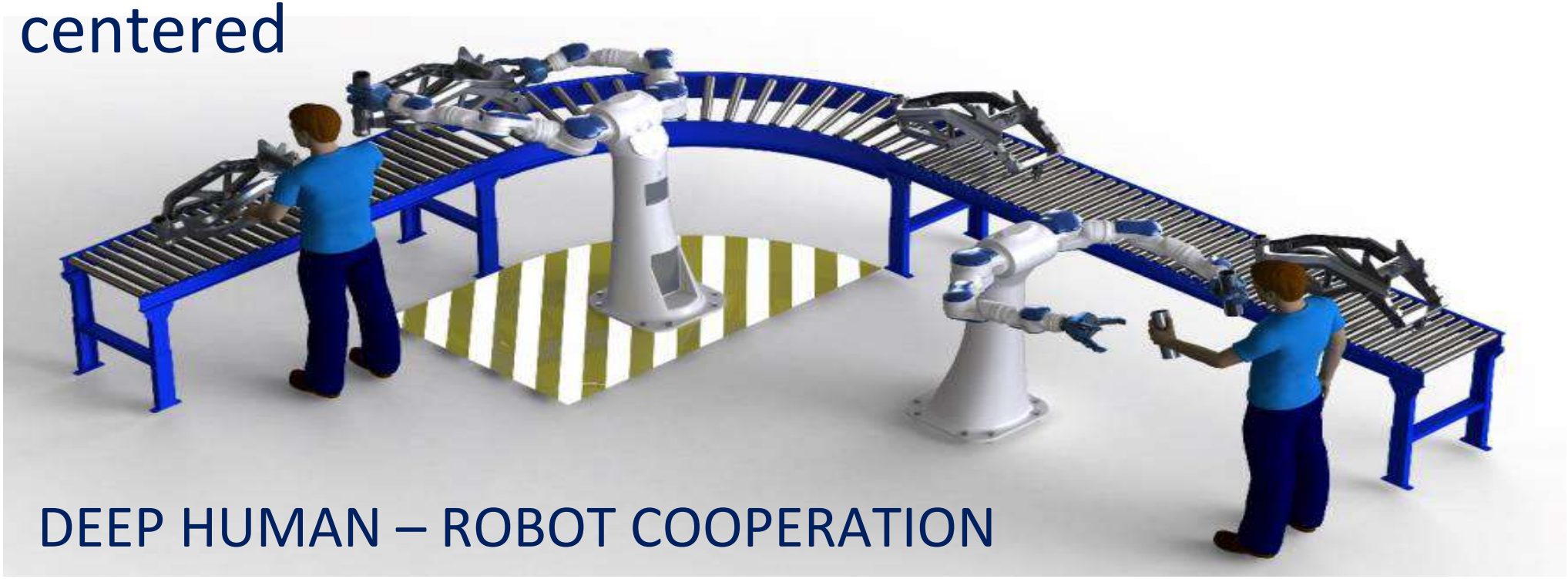
Disassembly

Primary Raw Materials

Disposal

Robots on the Shop-floor

BIO-AUTOMATION: the new frontier of automation ‘eco’, bio-inspired and human centered



DEEP HUMAN – ROBOT COOPERATION

Disassembly Robotic Tasks for Circular Economy

Paolo Dario, Annagiulia Morachioli, Ilaria Strazzulla, Cecilia Laschi, Fabio Bonsignorio

Abu Dhabi

25th January 2016

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New Industrial? Robots

New Robots + ML/DL, AI (mainly computer vision) →

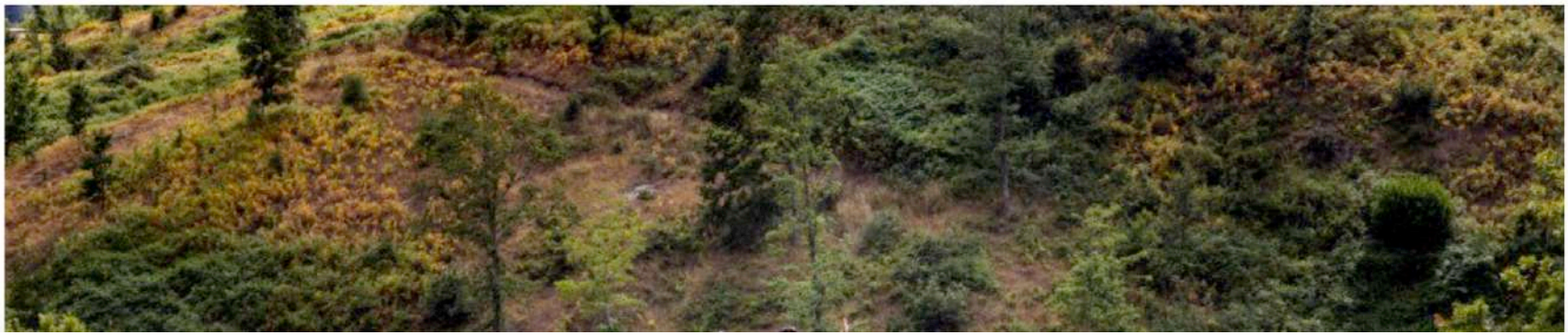
Precision Agriculture

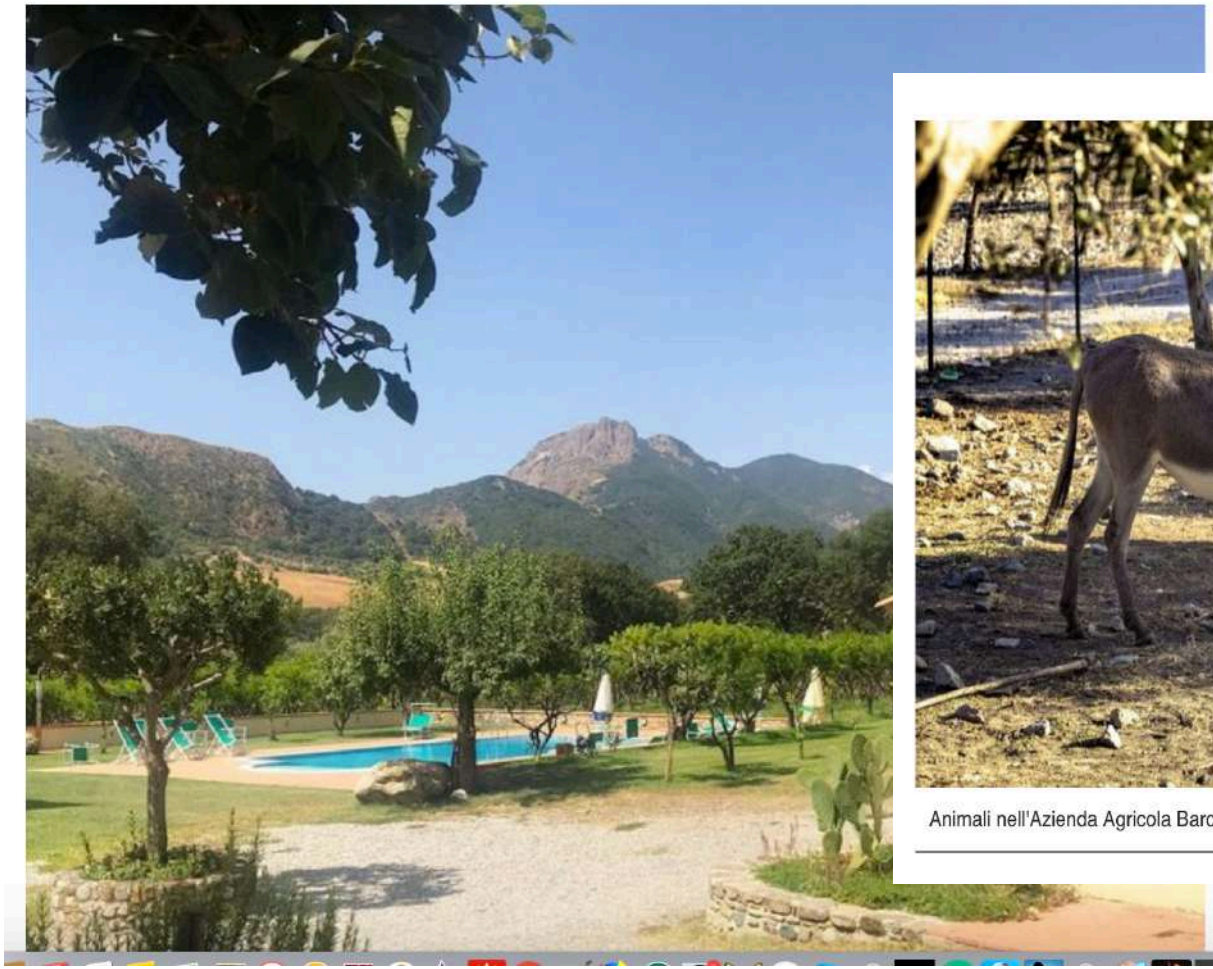
(even underwater fish-farming)

29 agosto 2019

Dalla Sila alla Locride lavorando sulla qualità: la Calabria riparte grazie ai fondi Ue

di SARA FICOCELLI - video di ANNA BENEDETTO





Animali nell'Azienda Agricola Barone G. R. Macrì

Robohub

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How regenerative agriculture and robotics can benefit each other

by John Payne

Environment-Agriculture Views

January 25, 2017

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Regenerative agriculture

From Wikipedia, the free encyclopedia

Regenerative agriculture is a conservation and rehabilitation approach to food and farming systems. It focuses on topsoil regeneration, increasing biodiversity,[1] improving the water cycle,[2] enhancing ecosystem services, supporting biosequestration, increasing resilience to climate change, and strengthening the health and vitality of farm soil. Practices include recycling as much farm waste as possible, and adding composted material from sources outside the farm.[3][4][5][6]

Regenerative agriculture on small farms and gardens is often based on ideologies like permaculture, agroecology, agroforestry, restoration ecology, keyline design and holistic management. Large farms tend to be less ideology driven, and often use "no-till" and/or "reduced till" practices.

