



LISBON
SCHOOL OF
ECONOMICS &
MANAGEMENT
UNIVERSIDADE DE LISBOA

A 4ª Revolução Industrial

Rui Rosa

Aula ISEG
10-Nov-2017

A 4ª Revolução Industrial

1. Como chegámos aqui
 - os pressupostos
2. Onde estamos
 - o fim da 3ª revolução industrial
3. O que estamos a fazer
 - 4ª revolução industrial
4. O impacto e valor da 4ª RI
 - o que muda, valor económico
5. O que falta e os perigos
 - investimento, maturação, energia, legislação, economia
6. Conclusão

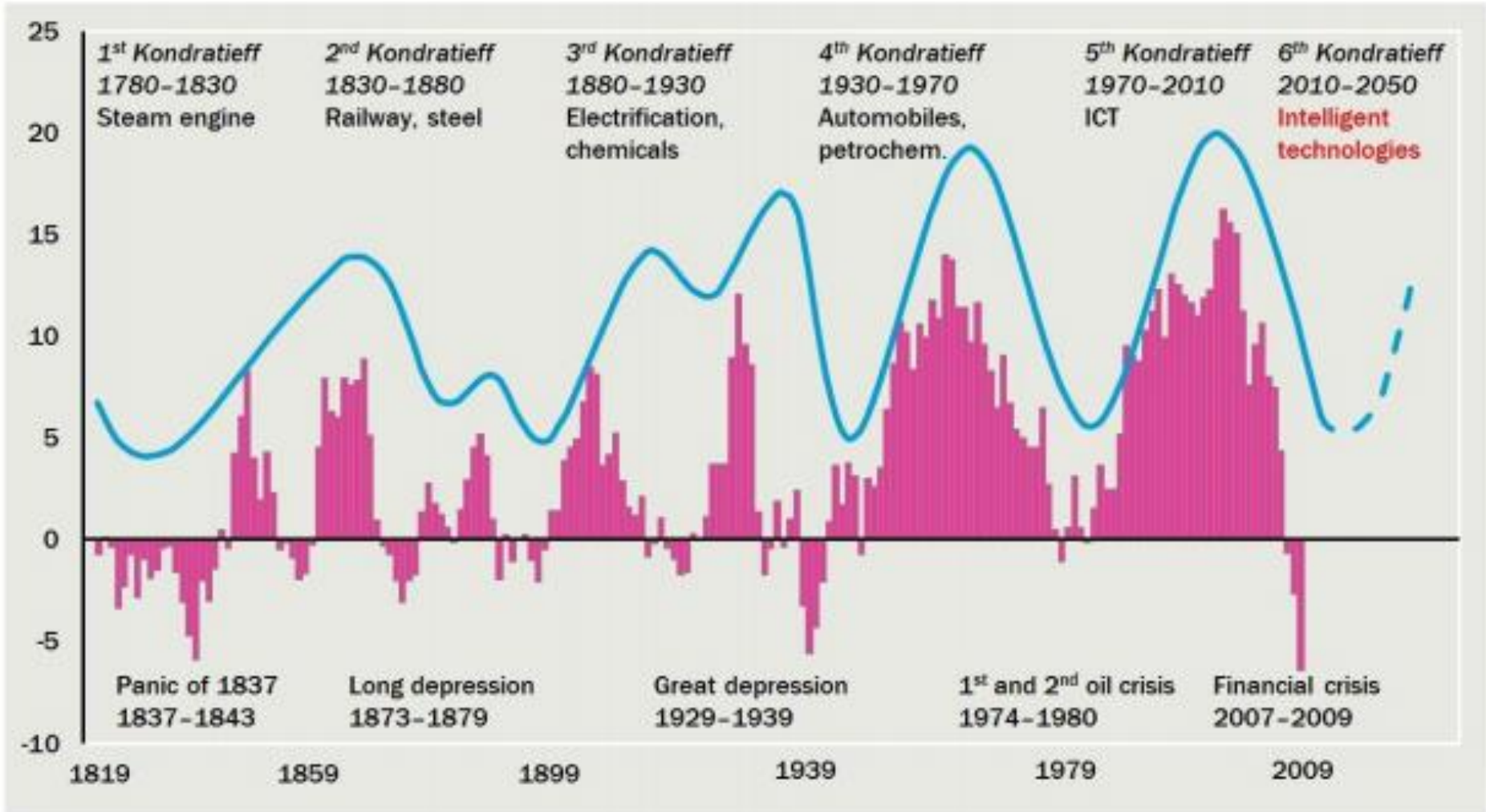
*Foco no desenvolvimento
e impacto da tecnologia*

COMO CHEGÁMOS AQUI

PADRÕES DE DESENVOLVIMENTO

Surtos de desenvolvimento

e tecnologia – Teoria das ondas de Kondratieff

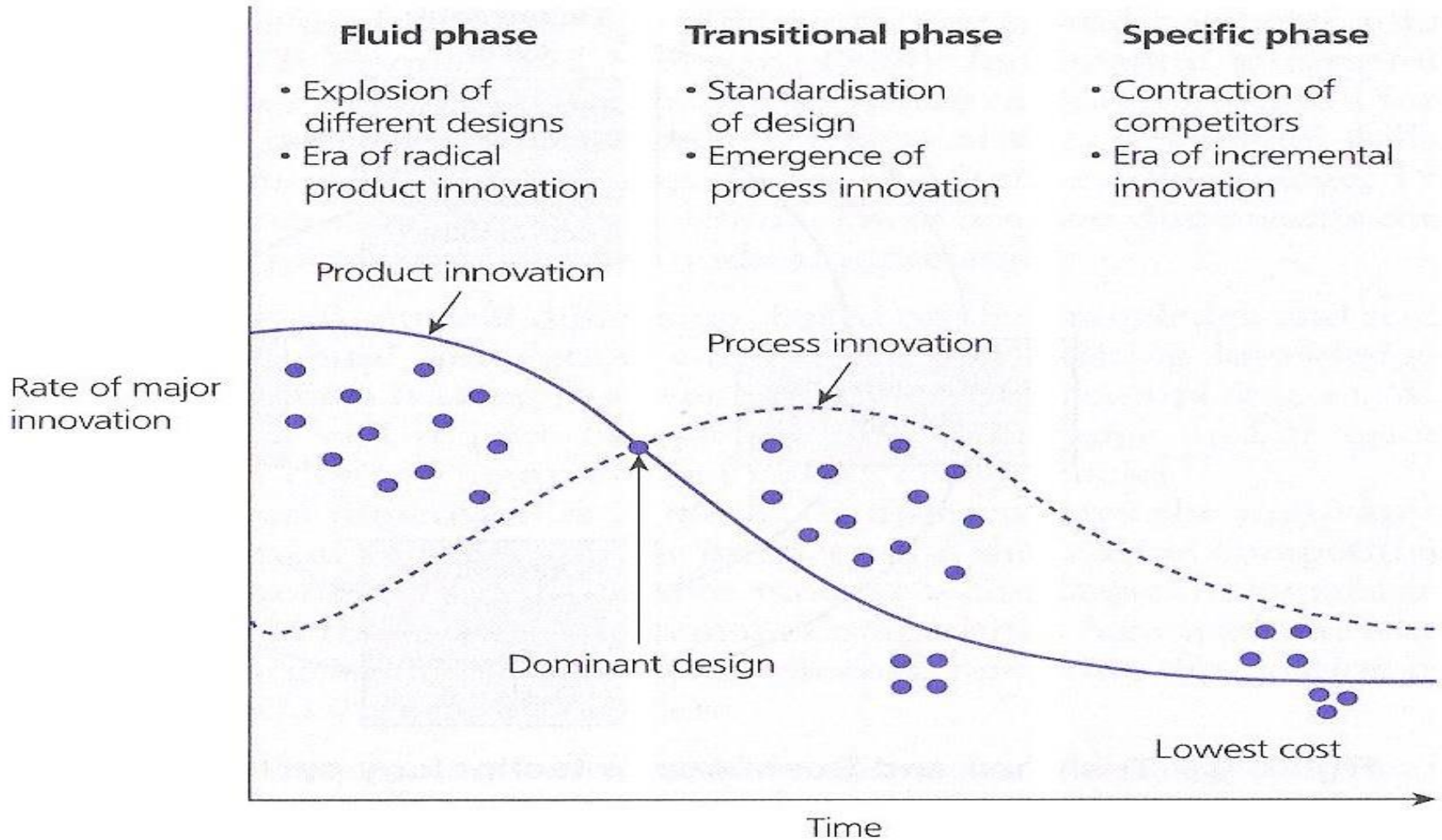


SURFING THE SIXTH WAVE

Exploring the next 40 years of global change

Markku Wilenius and Sofi Kurki

Difusão, assimilação e domínio tecnológico



Abernathy and Utterback's three phases of innovation

Source: Utterback (1994).

Combinação de fatores

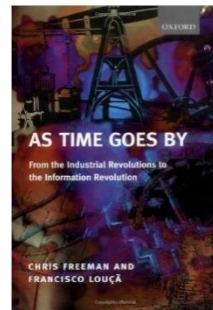


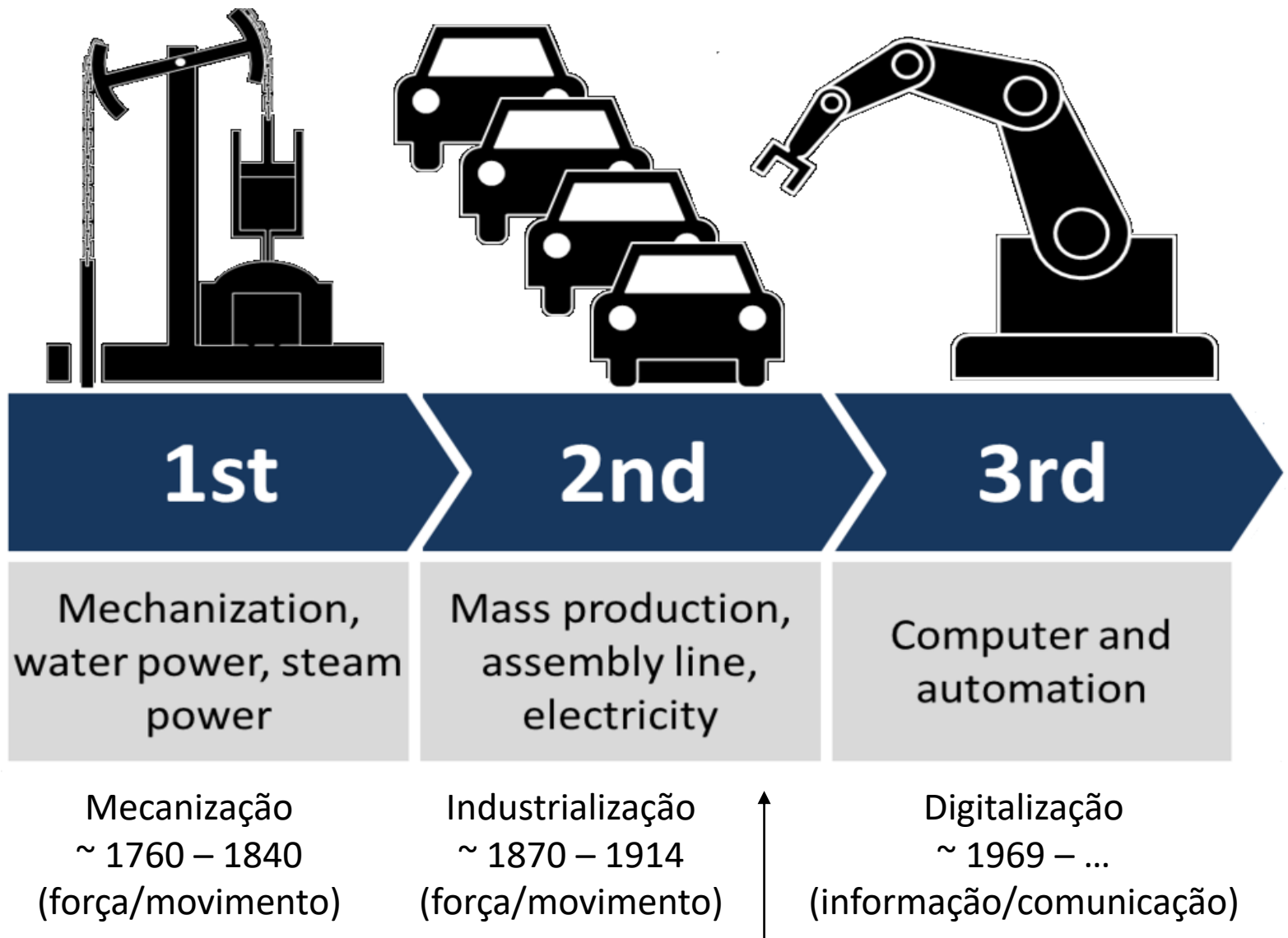
TABLE II.1. Condensed summary of the Kondratiev waves

Constellation of technical and organizational innovations	Examples of highly visible, technically successful, and profitable innovations	'Carrier' branch and other leading branches of the economy	Core input and other key inputs	Transport and communication infrastructure	Managerial and organizational changes	Approx. timing of the 'upswing' (boom)
(1)	(2)	(3)	(4)	(5)	(6)	'downswing' (crisis of adjustment) (7)
1. Water-powered mechanization of industry	Arkwright's Cromford mill (1771)	Cotton spinning Iron products Water wheels	Iron Raw cotton Coal	Canals Turnpike roads Sailing ships	Factory systems Entrepreneurs Partnerships	1780s–1815
	Henry Cort's 'puddling' process (1784)	Bleach				1815–1848
2. Steam-powered mechanization of industry and transport	Liverpool–Manchester Railway (1831)	Railways and railway equipment Steam engines	Iron Coal	Railways Telegraph Steam ships	Joint stock companies Subcontracting to responsible craft workers	1848–1873
	Brunel's 'Great Western' Atlantic steamship (1838)	Machine tools Alkali industry				1873–1895
3. Electrification of industry, transport, and the home	Carnegie's Bessemer steel rail plant (1875)	Electrical equipment Heavy engineering Heavy chemicals	Steel Copper Metal alloys	Steel railways Steel ships Telephone	Specialized professional management systems 'Taylorism'	1895–1918
	Edison's Pearl St. New York Electric Power Station (1882)	Steel products			Giant firms	1918–1940
4. Motorization of transport, civil economy, and war	Ford's Highland Park assembly line (1913)	Automobiles Trucks Tractors, tanks	Oil Gas Synthetic materials	Radio Motorways Airports Airlines	Mass production and consumption 'Fordism'	1941–1973
	Burton process for cracking heavy oil (1913)	Diesel engines Aircraft Refineries			Hierarchies	1973–
5. Computerization of entire economy	IBM 1401 and 360 series (1960s) Intel microprocessor (1972)	Computers Software Telecommunication equipment Biotechnology	'Chips' (integrated circuits)	'Information Highways' (Internet)	Networks; internal, local, and global	??

ONDE ESTAMOS

A Infraestrutura - As inovações base

A 3ª Revolução industrial



Onde estamos

Fase 1: A era das TIC - Digitalização (Y2K Bug)

Computador
Comunicações
Telemóvel



Internet
World Wide Web
Aplicações Informáticas

Onde estamos

Fase 1: A era das TIC - Digitalização

Global IP Traffic & Service Adoption Drivers

By 2019:



More Internet Users



2014	2019
2.8 Billion	3.9 Billion

More Devices & Connections



2014	2019
14.2 Billion	24.4 Billion

Faster Broadband Speeds



2014	2019
20.3 Mbps	42.5 Mbps

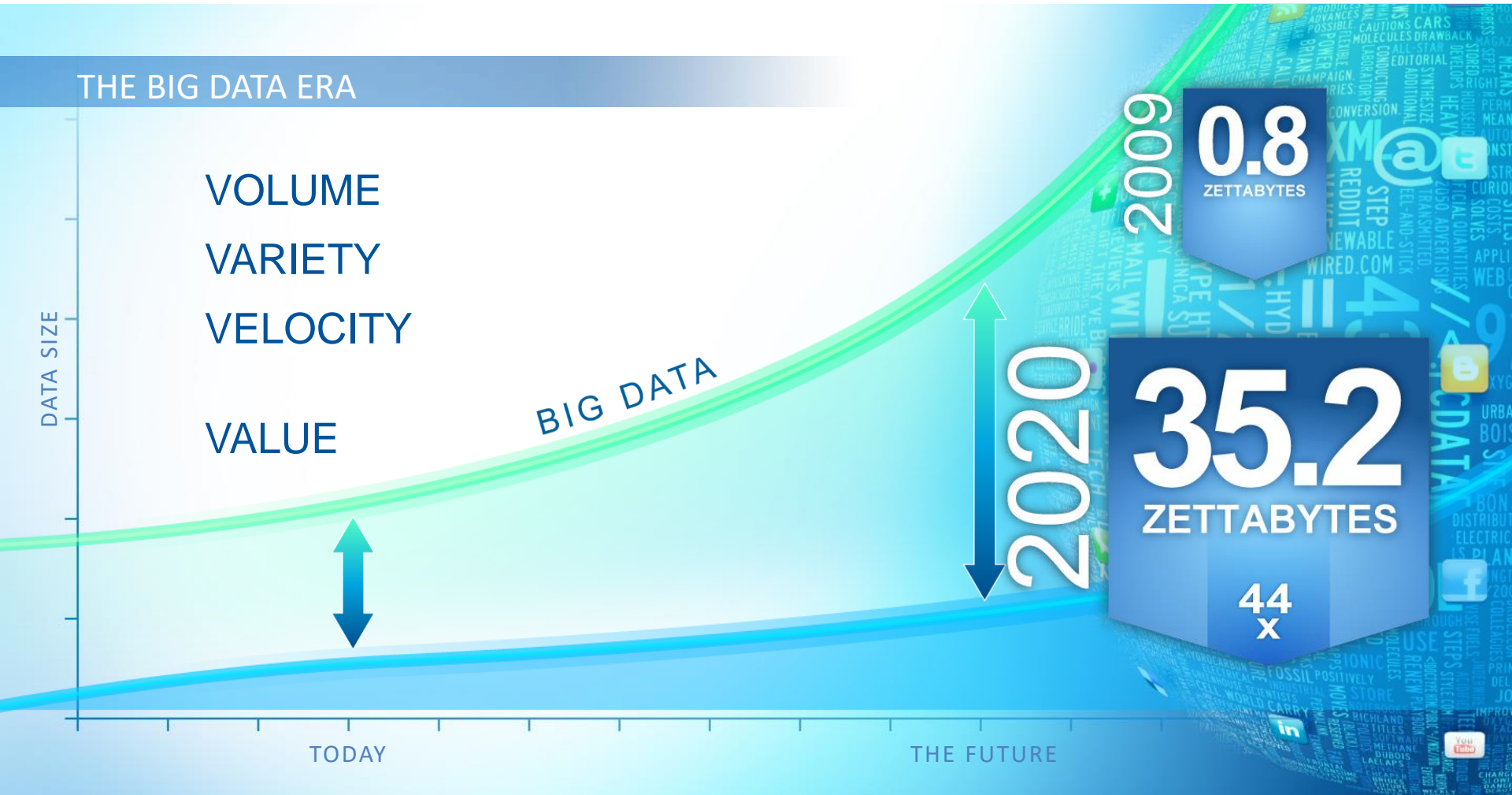
More Video Viewing



2014	2019
67% of Traffic	80% of Traffic

Onde estamos

Fase 2: "Big Data & Analytics"



Onde estamos

Fase 2: “Big Data & Analytics”

- “One Out of Two in Internet ”

Internet World Stats (2016); <http://www.internetworldstats.com/>

- “We create as much information in two days now as we did from the dawn of man through 2003.”