Biodiversity

On a regenerative farm, yield should increase over time. As the topsoil deepens, production may increase and less external compost inputs are required. Actual output is dependent on the nutritional value of the composting materials, and the structure and content of the soil.[7][8]

It's all about

DATA, Patterns, Sensors and Actuators

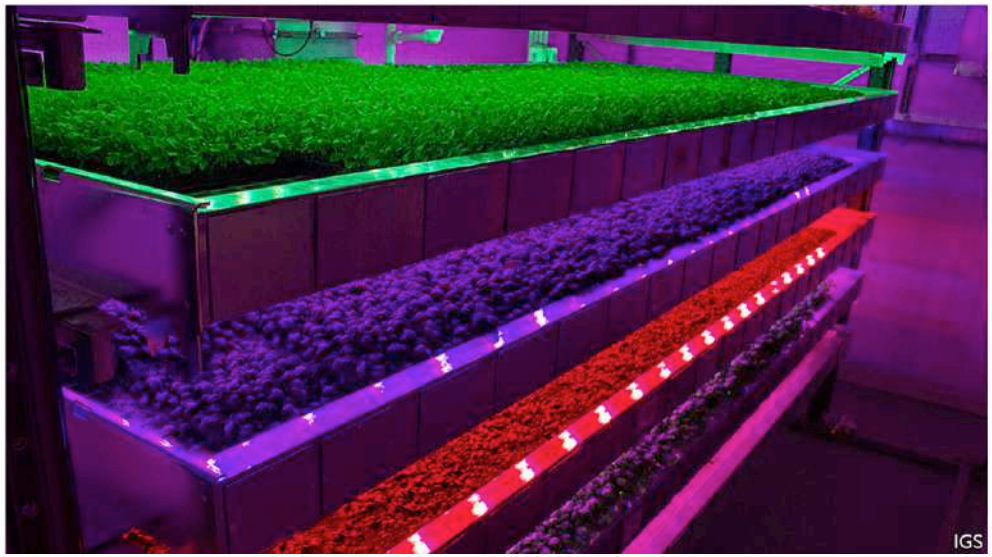
The Economist

Topics Current edition More

Growing higher

New ways to make vertical farming stack up

Cultivating fresh produce in an artificial environment is getting cheaper



The Alternative Daily

Create a Garden with No Soil, and Little Work

Learn how thousands of americans are using hydroponic techniques to grow their own food

Thursday, October 10 2019

Make your own meat with open-source cells – no animals necessary

Engineered meat is taking on a new flavour as an entrepreneur aims to help people make animal-free meat at home, like brewing beer, by sharing cell cultures

LIFE 11 January 2017

By Sandrine Ceurstemont

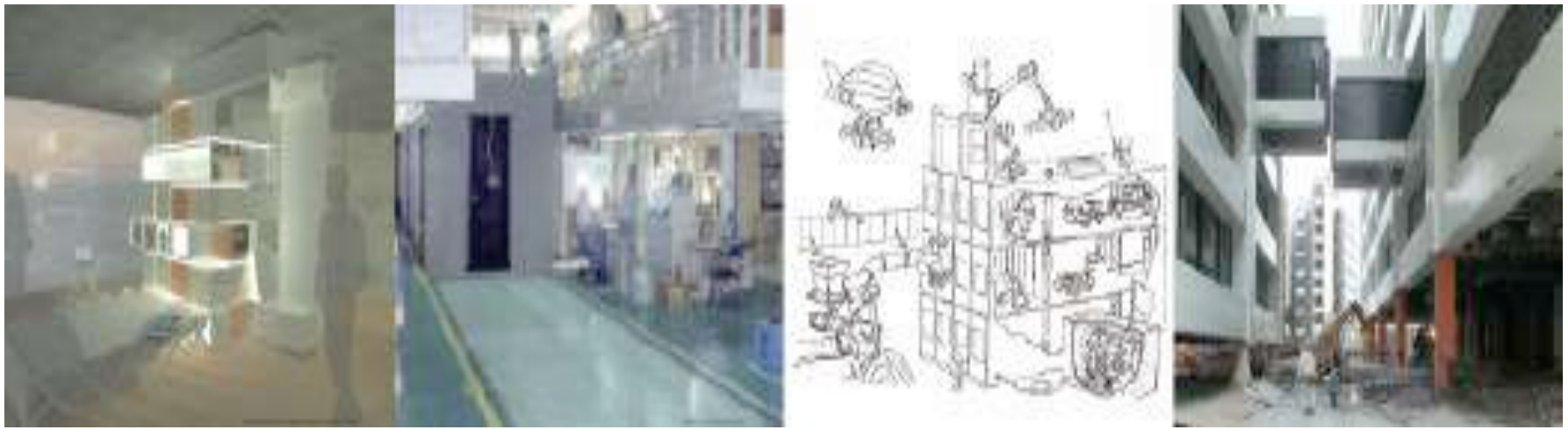
A nice side-effect of Industry 4.0 and CE: Economically and eco-sustainable refurbishment of low quality urban areas

Richard and Su Rogers. Zip-Up Enclosures No. 1 and 2, 1968-71
Model. On behalf of Rogers Stirk Harbour + Partners

KieranTimberlake Associates, Stephen Kieran and James Timberlake.
Cellophane House (Exterior)

Pictures from: K. Tadashi Oshima, R. Waern (authors), B. Bergdoll and P. Christensen (eds). Home Delivery, The Museum of Modern Art, New York, (2008)

Urban Refurbishment



a) Ambient Innovation; b) Industrialization; c) Site Automation; d) Robotic Deconstruction ('dismantling of buildings and built environments')

from T. Block. TARSA, Teaching Automation, Robotics and Services to Architects, (2010)

Outline of the talk

- Global Challenges
- Robotics ‘waves’
- Industry 4.0
- I4.0 impact on the Circular Economy
- Another I4.0 side effect: impact on Precision Agriculture and Construction Industry
- Open issues with current ‘paradigms’ and approaches, and the road ahead
- Societal impacts

The second wave: the success stories

DARPA (American Defense Advanced Research Projects Agency) challenges have demonstrated how current robots are becoming **more accurate**, **fast** and **dexterous in structured and unstructured environments**.

Not everything worked as expected!

The second wave: the current approach shows some limitations

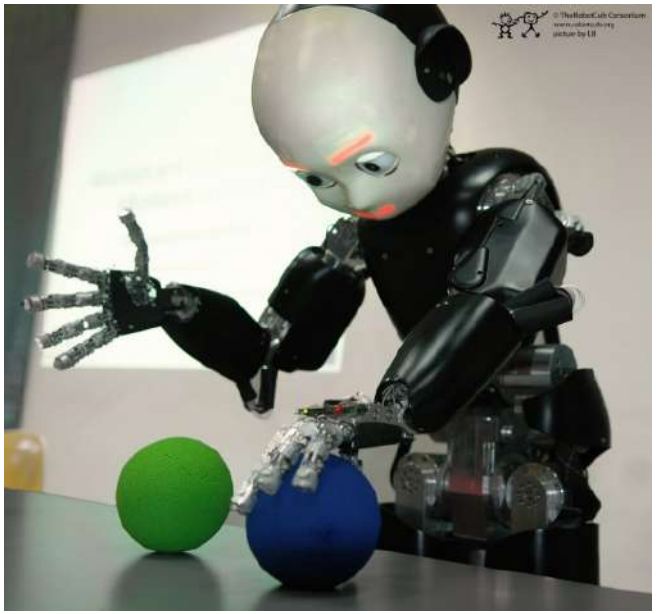
On the other hand the debriefing of DARPA DRC shows clearly that humanoid robots are **still far from the required level of capabilities in fact many metrics**, **such as time-to-completion, are highly application or task specific.**

According to H.Yanco a minimum of 9 people were needed to teleoperate latest DRC's robots!!!

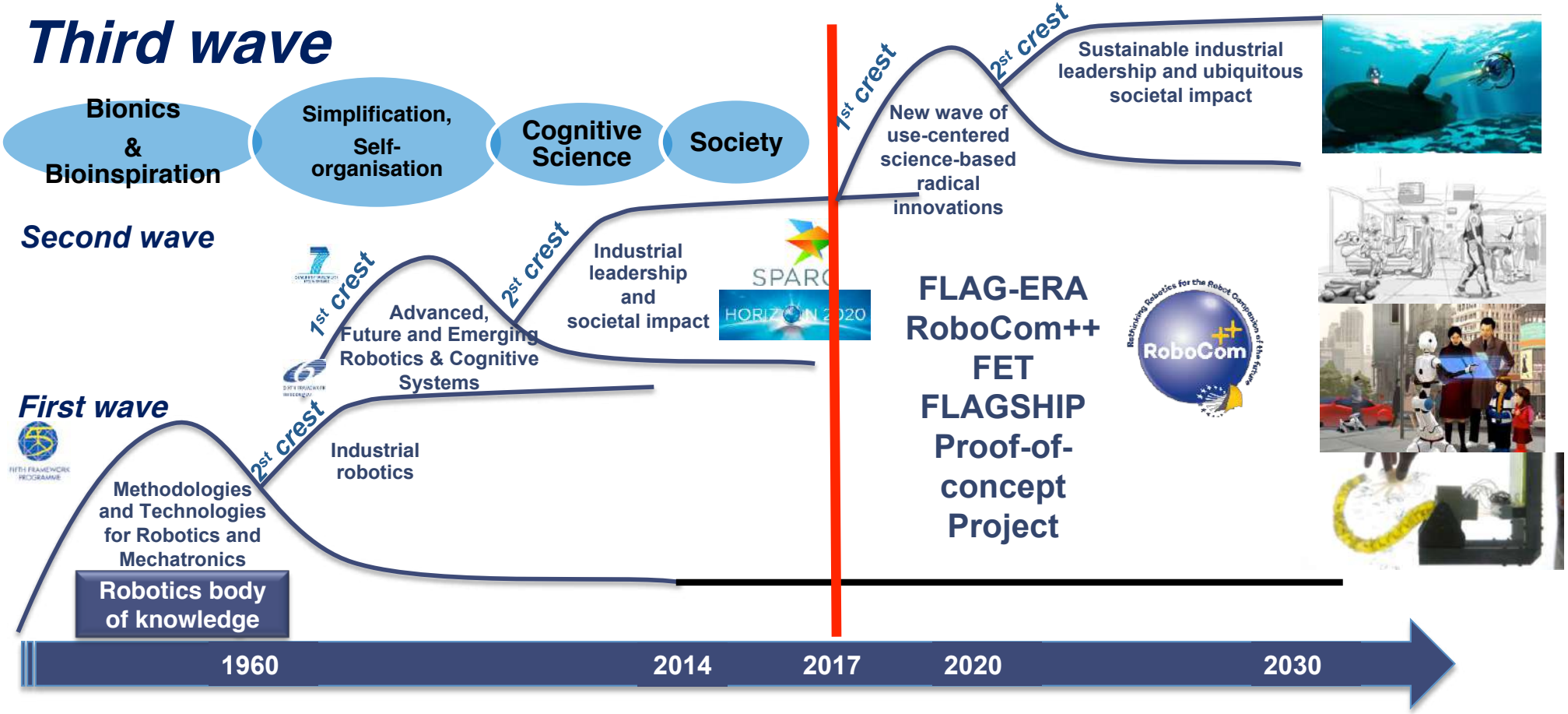
Pursuing new frontiers:
The robotics bottleneck

Today, more functionality means:

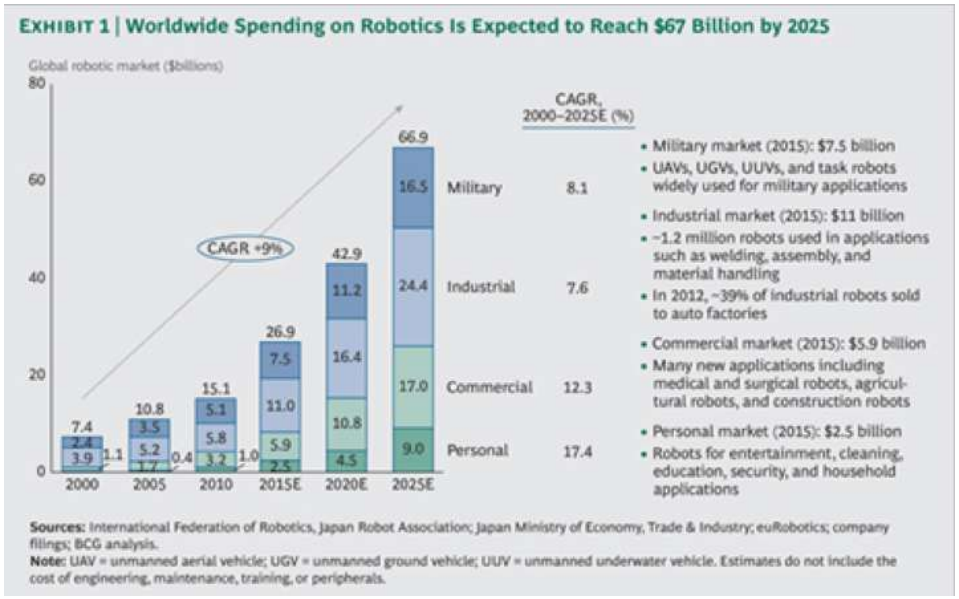
- **more** complexity, energy, computation, cost
- less controllability, efficiency, robustness, safety