Eric Schmidt at Techonomy (2010); <http://techcrunch.com/2010/08/04/schmidt-data/>

- “Every day, we create 2.5 quintillion (Eb) bytes of data”

IBM (2013); <http://www-01.ibm.com/software/data/bigdata/what-is-big-data.html>

- “A full 90% of all the data in the world has been generated over the last two years.”

SINTEF (2013); <http://www.sintef.no/home/Press-Room/Research-News/Big-Data--for-better-or-worse/>

- “From now until 2020, the digital universe will about double every two years.”

IDC (2012); <http://www.emc.com/collateral/analyst-reports/idc-the-digital-universe-in-2020.pdf>

Onde estamos

Fase 2: “Big Data & Analytics”

The second economy

W. Brian Arthur

Digitization is creating a second economy that's vast, automatic, and invisible—thereby bringing the biggest change since the Industrial Revolution.

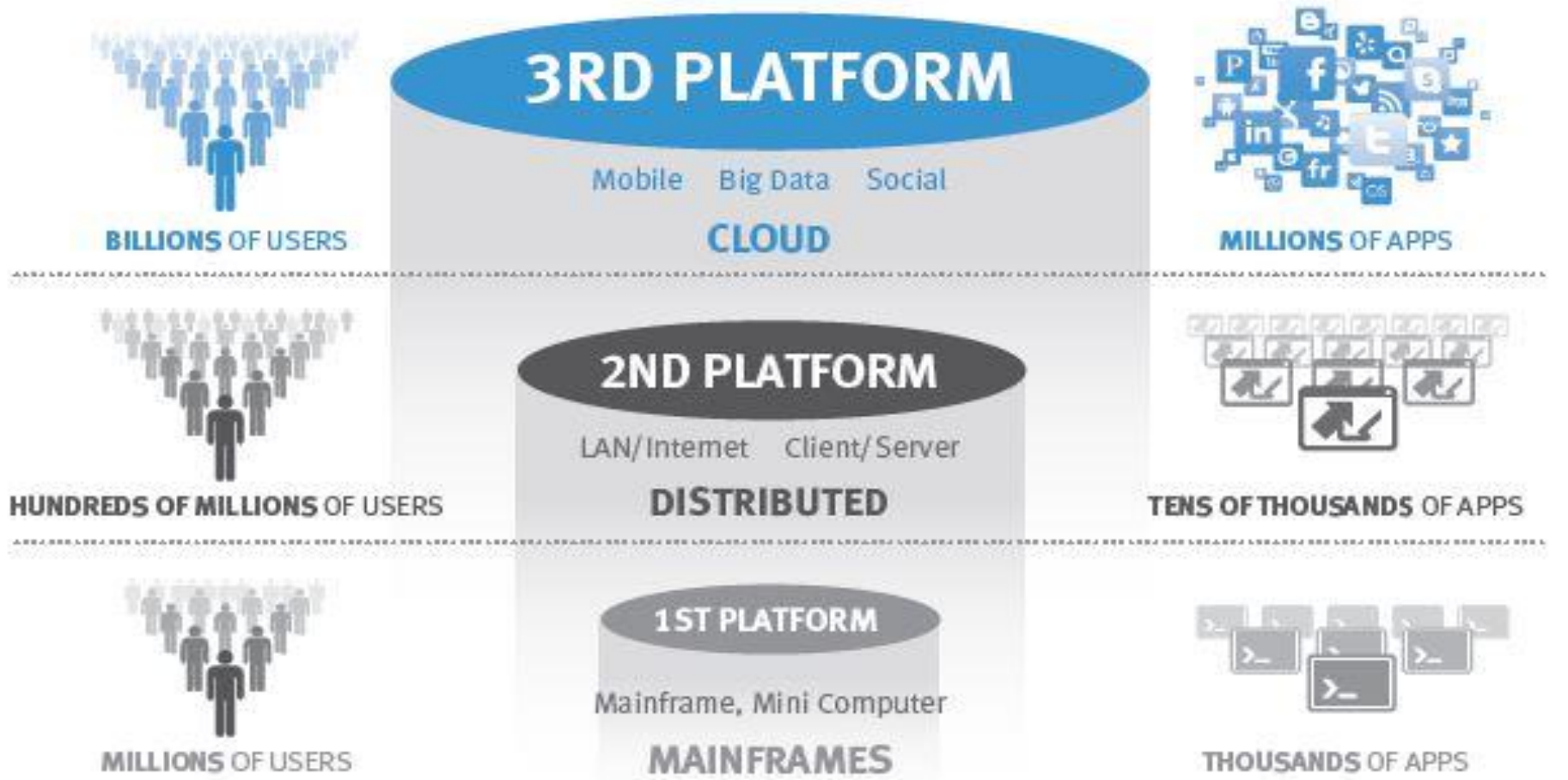
Onde estamos

Fase 3: A 3ª plataforma de TIC



THE THIRD PLATFORM

The Third Platform is described by IDC as the next-generation compute platform that is accessed from mobile devices, utilizes Big Data, and is cloud based.



Onde estamos

Fase 4: Internet das Coisas e Aceleradores

Low cost processors
and sensors

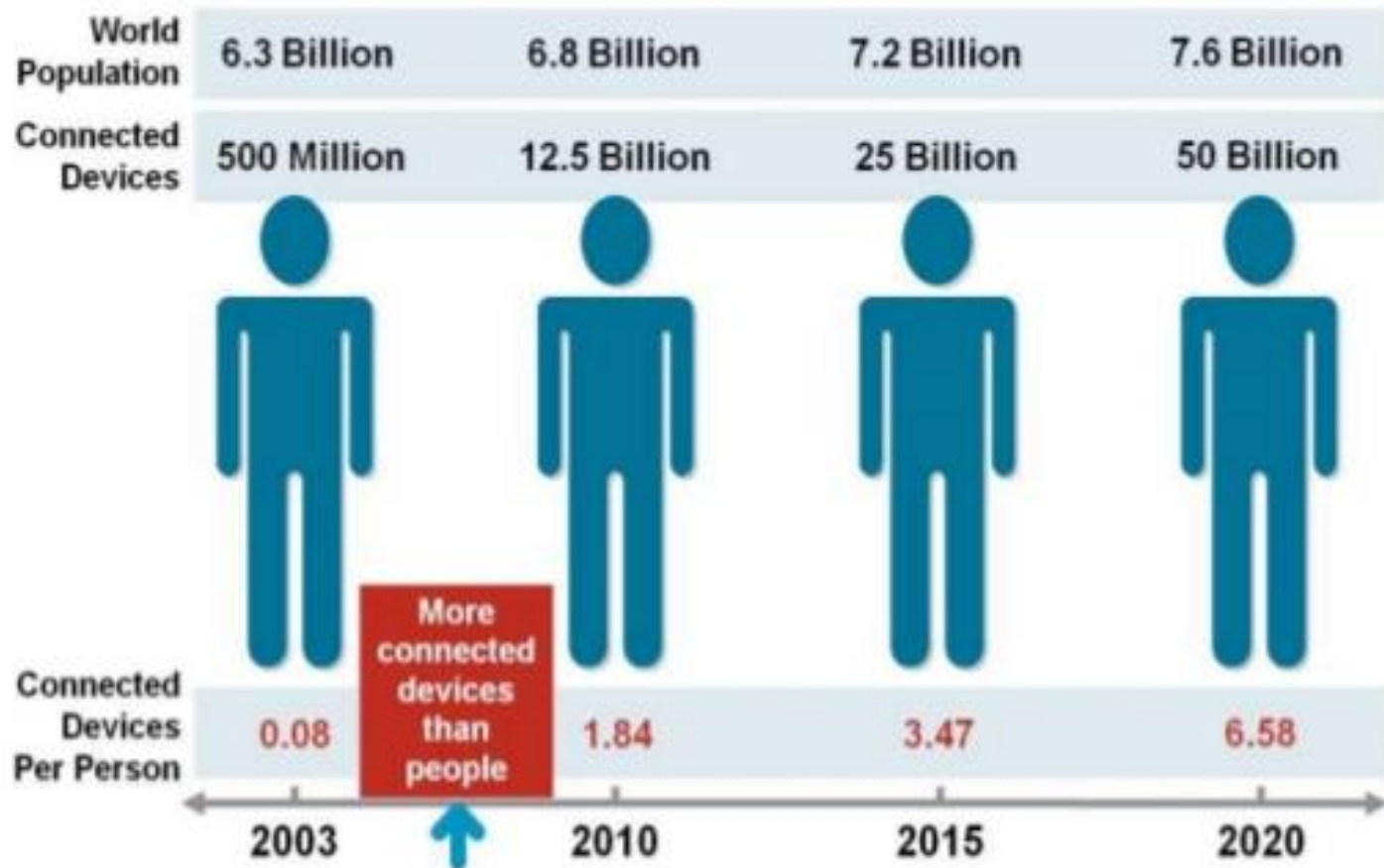
Low cost
communications



Onde estamos

Fase 4: Internet das Coisas

ACCORDING TO ABI RESEARCH MORE THAN 30 BILLION DEVICES WILL BE WIRELESSLY CONNECTED TO THE INTERNET BY 2020.