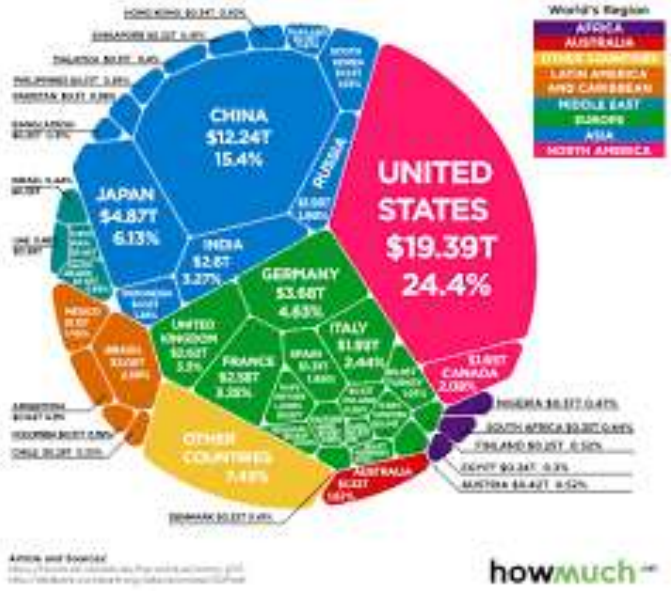


The Robotics waves

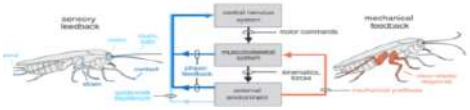


What's going on…





BioRobotics and Bionics convergence



2005
PhD in BioRobotics at IMT (Lucca) and SSSA

2011
The BioRobotics Institute in Pisa

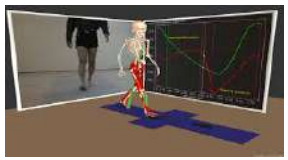
Bioengineering

Biology

Neuroscience

BioRobotics

TODAY
BioRobotics and Bionics



1980s
Service and Humanoid Robotics

1990s
Biomedical applicatio

2000s
Bioinspiration

Mid-2000s
Neuro-robotics and Soft-Robotics

2005+
Clinically implanted artificial organs and limbs

2009
IEEE Technical Committee in BioRobotics

1970s
ndustrial Robotics

1975-1990
'Anthropomorphic robotics'

1989
Robots and Biological Systems: Towards a New Bionics?

(Proceedings of the NATO Advanced Workshop on Robots and Biological Systems
Editors: Dario, Paolo, Sandini, Giulio, Aebischer, Patrick)

'New' Bionics

Robotics

1960
Birth of modern robotics

1976-78
The Bionic Woman "killed" the newborn bionics (Von Gierke)

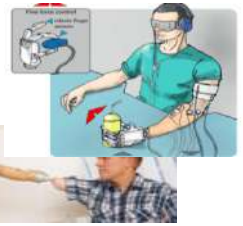
Bionics

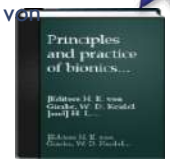
1970
Principle and practice of Bionics (Henning Edgar von Gierke, 1970)

1961
First published report on Bionics
(**Science** Vol. 133 no. 3452 pp. 588-593

1958
Major J. E. Steele coined the term Bionics

2006
BioRob International conference





Materials Science

Computer Science

Medicine

Paolo Dario

BioRobotics and Bionics convergence

NEURALINK

Neuralink is developing ultra high bandwidth brain-machine interfaces to connect humans and computers.

BioRobotics and Bionics convergence

Mary Lou Jepsen's TED talks

Could future devices read images from our brains?

Posted Mar 2014

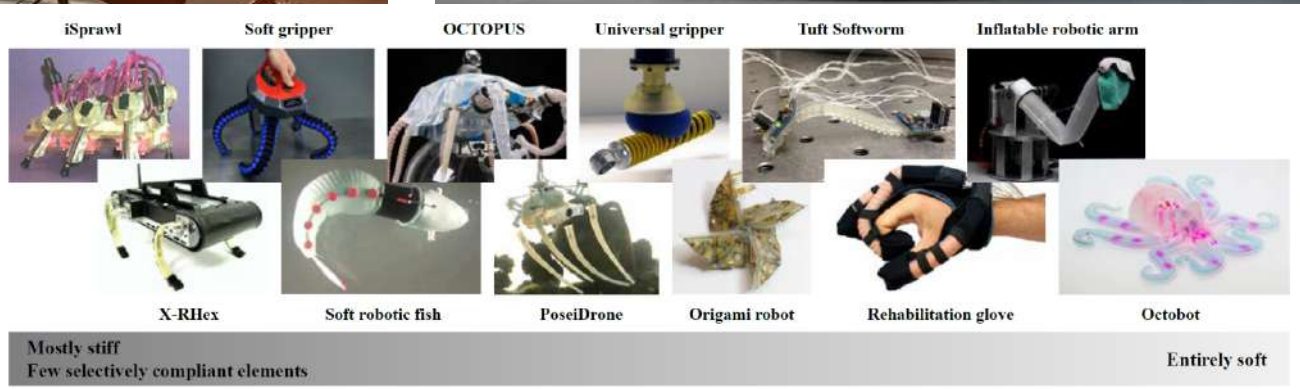
How we can use light to see deep inside our bodies and brains

Posted Aug 2018

BioRobotics and Bionics convergence

SCIENCE ROBOTICS

The marvellous progress of Robotics and AI…'Look Ma, No Hands' syndrome?



Also spracht Rodney Brooks ☺

JUNE 17, 2017 — ESSAYS

Edge Cases For Self Driving Cars

rodneybrooks.com/edge-cases-for-self-driving-cars/

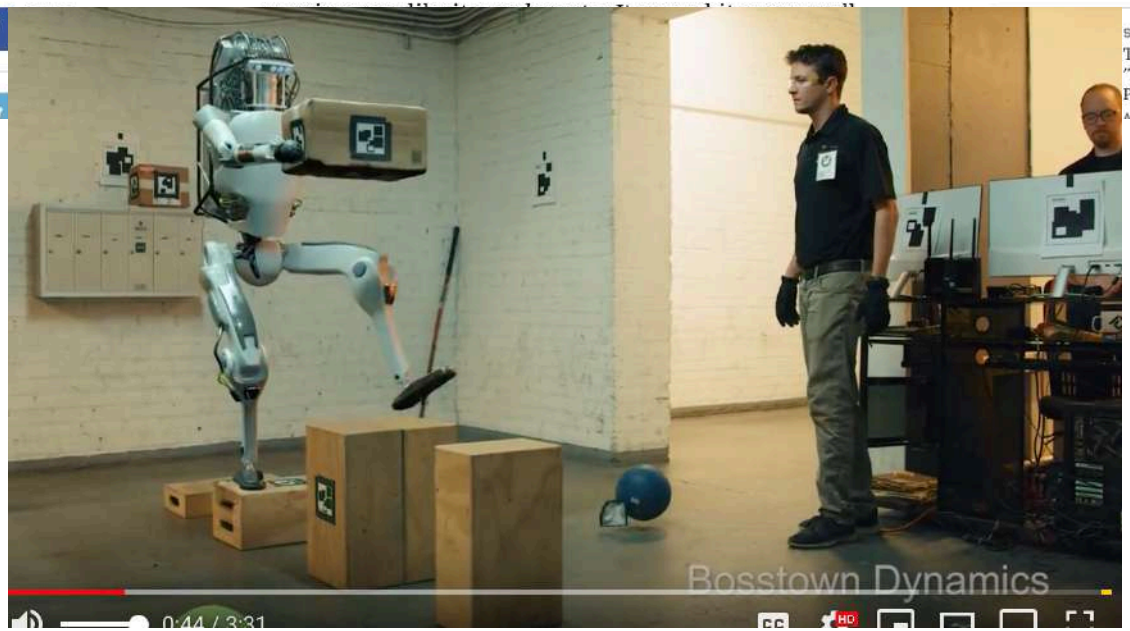
“Perhaps through this essay I will get the bee out of my bonnet that fully driverless cars are a lot further off than many techies, much of the press, and even many auto executives seem to think. They will get here and human driving will probably disappear in the lifetimes of many people reading this, but it is not going to all happen in the blink of an eye as many expect. There are lots of details to be worked out.”

Also spracht Marc Raibert ☺

YOU'RE EXPECTING TOO MUCH OUT OF BOSTON DYNAMICS' ROBOTS

SHARE

At the WIRED25 festival in San Francisco Sunday evening, Boston Dynamics' SpotMini robot got onstage and did what no other quadruped robot has done before: It danced the



MOST POPULAR

SECURITY
The Highly Dar
'Triton' Hacke
Probed the US

You might have seen the video a few days ago of Atlas doing parkour, bounding up a multi-leveled structure with ease. While the performance seemed effortless, it took over 20 attempts. After the robot gets in the groove, though, its success rate is around 90 percent.[1] "In our videos we typically show the very best behavior," Raibert said. "It's not the average behavior or the typical behavior. And we

- 'Look Ma, No Hands' syndrome?
- Replication of experiments
- Performance benchmarks, challenges and competitions to allow comparisons of results
- Needed to foster research advancement and enable practical application of research achievements

Much Needed to define ‘How good’ is a robot at performing tasks

A bit of History

Early stages 2008-2010

- 2008 Euron establishes the GEM SIG (coordinated by me, John Hallam, Angel P. del Pobil as a small fundednetworking project
- Reproducibility issues in Robotics exposed at Euron General Meeting in Prague.
- Many meetings help define the issues related to Benchmarking and Good Experimental methodology in Robotics
- 2009: The IEEE RAS TC on Performance Evaluation and Benchmarking of Robotics and Autonomous Systems (PEBRAS) is established