Onde estamos

Fase 4: Internet das Coisas

- “Since 2013, 650 million new physical objects have come online; ... 10 percent of automobiles became connected; ... In 2015, all of these things will double again.”

Gartner (2014) <http://www.gartner.com/newsroom/id/2865519>

- “The number of mobile-connected devices exceeded the world’s population in 2014” (1.5 in 2019)

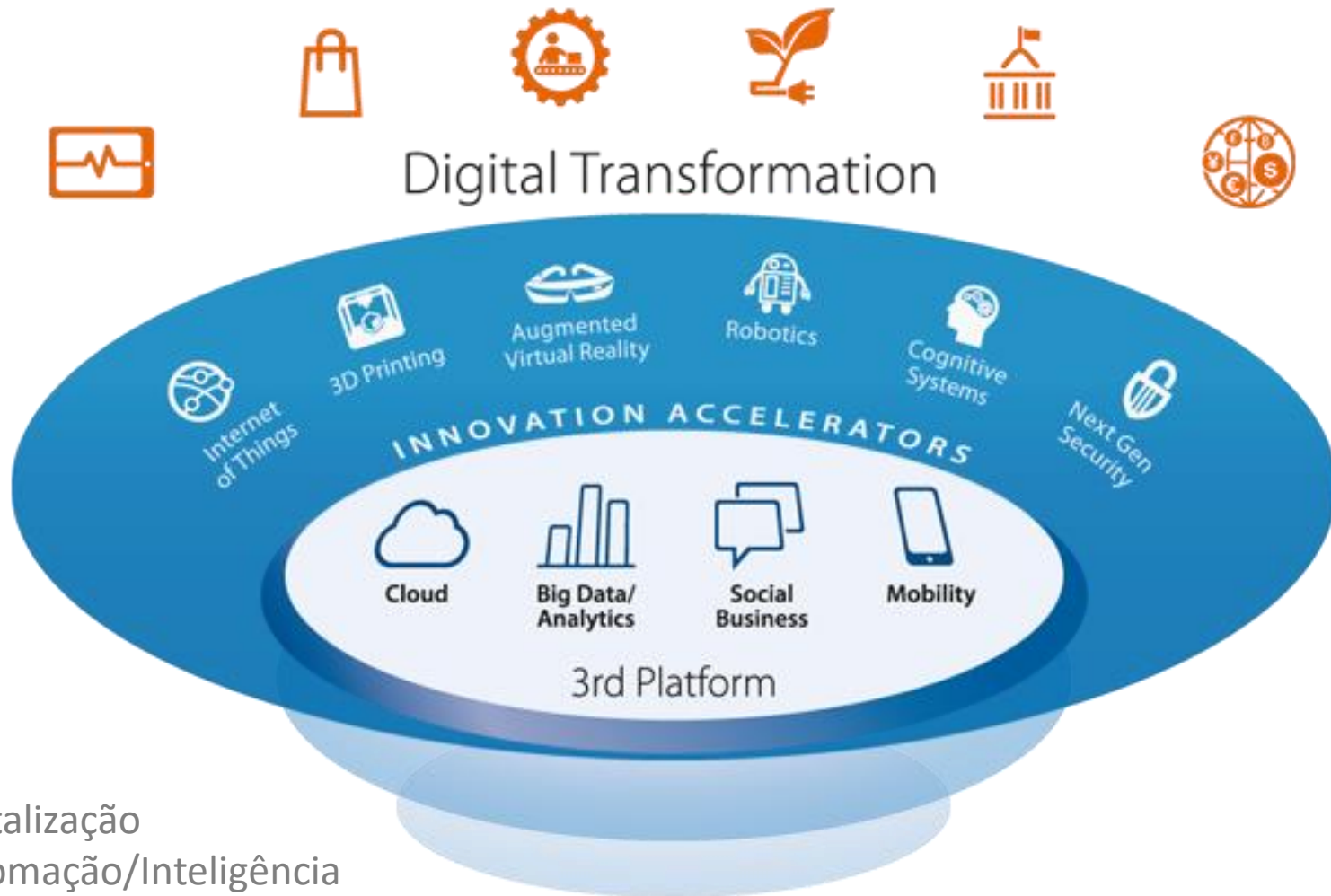
Cisco (2013); http://www.cisco.com/c/en/us/solutions/collateral/service-provider/visual-networking-index-vni/white_paper_c11-520862.html

- “In 2013, connected “things” were 7% of the total. By 2020, that will grow to 15%”

EMC (2014); <http://www.emc.com/collateral/analyst-reports/idc-digital-universe-2014.pdf>

Onde estamos

Fase 4: Os aceleradores (interfaces)



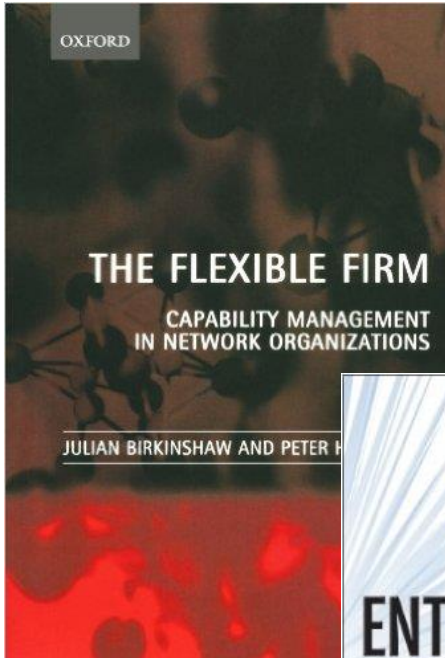
- Digitalização
- Automação/Inteligência
- Interfaces físico/digital

O QUE ESTAMOS A FAZER

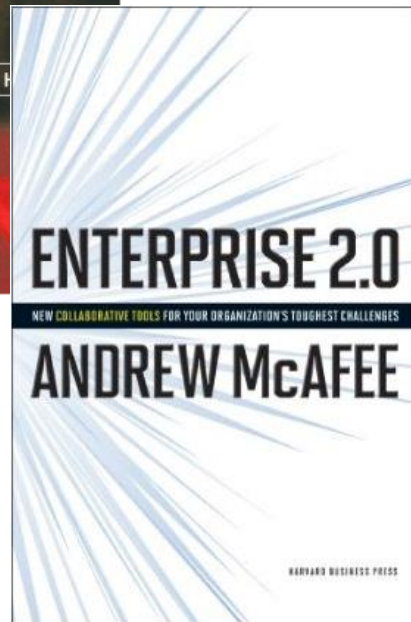
A estrutura - ligando as peças

O que estamos a fazer

Fase 5: Empresa 2.0



Network-like organizational forms that firms are adopting to make themselves more flexible and responsive to changing technologies and customer demands



Enterprise 2.0 is the use of emergent social software platforms within companies, or between companies and their partners or customers

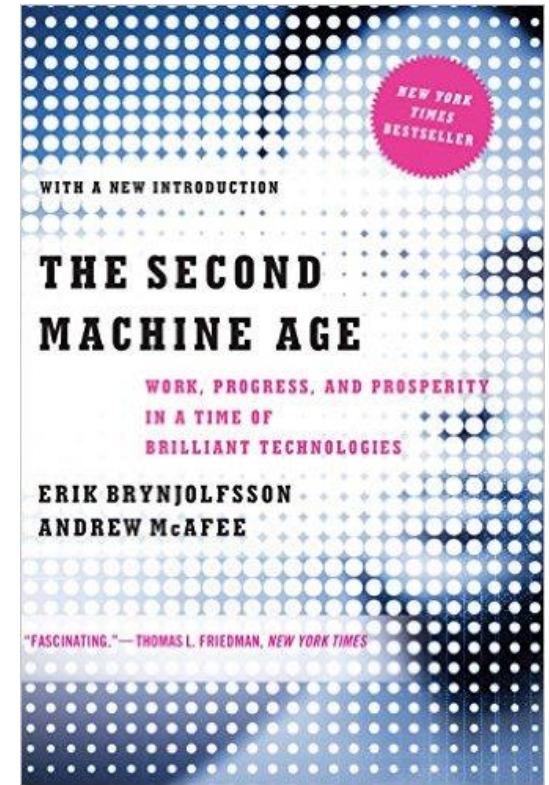
- *Group editing*
- *Authoring*
- *Broadcast Search*
- *Collective Intelligence*
- *Self-organization*