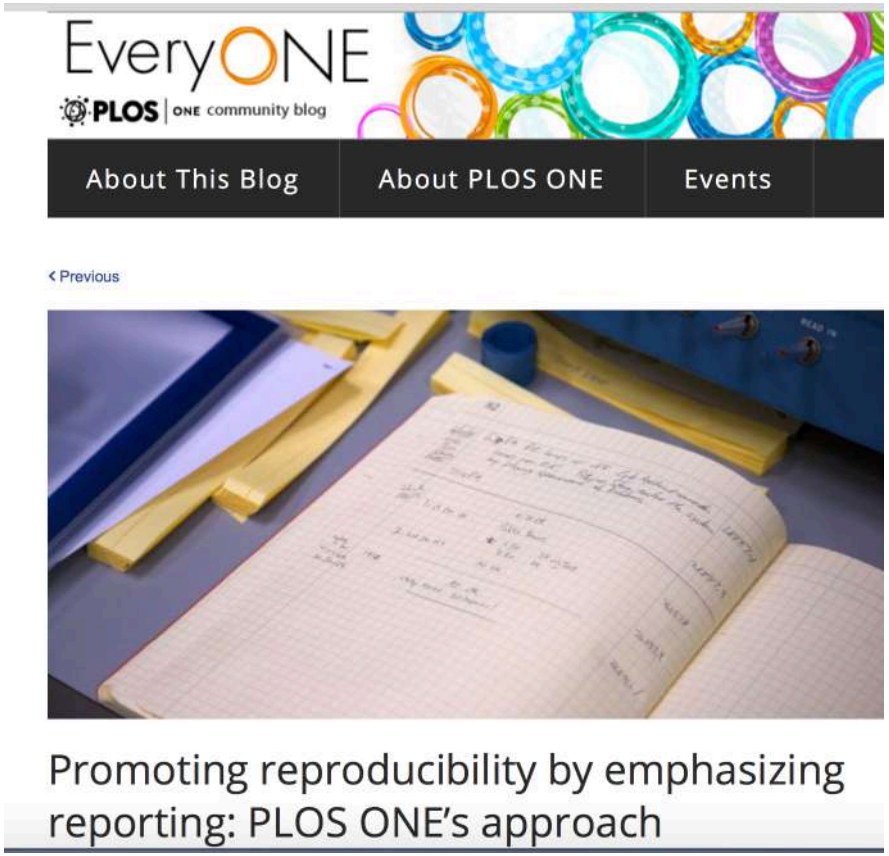
2010-2016

- More than 20 workshops at ICRA, IROS, RSS, ERF discuss the issues and propose solutions
- 2015: the very first Special issues made of Reproducible paper on an high profile venue on IEEE R&A Magazine
- 2015: the first IEEE RAS Summer School on Reproducible Research in Robotics

Today

- Still more workshops (the latest at ICRA 2017 in Singapore)
- New cool upcoming initiatives on IEEE RAM
- The best is yet to come!

We are not alone: the ‘reproducibility crisis’



An experiment in Robotics is a well defined (stochastically) repeatable set of (stochastically) reproducible behaviors in well defined set of (stochastically) similar set of environments (see clinical studies in Medicine, Biology, Psychology, etc.)

Performance evaluation

Dyson's robot vacuum cleaner should be considered more intelligent than the Roomba?

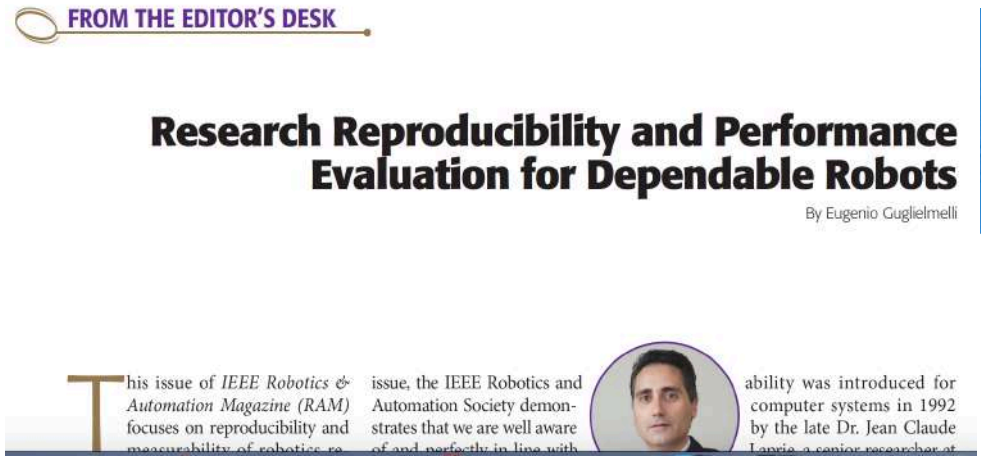
How to compare, classify and rank complex adaptive behaviors (Intelligent/Cognitive)?

A new kind of papers?

- ‘description’ : a journal paper text+figures+ multimedia ….according to GEM Guidelines (or similar)
- Data sets (attachments, not just ‘multimedia’
- Complete ‘code’ identifiers and or downloadable code (executables may be enough)
- ‘HW’ description or HW identifier (if it is identifiable)

…

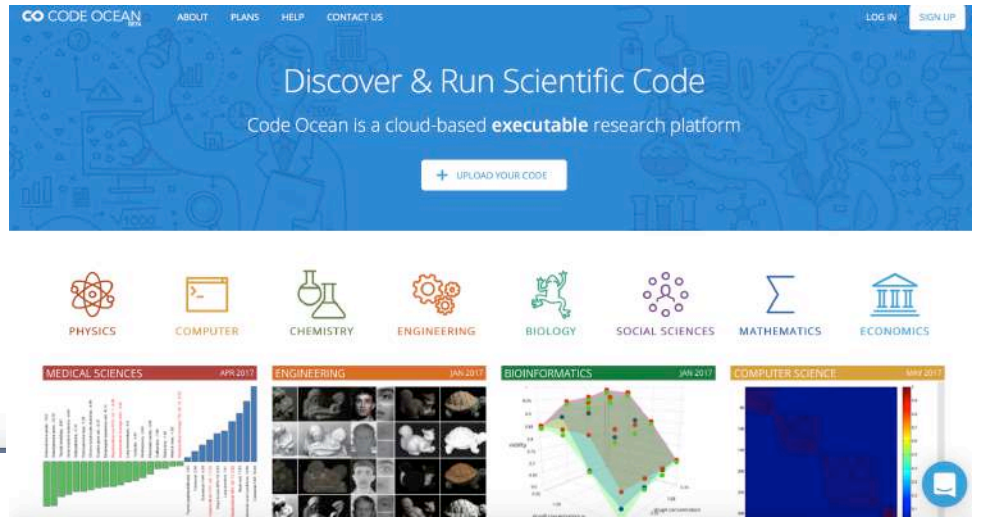
Reproducible Research now an IEEE priority


FROM THE EDITOR'S DESK

Research Reproducibility and Performance Evaluation for Dependable Robots

By Eugenio Guglielmelli

This issue of *IEEE Robotics & Automation Magazine (RAM)* focuses on reproducibility and measurability of robotics re- issue, the IEEE Robotics and Automation Society demonstrates that we are well aware of and perfectly in line with ability was introduced for computer systems in 1992 by the late Dr. Jean Claude Laprie, a senior researcher at



R(eproducible)-Articles on IEEE R&A Magazine

Medium-Long term

Prescribing criteria for statistical significance

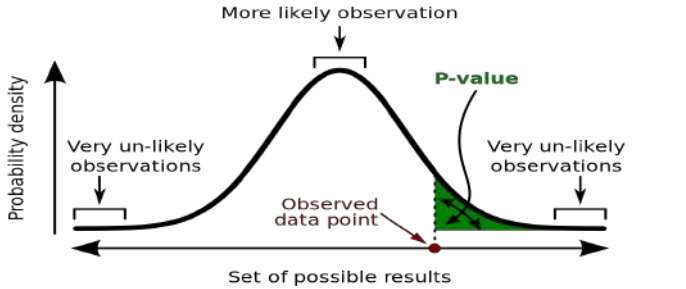
Basic

Important:

Pr (observation | hypothesis) ≠ Pr (hypothesis | observation)

The probability of observing a result given that some hypothesis is true is *not equivalent* to the probability that a hypothesis is true given that some result has been observed.

Using the p-value as a "score" is committing an egregious logical error: **the transposed conditional fallacy.**



A **p-value** (shaded green area) is the probability of an observed (or more extreme) result assuming that the null hypothesis is true.

Picture source: wikipedia

Advanced

http://www.equator-network.org/

Medium-Long term

Introducing more detailed classification of articles (see ACM ‘badging’

https://www.acm.org/publications/policies/artifact-review-badging

Editorial | Published: 11 June 2019

Robotics and the art of science

Nature Machine Intelligence **1**, 259 (2019) | Download Citation

Bringing reproducibility to robotics.

It is an exciting time to work in robotics. There are plenty of interesting challenges in designing machines that intelligently interact with both humans and their environment, and a range of techniques and insights from engineering, computer science, physics, biomechanics, psychology and other fields are available to help solve them. The International Conference on Robotics and Automatio organized by the IEEE, is a lively affair: over 4,000 pa

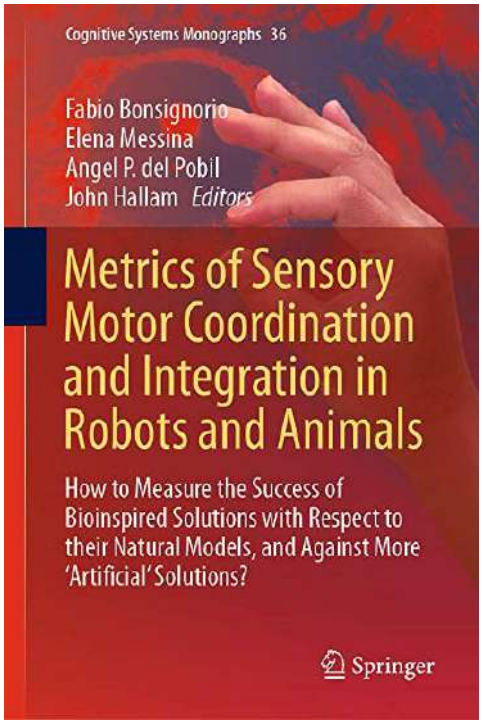
It is an exciting prospect that robotics can start growing as a scientific discipline, with clearly defined methods of evaluation and measurements in place.

References

1. Leitner, J. *Nat. Mach. Intell.* **1**, 162 (2019).
Article Google Scholar

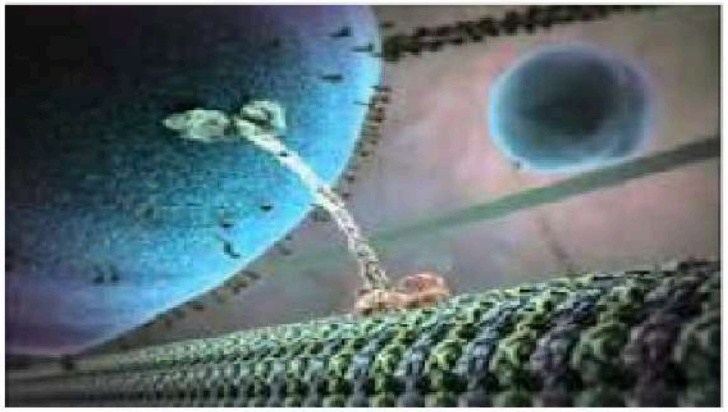
2. Bonsignorio, F. & Del Pobil, A. P. *IEEE Robot. Autom. Mag.* **22**, 32–35 (September, 2015).

3. Bonsignorio, F. A. *IEEE Robot. Autom. Mag.* **24**, 178–182 (September, 2017).



Is It Alive?

Big Questions lie in front of us!