The Flexible Firm – Birkinshaw, Hagstrom (2010)

Enterprise 2.0: The Dawn of Emergent Collaboration – McAfee (2009)

O que estamos a fazer

Fase 5: Máquina 2.0, iterativa e autónoma



Useless robot waiters fired for incompetence in China

The Telegraph, April 2016

Sophia, the first robot to be granted citizenship

Independent, October 2017

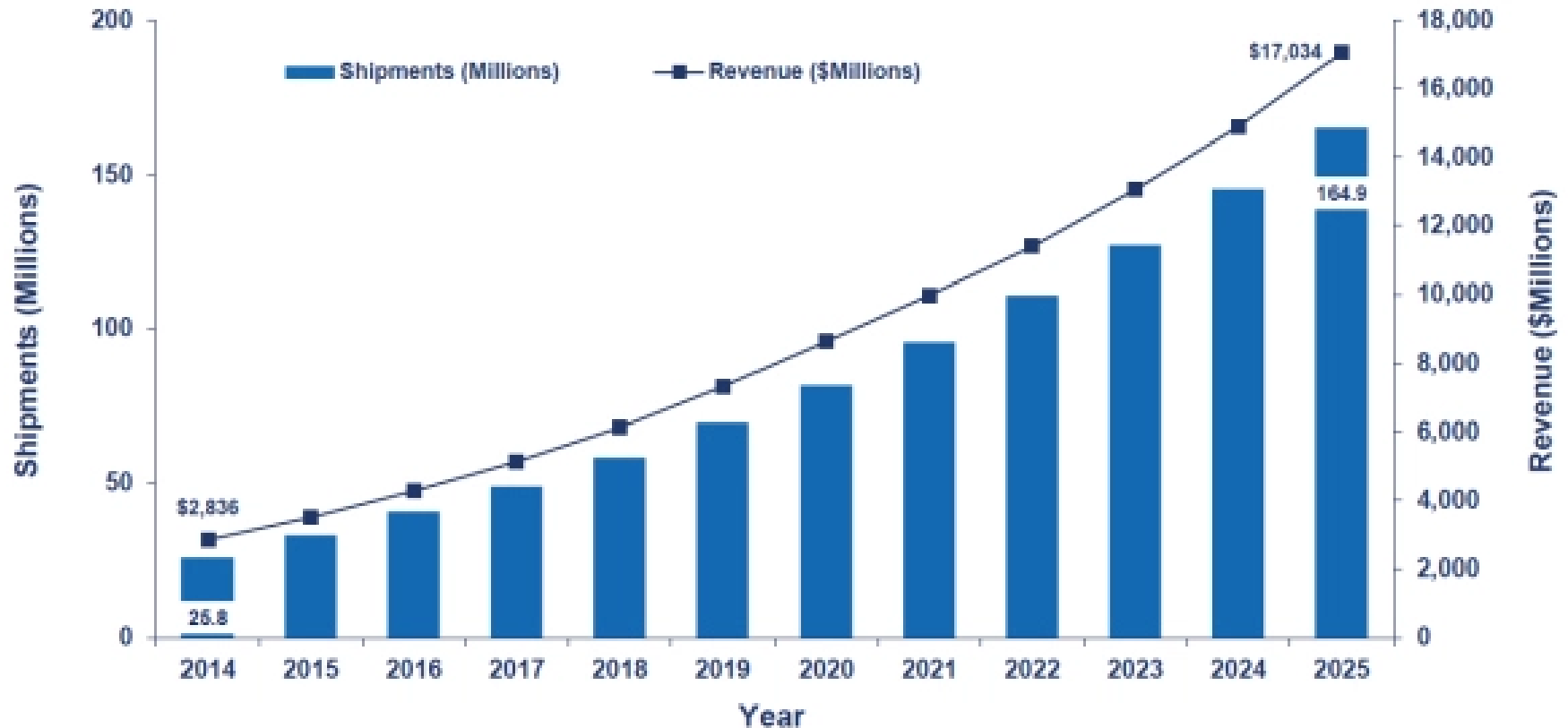


O que estamos a fazer

Fase 5: Máquina 2.0, iterativa e autónoma

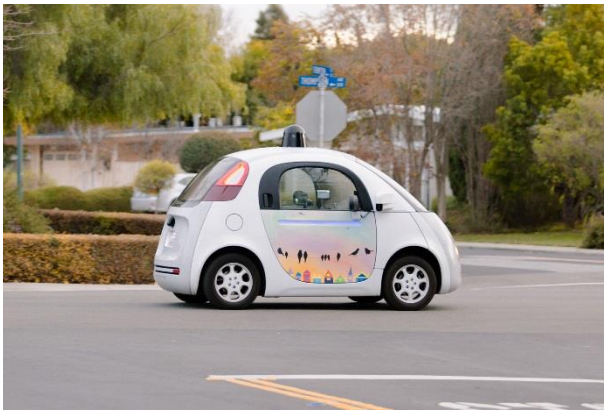
Figure 12: Worldwide Consumer Robotics Product Shipments and Revenue

(Source: ABI Research)



O que estamos a fazer

Fase 5: Dispositivos 2.0, ligados ao mundo



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O que estamos a fazer

Fase 5: Dispositivos 2.0, ligados ao mundo

Harvard
Business
Review



MANAGING ORGANIZATIONS

How Smart, Connected Products Are Transforming Companies

by Michael E. Porter and James E. Heppelmann

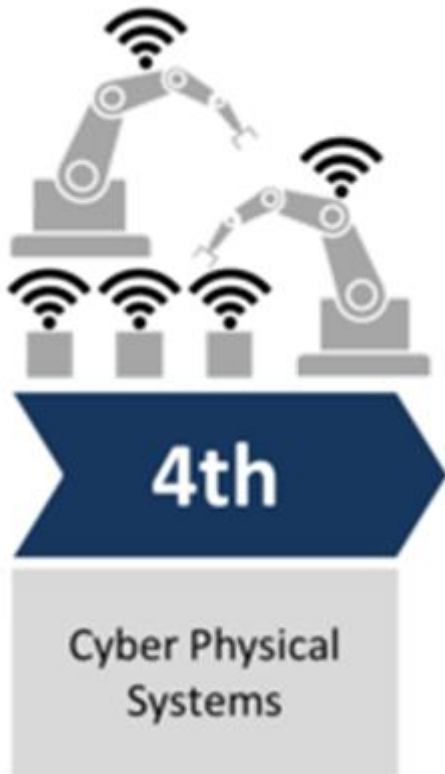
FROM THE OCTOBER 2015 ISSUE

“How the nature of smart, connected products substantially changes the work of virtually every function within the manufacturing firm. The core functions - product development, IT, manufacturing, logistics, marketing, sales, and after-sale service - are being redefined, and the intensity of coordination among them is increasing. Entirely new functions are emerging, including those to manage the staggering quantities of data now available”

**Harvard
Business
Review**

O que estamos a fazer

Fase 5: Industria 4.0



Industry 4.0 - Digitalization of Manufacturing
The transformations in design, manufacture, operation and service of manufacturing systems and products

- *Aplicação TIC: digitalização, internet, cloud, IA*
- *Sistemas ciber-físicos: IoT, robots, drones*
- *Automação: CAD, ERP, BPM (desenho, operação, monitorização)*

Industry Internet of Things
Smart Factories
Digital Value Chain Integration

Industry 4.0

Digitalisation for productivity and growth

EPRS | European Parliamentary Research Service

Author: Ron Davies

September 2015

O que estamos a fazer

Fase 5: Industria 4.0

What is new? The way in which the IoT promises to take smart factory automation to a whole new level by intelligently connecting all phases of the product life cycle, from sourcing to delivery and right into the customer's home.

To make a new kind of shoe, adidas had to change everything

adidas's South Asian factories churn out 720 million shoes a year, but production is slow and inflexible. In Bavaria, robots can make every pair unique. Welcome to the Speedfactory

WIRED

By ROWLAND
MANTHORPE

—
Wednesday 4 October 2017

O que estamos a fazer

Fase 5: Cidades Inteligentes



European Innovation Partnership on Smart Cities and Communities
ROADMAP 2016
Supporting European Smart Cities

What?

To overcome market fragmentation and achieve scale in building a market for smart city innovations

-  Quality of life
-  Business
-  Job creation
-  Low carbon
-  Sustainability

How?

 Public partners +  Private partners →  Co-creating +  Sharing risk

Who?