Two views of intelligence

classical:
cognition as computation

embodiment:
cognition emergent from sensory-motor and interaction processes

PARADIGM CLASHES

www.shanghailectures.com

Soft Robotics: a working definition

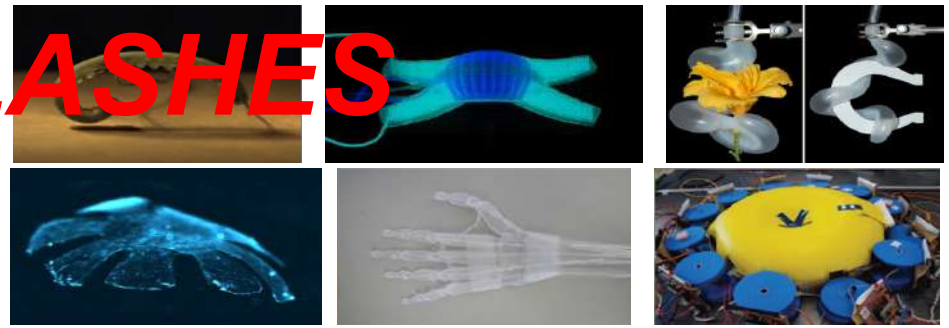
Variable impedance actuators and stiffness control

* Actuators with variable impedance
* Compliance/impedance control
* Highly flexible (hyper-redundant or continuum) robots

IEEE Robotics and Automation Magazine, Special Issue on Soft Robotics, 2008
A. Albu-Schaffer et al. (Ed.s)

Use of soft materials in robotics

* Robots made of soft materials that undergo high deformations in interaction
* Soft actuators and soft components
* Control partially embedded in the robot morphology and mechanical properties



Kim S., Laschi C., and Trimmer B. (2013) Soft robotics: a bioinspired evolution in robotics, *Trends in Biotechnology*, April 2013.
Laschi C. and Cianchetti M. (2014) "Soft Robotics: new perspectives for robot bodyware and control" *Frontiers in Bioengineering and Biotechnology*, 2(3)

PARADIGM CLASHES

Outline of the talk

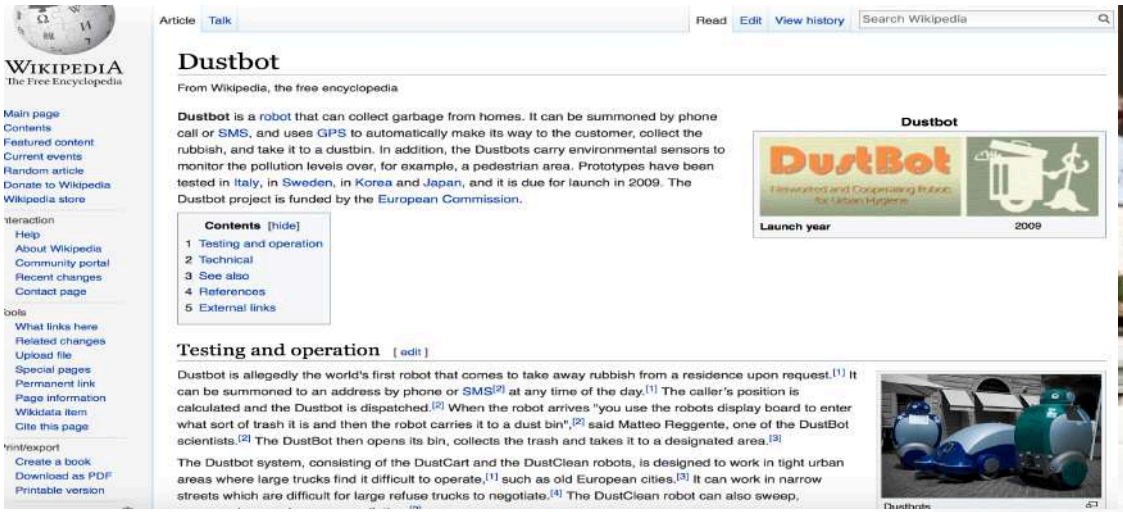
- Global Challenges
- Robotics ‘waves’
- Industry 4.0
- I4.0 impact on the Circular Economy
- Another I4.0 side effect: impact on Precision Agriculture and Construction Industry
- Open issues with current ‘paradigms’ and approaches, and the road ahead
- Societal impacts

Not 'academic issues'

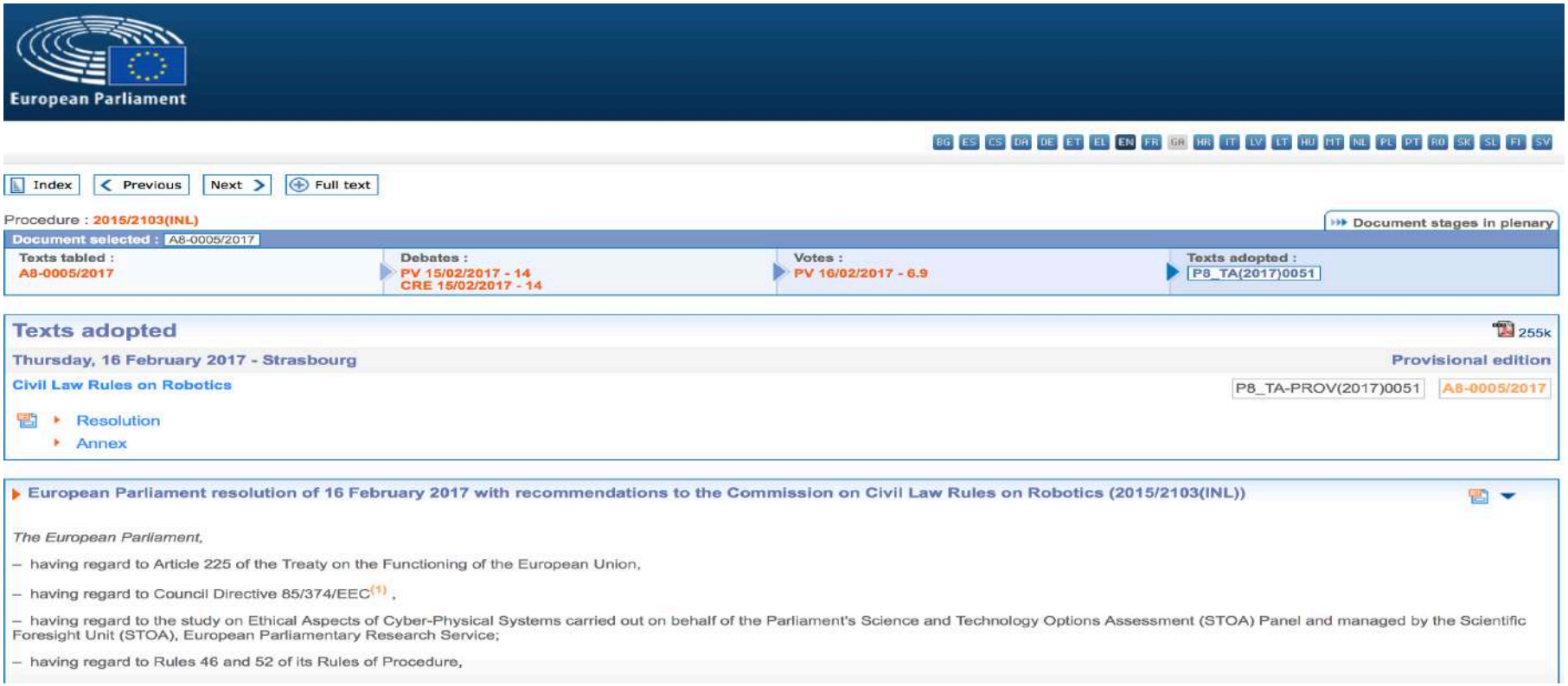
The crashed Tesla S car involved in the first fatal self driving car accident on May 7th 2016. Source: Reuters

As early as in 2001 the first RoboEthics workshop was held in Pisa at SSSA

DustBot FP6 Project 2006-2009 took waste collecting robots in the streets of the Tuscan 'borgo' of Peccioli…From that experience 'Law issues' with massive deployment of robots became clear ….Guess who started the discussion leading to the RoboLaw Project 2011-2014) coordinated by SSSA.



RoboLaw's Guidelines and SSSA have already heavily influenced the EU's Lawmakers work…



European Parliament

BG ES CS DA DE ET EL EN FR GA HR IT LV LT HU MT NL PL PT RO SK SL FI SV

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Procedure : 2015/2103(INL)

Document stages in plenary

Document selected : A8-0005/2017

Texts tabled :	Debates :	Votes :	Texts adopted :
A8-0005/2017	PV 15/02/2017 - 14 CRE 15/02/2017 - 14	PV 16/02/2017 - 6.9	P8_TA(2017)0051

Texts adopted 255k

Thursday, 16 February 2017 - Strasbourg — Provisional edition

Civil Law Rules on Robotics — P8_TA-PROV(2017)0051 — A8-0005/2017

- Resolution
- Annex

European Parliament resolution of 16 February 2017 with recommendations to the Commission on Civil Law Rules on Robotics (2015/2103(INL))

The European Parliament,

– having regard to Article 225 of the Treaty on the Functioning of the European Union,

– having regard to Council Directive 85/374/EEC[1] ,

– having regard to the study on Ethical Aspects of Cyber-Physical Systems carried out on behalf of the Parliament's Science and Technology Options Assessment (STOA) Panel and managed by the Scientific Foresight Unit (STOA), European Parliamentary Research Service;