At least **100** cities to collaborate on bundling demand,
100 industries cooperate and develop solutions

-  **100** cities
-  **100** industry partners
- with the support of:**
-  Governments
-  Civil society
-  Academia

O IMPACTO DA 4ª RI

O que muda

O impacto da 4ª RI

Conetividade, Tempo-real, Integração Físico-Digital, IA



O impacto da 4ª RI

Desmaterialização e Desintermediação



Digitalização de produtos e serviços

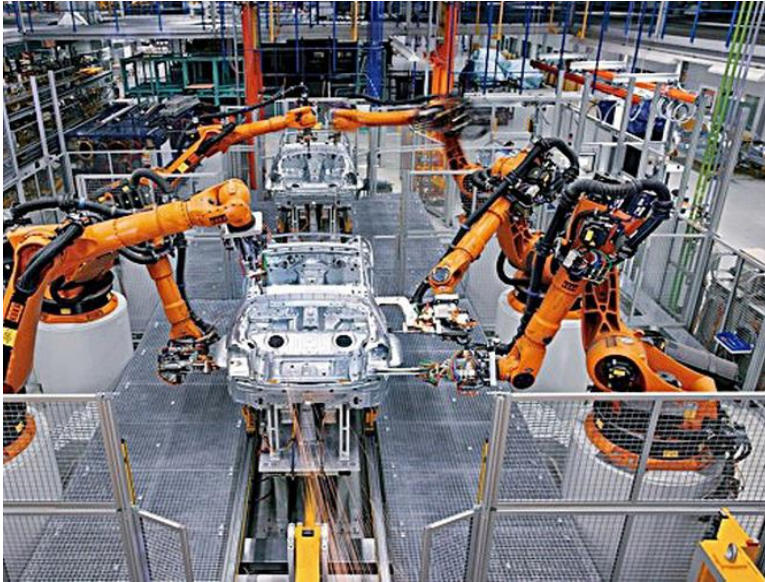
Desintermediação da cadeia de valor

O impacto da 4ª RI

Automação e Personalização

Redução custos, eficiência recursos

“No humans allowed”



O impacto da 4ª RI

Novos modelos de negócio (plataformas digitais)



UBER



airbnb

eCooltra

citydrive



threadless



coursera



KHAN
ACADEMY



fintech



bitcoin

You Tube

NETFLIX

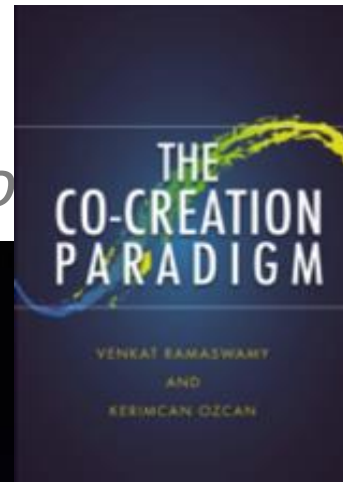
Plataformas

Social

Colaboração e cocriação

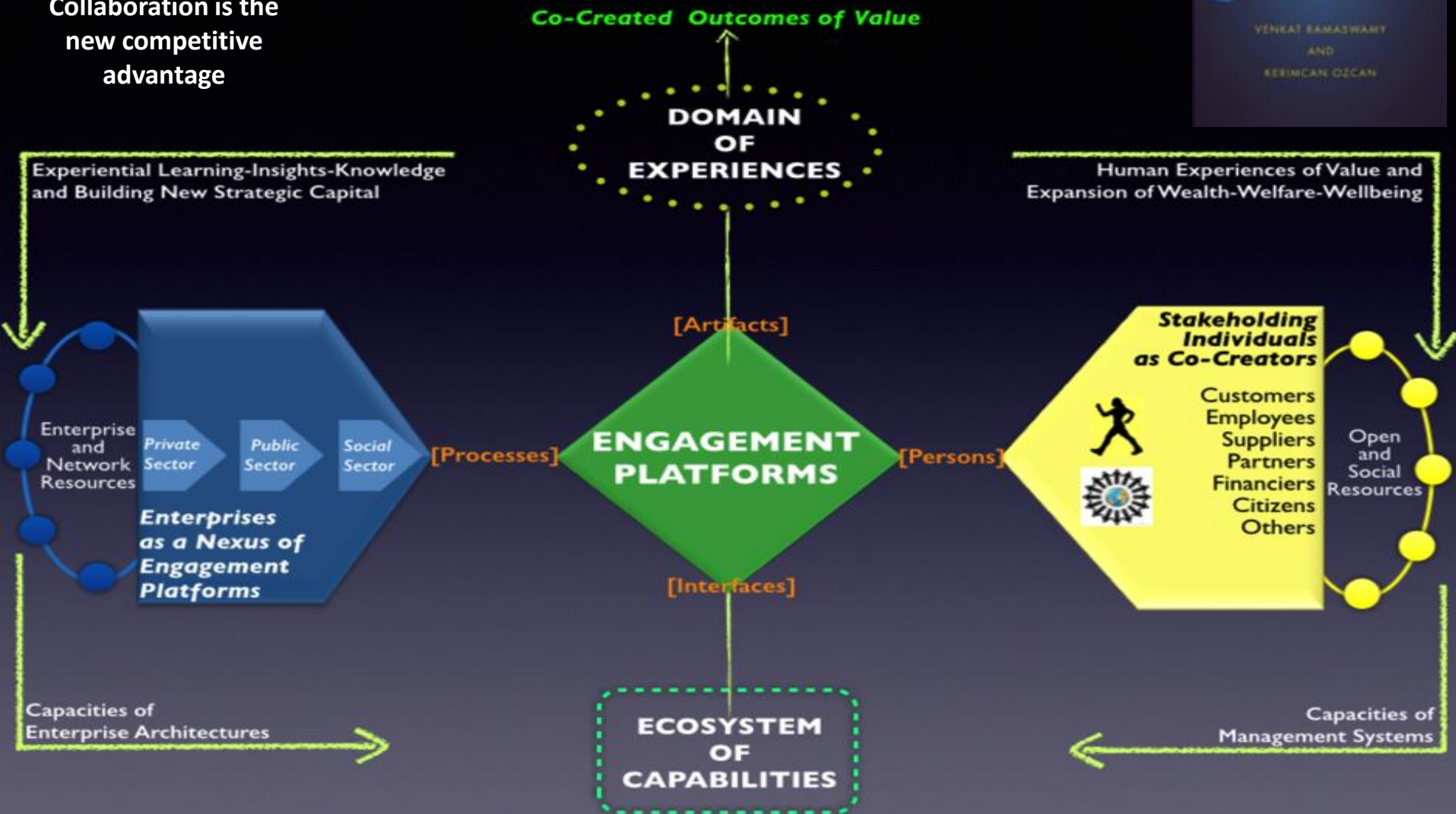
O impacto da 4ª RI

Plataformas de Colaboração e Cocriação



The Co-Creation Paradigm of Value Creation

Collaboration is the new competitive advantage



O valor da 4ª RI

Valor (triliões!)

IoT Market Size

(by 2025)

McKinsey&Company

\$6.1T



\$7.1T



CISCO

\$14.4T

Connected Devices

(by 2020)

Gartner

26B



32B



CISCO

50B

Data Growth

(2013 vs 2020)



Total Data

4.4ZB → 44.4ZB

10x

IoT Data

.09ZB → 4.4ZB

49x

O valor da 4ª RI

Valor (Industria 4.0)

- Industry 4.0 can deliver estimated annual efficiency gains in manufacturing of between 6% and 8%
- The Boston Consulting Group predicts that in Germany alone, Industry 4.0 will contribute 1% per year to GDP over ten years, creating up to 390 000 jobs
- Globally, the Industrial Internet will grow from US\$20 billion in 2012 to more than US\$500 billion in 2020, and that value added will surge from \$US23 billion in 2012 to US\$1.3 trillion in 2020
- The United States has established a National Network for Manufacturing Innovation with a proposed US\$1 billion of public funding
- Companies in the Asia/Pacific were expected to invest US\$10 billion in the Industrial IoT in 2012, with that figure rising to nearly US\$60 billion by 2020