– having regard to Rules 46 and 52 of its Rules of Procedure,

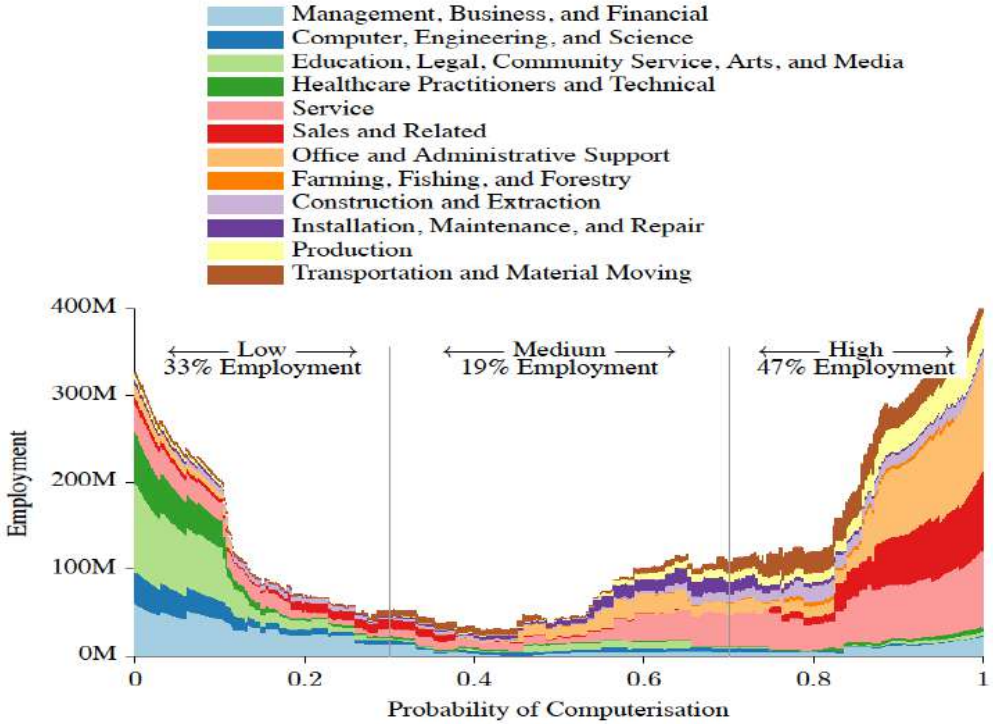
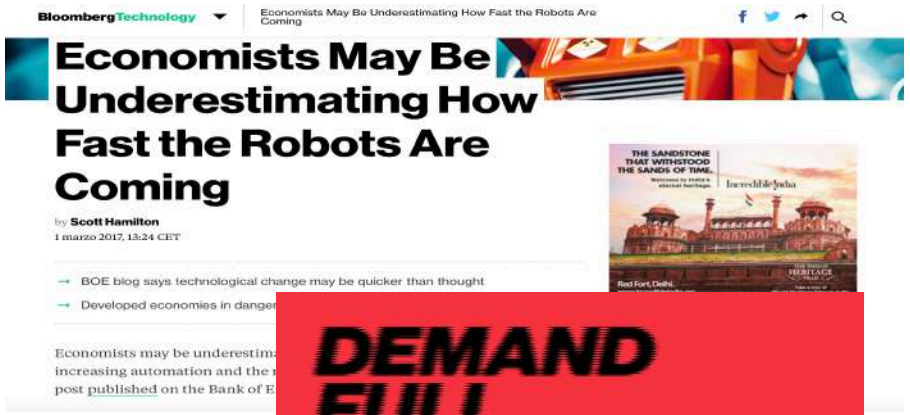
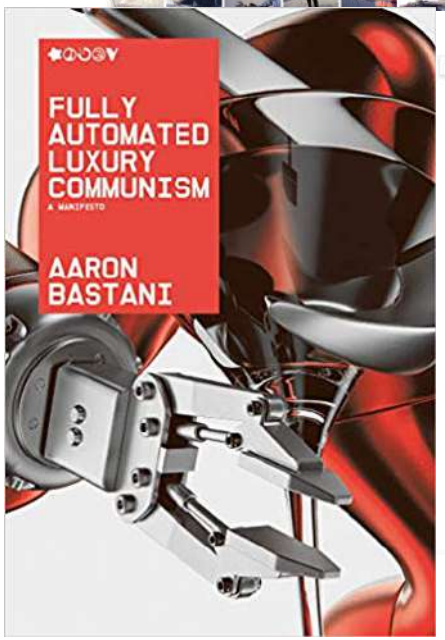


FIGURE III. The distribution of BLS 2010 occupational employment over the probability of computerisation, along with the share in low, medium and high probability categories. Note that the total area under all curves is equal to total US employment.


WORLD ECONOMIC FORUM
COMMITTED TO IMPROVING THE STATE OF THE WORLD
Global Challenge Insight Report
The Future of Jobs
Employment, Skills and Workforce Strategy for the Fourth Industrial Revolution
January 2016


BloombergTechnology
Economists May Be Underestimating How Fast the Robots Are Coming
Economists May Be Underestimating How Fast the Robots Are Coming
by Scott Hamilton
1 marzo 2017, 13:24 CET
BOE blog says technological change may be quicker than thought
Developed economies in danger
Economists may be underestima
increasing automation and the
post published on the Bank of E
THE SANDSTONE THAT WITHSTOOD THE SANDS OF TIME.
Incredible India
Red Fort, Delhi


FULLY AUTOMATED LUXURY COMMUNISM
A MANIFESTO
AARON BASTANI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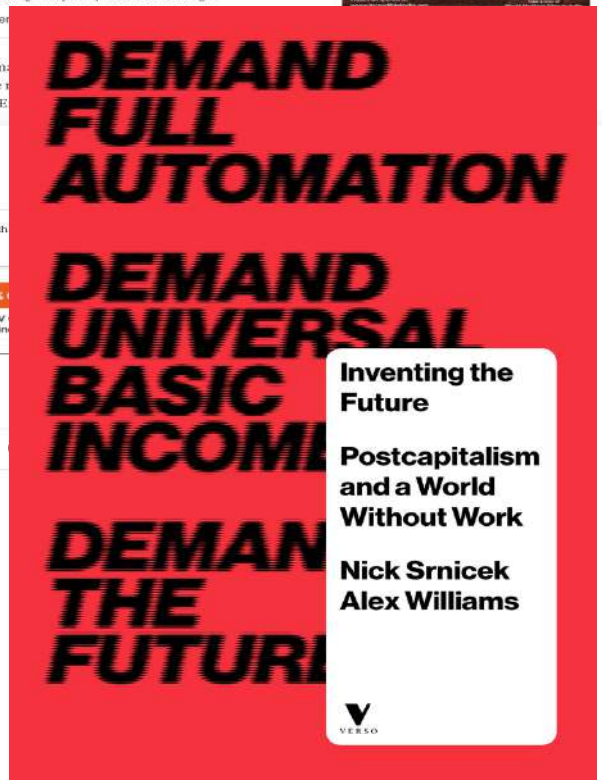
Open Source for Arduin
The Opinion Pages | EDITORIAL
No, Robots Aren't Killing the American Dream
By THE EDITORIAL BOARD | FEB. 20, 2017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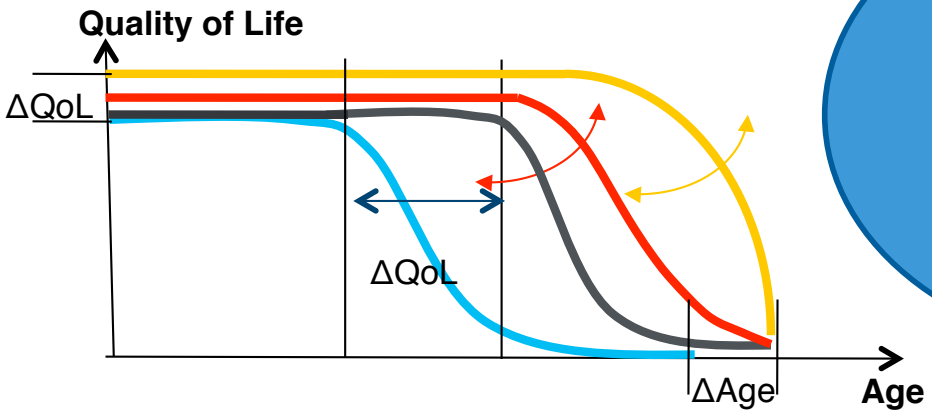
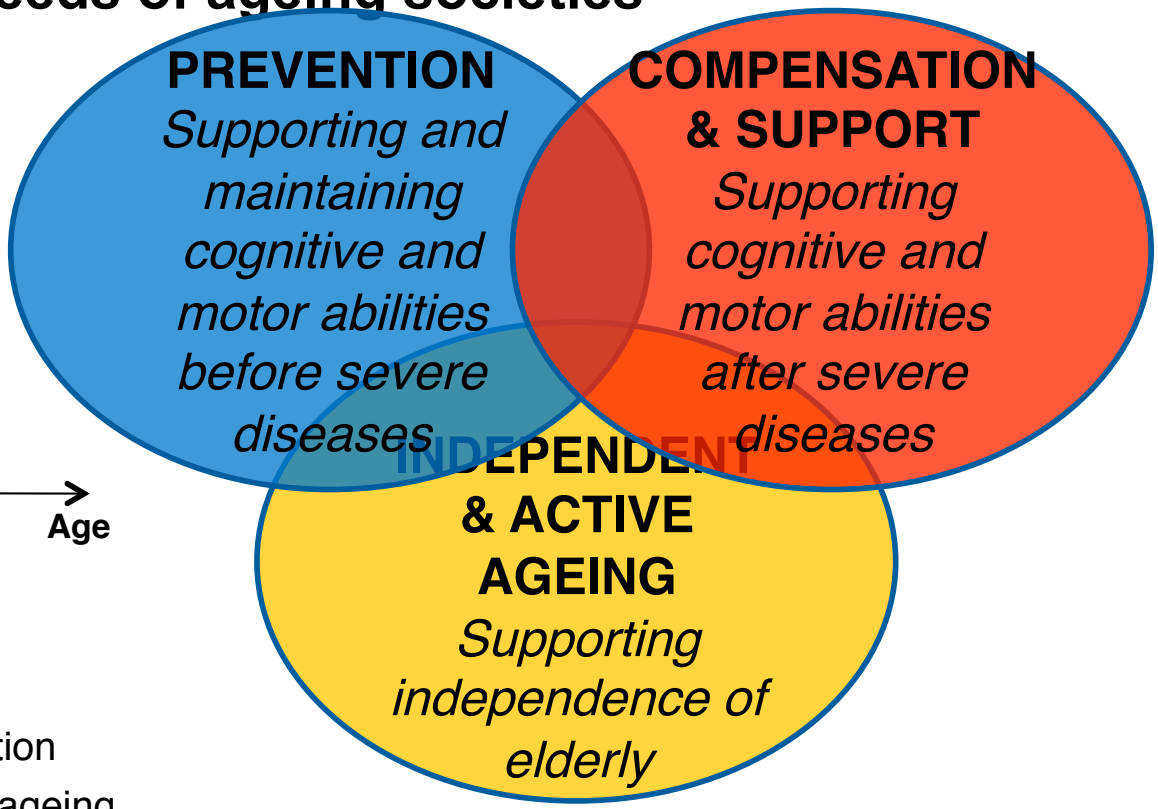
DEMAND UNIVERSAL BASIC INCOM
DEMAN THE FUTUR
Inventing the Future
Postcapitalism and a World Without Work
Nick Srnicek
Alex Williams
VERSO

Uncoped issues:
The new Needs of ageing societies





Without devices and services

Effects of prevention

Effects of support and compensation

Effects of indipendent and active ageing

Some outcomes from AAL2 and RobotEra Projects, Paolo Dario coordinated RobotEra. Filippo Cavallo (also from our group) was the pm.

How can STI (Science, Technology and Innovation) contribute to the new needs of ageing societies?

Service Robotics

Wearable Systems

Big Data

Ethical Issues

"Despite the possible benefits,….:

(1) the potential reduction in the amount of human contact;

(2) an increase in the feelings of objectification and loss of control;

(3) a loss of privacy;

(4) a loss of personal liberty;

(5) deception and infantilisation;

(6) the circumstances in which elderly people should be allowed to control robots

We conclude by balancing the care benefits against the ethical costs. If introduced with foresight and careful guidelines, robots and robotic technology could improve the lives of the elderly, reducing their dependence, and creating more opportunities for social interaction"

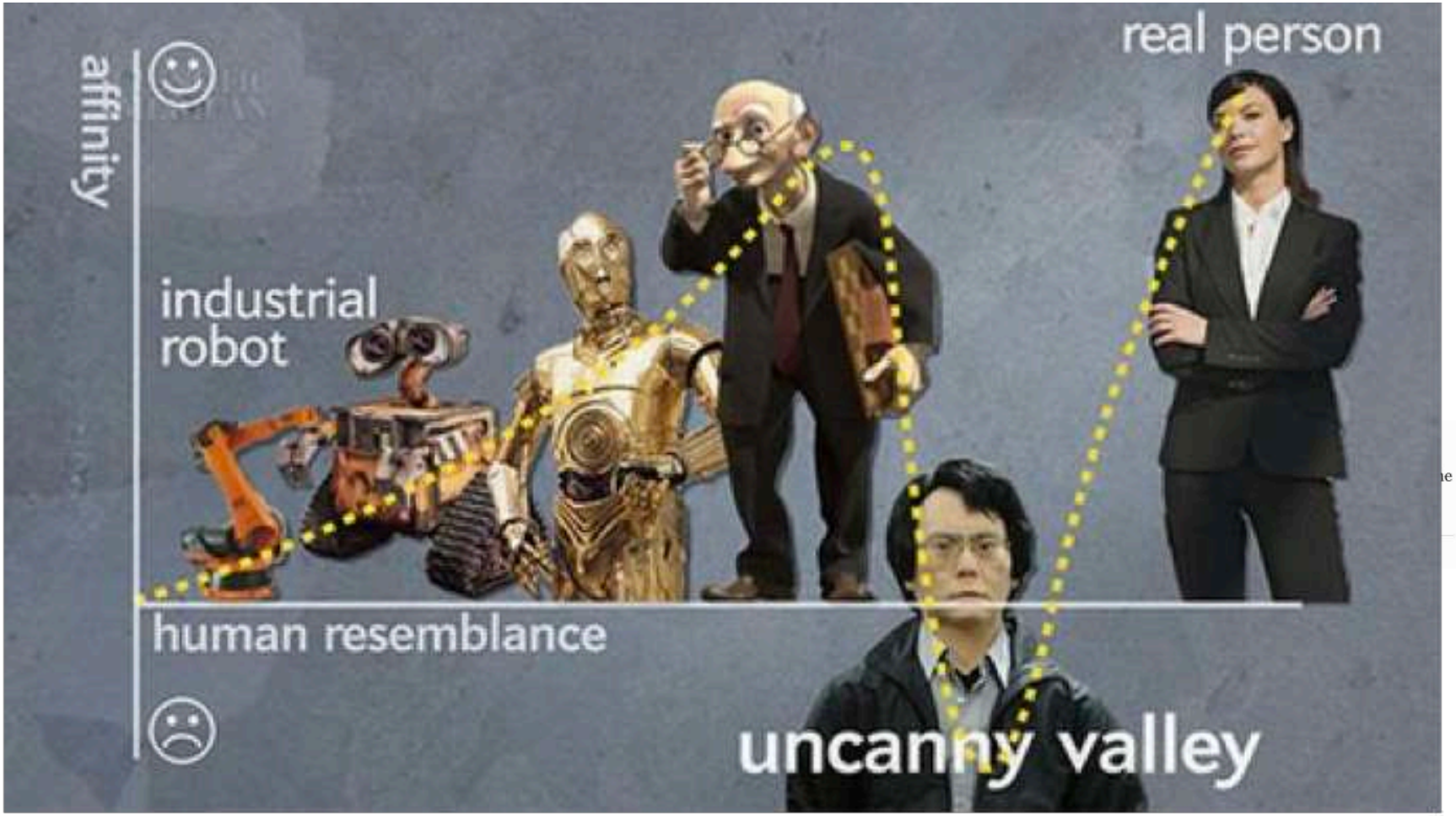


image from scoop.it Stephanie Lay

Experts In Focus

Is Radical Life Extension Good for Society?

By **Shelly Fan** - Dec 01, 2016 6,636

From time to time, the Singularity Hub editorial team unearths a gem from the archives and wants to share it all over again. It's usually a piece that was popular back then and we think is still relevant now. This is one of those articles. It was originally published Febuary 14, 2016. We hope you enjoy it!

1.1K

It's no longer a radical question.

The aging literature is replete with treatments that could prolong lifespan by 20-40%, at least in lab animals. Interventions such as caloric restriction, rapamycin and metformin have been studied for decades for their anti-aging capacity. Although there is still some discrepancy in their effectiveness in primates, the biomedical community agrees that they're promising.

A glimpse to the future of ‘Industry’ after I4.0

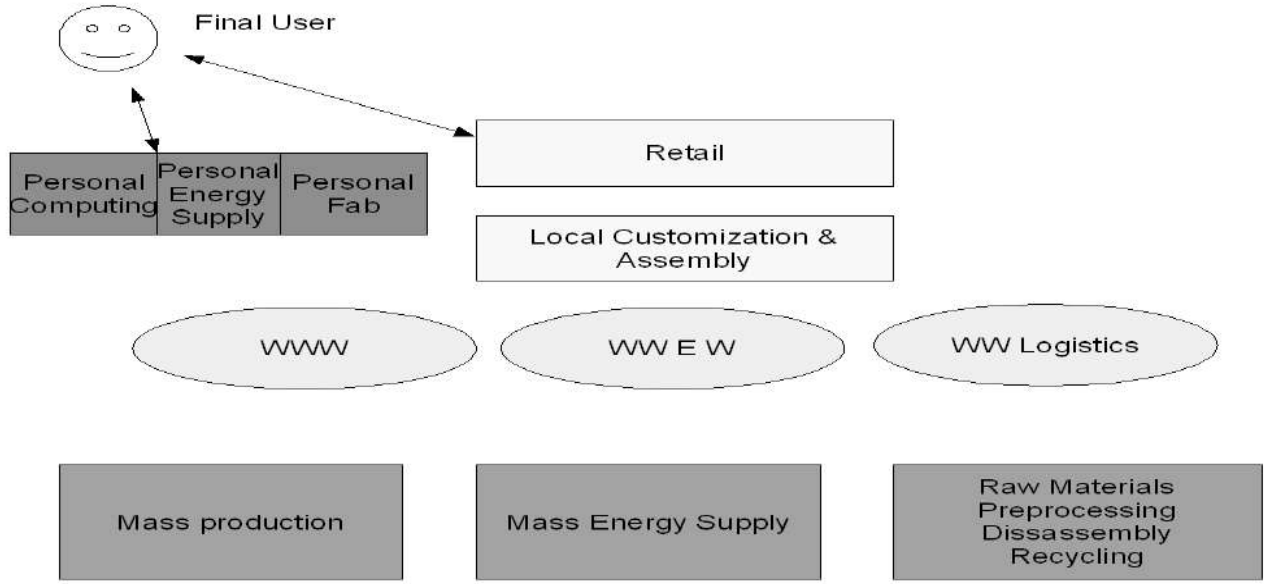
In a 5-15 year perspective a radical *paradigm change* in the full cycle of consumer service-products from raw materials to disposal will likely become mature.

- continuous progress in the price/performance ratio of computing equipment (see R. Kurzweil, ‘The singularity is near’) and new paradigm computing (neuromorphic, quantum…)
- transition from a ‘browsing’ internet to internet computing,
- continuous reduction in the cost of manufacturing – towards personal fabrication
- expected progress in cognition sciences, robotics and AI
- the emergence of *bio-automation*

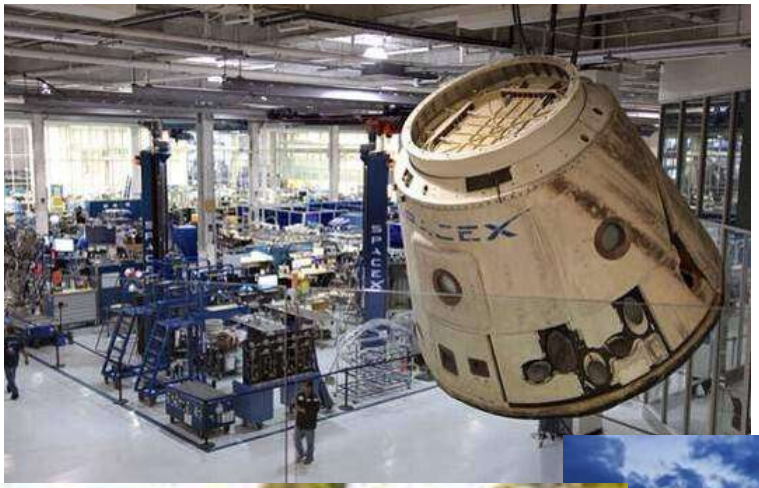
Swarm intelligence eco/bio inspired systems should connect the consumers to the intelligent service agents in the physical and cyber world negotiating between demand and supply and *continuosly adaptively managing* the available resources (material, energy) , *cognitive physical agents* (from mining to manufacturing to distribution to disposal), intelligent autonomous design/supply management sytems, etc. to meet users needs.

A totally new sustainable ecology of service/products might emerge.

A concept picture of the envisioned manufacturing and supply system



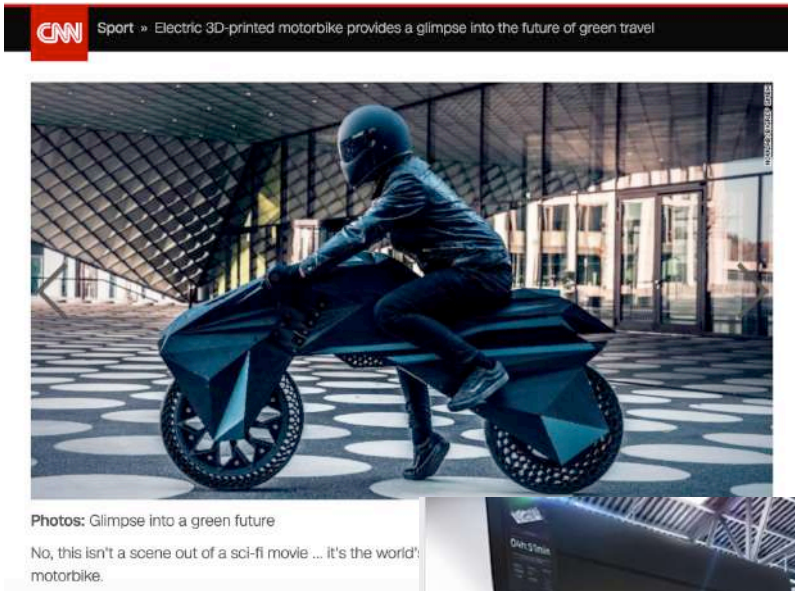
A concept picture of the envisioned manufacturing and supply system



Intel To Reopen Mothballed Chandler Factory

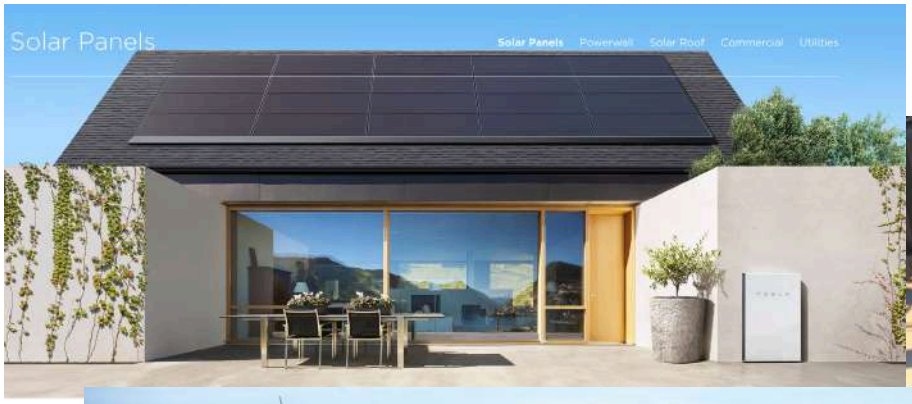
Contributed Photo/Courtesy Intel: The Intel Corporation announced plans to invest more than $7 billion to complete Fab 42, a microchip manufacturing plant in Chandler. The plant is expected to be the most advanced semiconductor factory in the world.