Industry 4.0

Digitalisation for productivity and growth

EPRS | European Parliamentary Research Service

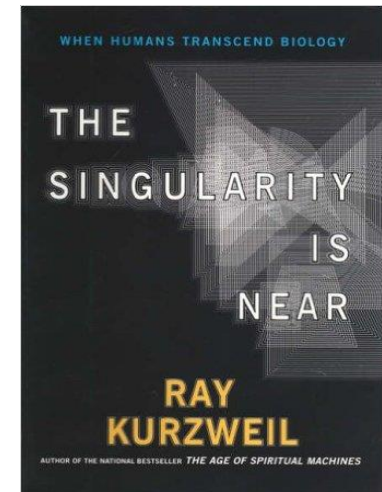
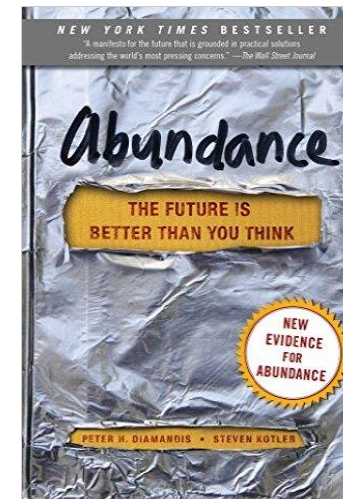
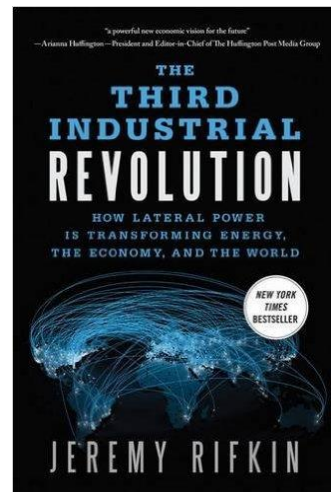
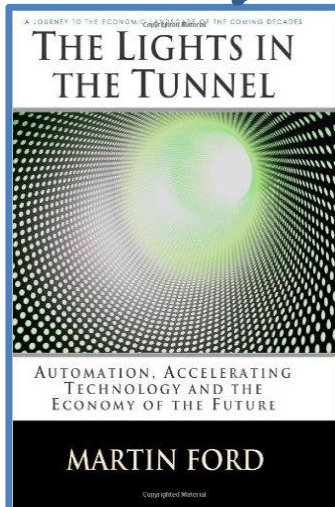
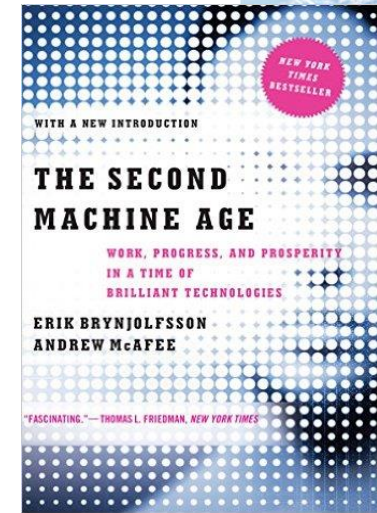
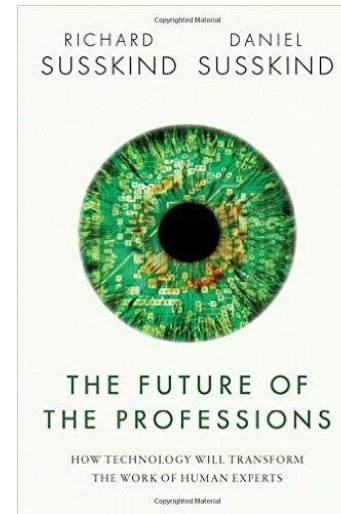
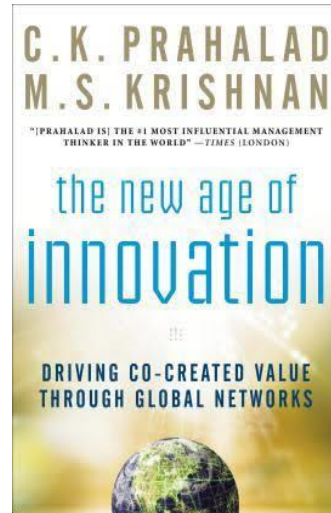
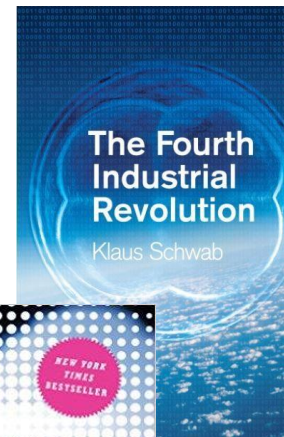
Author: Ron Davies

September 2015

O impacto e valor da 4ª RI

- Empresa
- Trabalho
- Educação
- Saúde
- Energia
- Liberdade

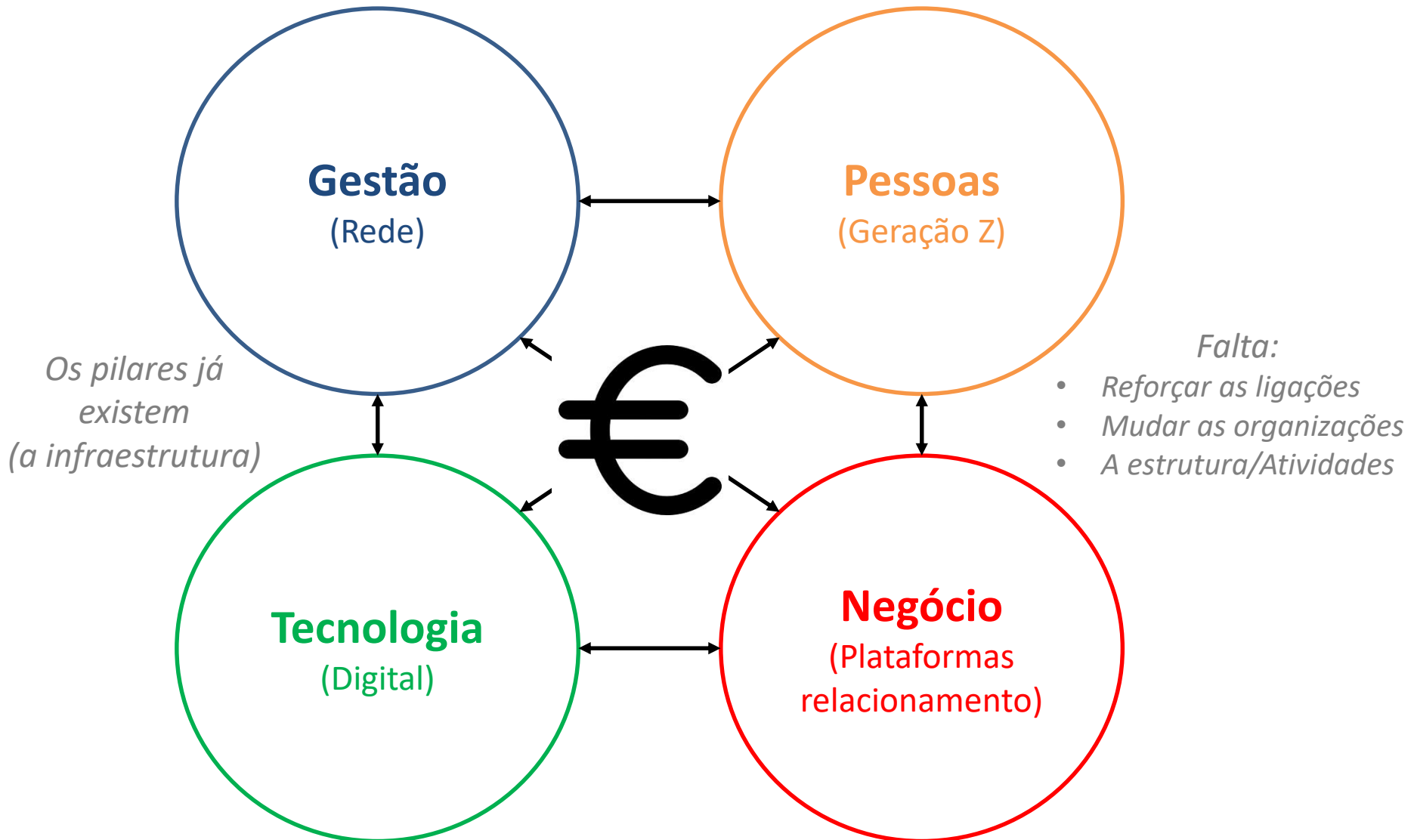
Ler



O QUE FALTA E OS PERIGOS

O que falta

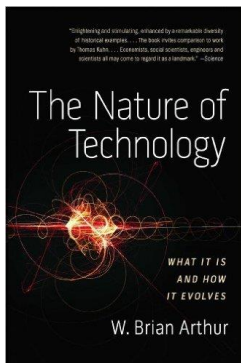
As ligações, investimento e mudança



O que falta

Maturação, difusão e adoção tecnológica (tempo!)

Gartner's 2015 Hype Cycle for Emerging Technologies Maps the Journey to Digital Business



Estamos prontos mas ... vai levar tempo (Abernathy e Utterback)!

O que falta

Standards - A guerra já começou



European
Commission

How will standards facilitate new production systems in the context of EU innovation and competitiveness in 2025? (2014)