A concept picture of the envisioned manufacturing and supply system



Bill Viola: the genious video artist

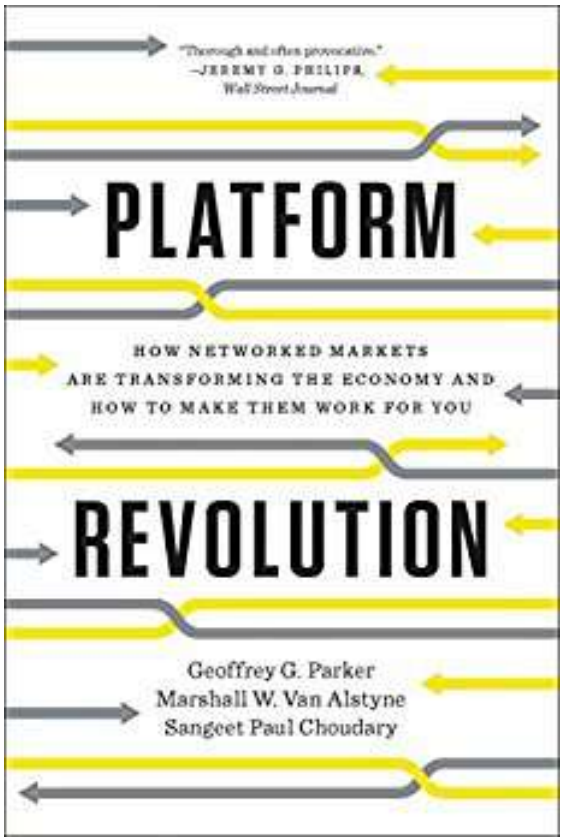
A concept picture of the envisioned manufacturing and supply system



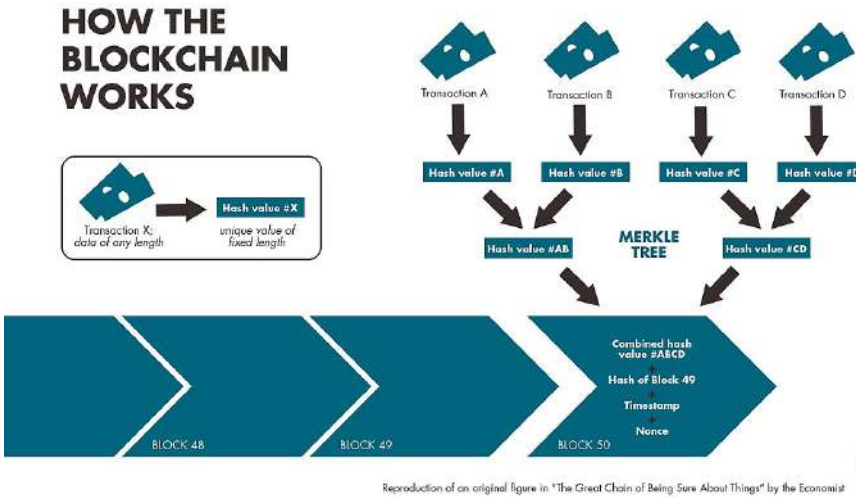
What can be done NOW (during the transition)?

- Semi structured environments
- Network of connected agents with limited ‘intelligence’ (remember H.Simon’s ‘bounded rationality’: it’s a continuum)
- Instrumented smart environments, Smart cities, Smart factories, Smart Supply Chains, … Smart X

In the meantime….



Are there alternatives? Yes, maybe: p2p for finance i.e. the blockchain



COMMERCE GUEST

Blockchains aren't just tech, they're new economic systems

JEREMY EPSTEIN, NEVER STOP MARKETING @JER979 APRIL 1, 2018 2:33 PM

VB Recommendations

VR's biggest reason to jump in now: price drops

Why and how GitLab abandoned Microsoft Azure for Google Cloud

ProBeat: Windows 10 Mail is already abysmal, and Microsoft wants to make it worse

"Just like any economy, a blockchain requires that its designers define monetary policy* (inflation), fiscal policy (block size), taxation (fees), voting (governance/upgrades), and provide for the common defense (securing the network). Yet, unlike traditional economies, they offer the possibility of greater freedom and transparency because they avoid the problems of centralization and concentration of power.

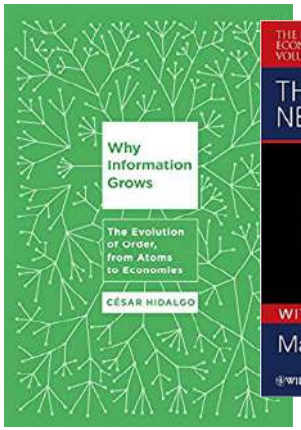
That's the good news.

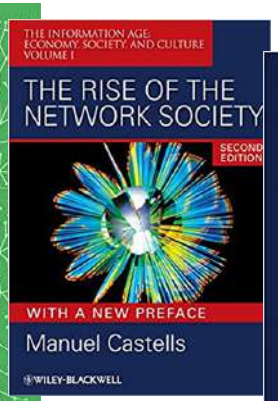
The bad news is that these new economies comes with extremely high risk.

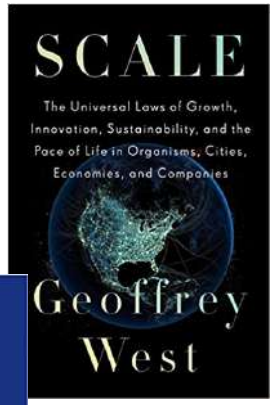
One of the risks, ironically, is also one of the technology's greatest strengths.

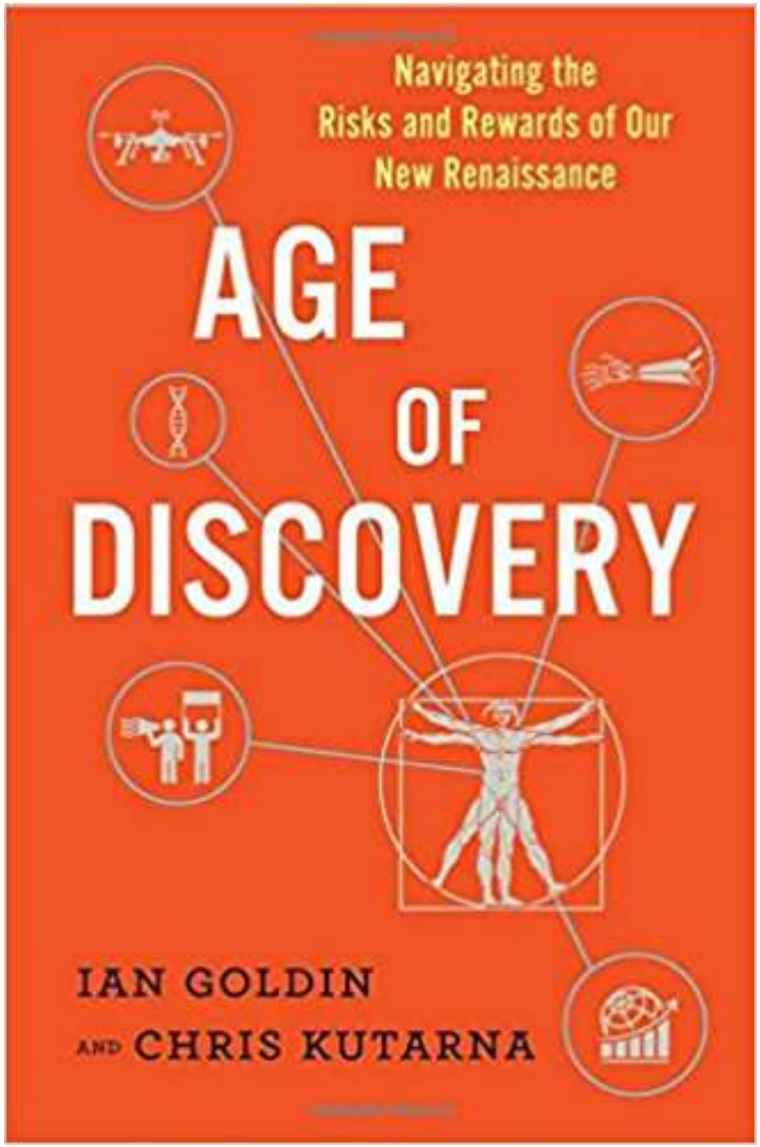
As Elad Verbin points out in his post on Behavioral Crypto-Economics, "Blockchain systems are, by design, difficult to change once deployed."

The possibility of a whole TRULY NETWORKED new economy where humans, Robots, AIs interact seamlessly in a multivendor multi technology environenment with no centralised hubs (such as the 'four' plus Alibaba, Tencent and the likes, present and future.
We need new paradigms in Economics and policies?








Navigating the
Risks and Rewards of Our
New Renaissance
AGE
OF
DISCOVERY
IAN GOLDIN
AND CHRIS KUTARNA

Carry-home messages (and remarks) (1)

We will need to dramatically increase work productivity not only to cope with a shrinking work-force and growing number of people in old and very old age, but also to mobilize resources to help the ecologically sustainable development of the global economy and provide food and infrastructures to billions of more people.

- A steep progress in Robotics and AI seems a dramatic necessity in this context.
- The Advanced Mechatronic Technologies of the 'Second Wave' will have tremendous impact
- it seems unlikely that they can provide satisfactory 'companions' or life-like robustenss and adaptation
- An evidence-based answer to this question requires a boost in the ways research is performed and reported
- To enable the 'Third Wave' of Robotics a massive effort will be needed (also in terms of dramatically improved research methodologies as existing results are 'anedoctical')

Carry-home messages (and remarks) (2)

- We will have to structure/digitalize living spaces to be able to exploit the existing and close future available technologies
- Given the cognitive/perception limits of current robots teleoperation, scalable autonomy and in general human-in-the-loop solutions will work better
- Non obvious human-in-the-loop solutions: prosthetics, body-augmentation, artificial organs, high-bandwidth BCI/BRI
- We should take care of the disciplinary interfaces with traslational genomics, connectomics, brain sciences, digital medicine, emerging rejuvenating technologies, to pursue successful holistic solutions for late age healthy and independent living
- We will still (sometimes remotely operating) need human caregivers: we should not leave elders andd impaired persons alone with deceptive robot 'companions'(it would/will make sense iff/when we will have conscious robots, that would open a huge number of different issues, though). Hopefully Industry 4.0, Robotics and AI (and what will follow) will free human resources!

A Weberian approach

- Ethics of conviction (Gesinnungsethik)
- Ethics of responsibility (Verantwortungsethik).

We need DATA and EVIDENCE

Maximilian Karl Emil "Max" Weber (German: [ˈmaks ˈveːbɐ]; 21 April 1864 – 14 June 1920) was a German sociologist, philosopher, jurist, political economist. Weber is often cited, with Émile Durkheim and Karl Marx, as among the three founders of sociology. (Source: Wikipedia)

Carry Home Message (imho)

- **Robotics and AI will not just impact economy and society (including societal power relations) …**
- **It will change the very 'fabric' of economy and society**

the promise of robotics….

Human centered design Science, Technology, Innovation for a Global Renaissance

It is our generation's responsibility to make the right choices.

The future can be bright.

Thank you!

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Natural and Artificial Intelligence in Embodied Physical Agents