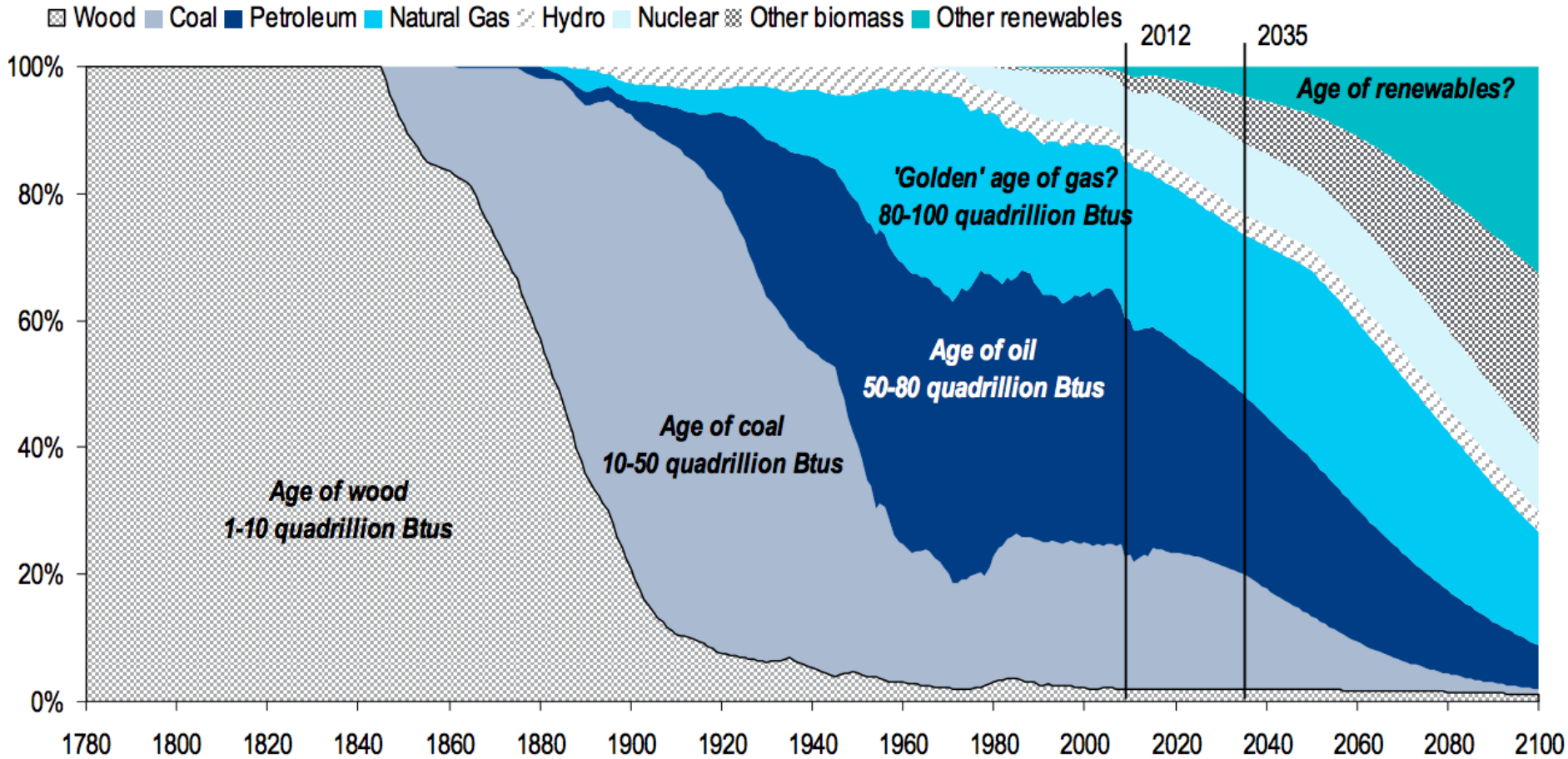
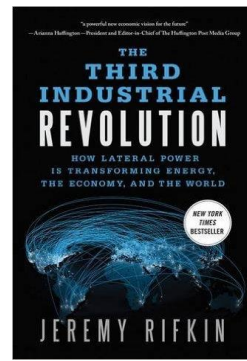
Digitising European Industry - Reaping the full benefits of a Digital Single Market (2016)

IoT SDOs and Alliances Landscape (Technology and Marketing Dimensions)



O que falta

Energia barata, muita!



O que falta

Legislação, Políticas e Economia

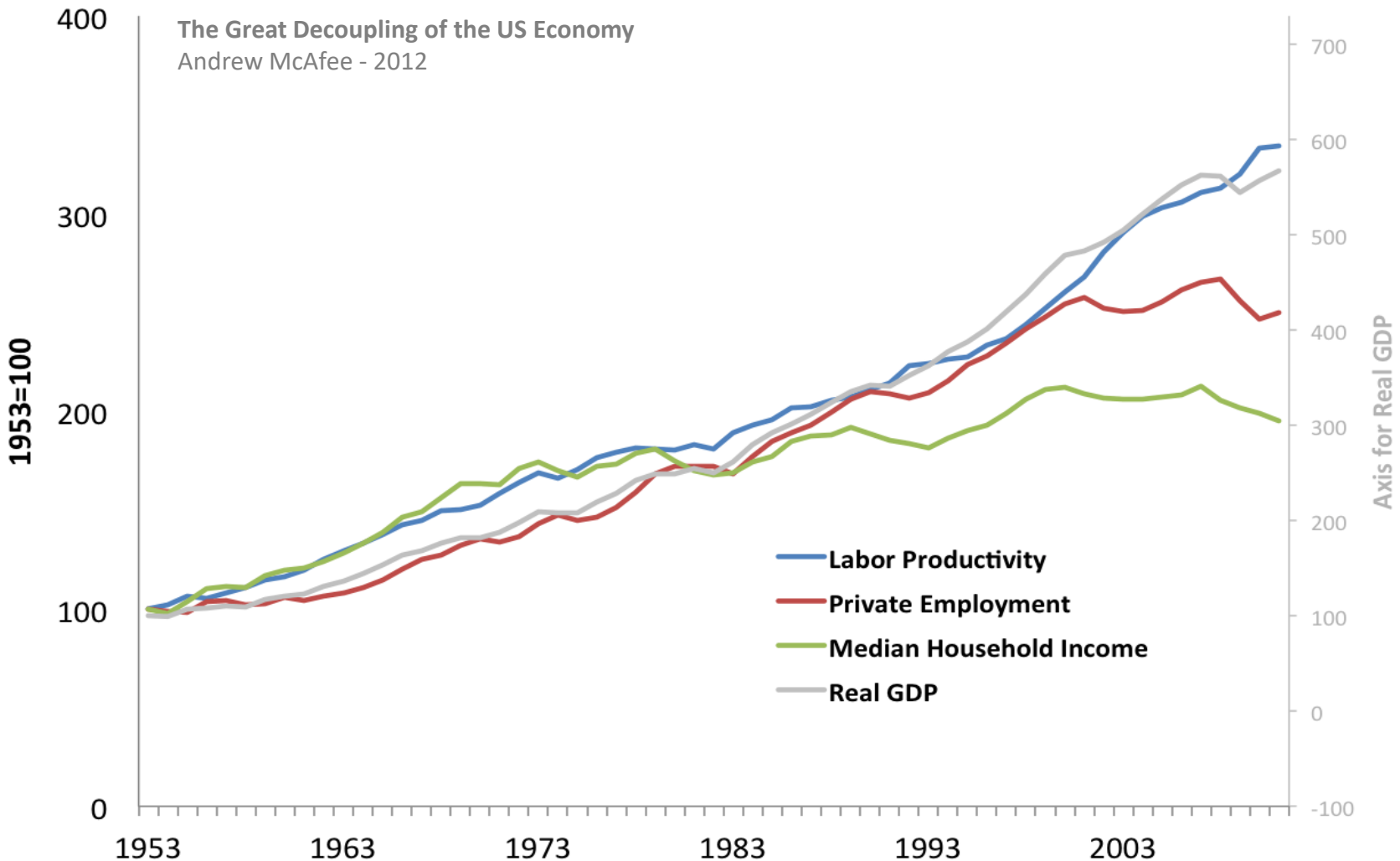
Legislação

- Segurança dos dados
- Proteção pessoal
- Supervisão
- Responsabilidade
- Propriedade intelectual
- Emprego e desenvolvimento pessoal
- Incentivos à indústria e indivíduos



O que falta

US Productivity, GDP, Employment, and Income: 1953-2011



O que falta

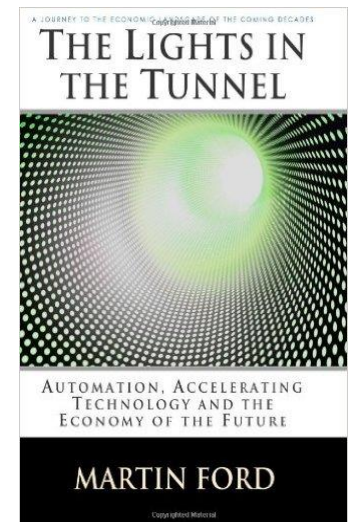
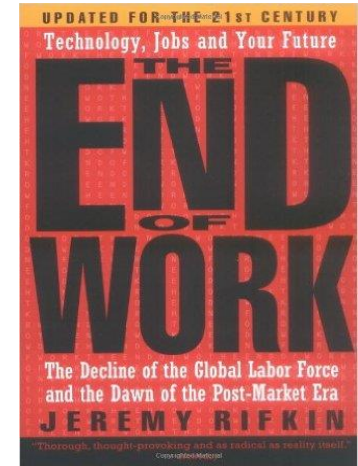
O fim do trabalho?

Cenário 1 – curto prazo

- As máquinas automatizam tarefas simples
- São eliminados muitos empregos
- O que fazer com os trabalhadores nesta situação?
- E com os jovens a entrar no mercado trabalho?

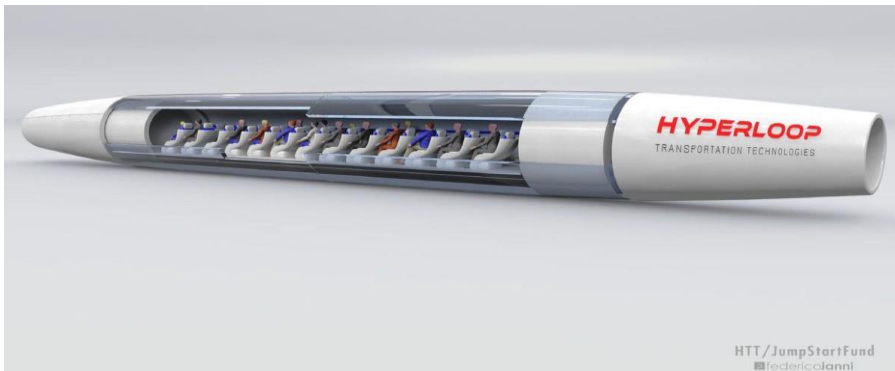
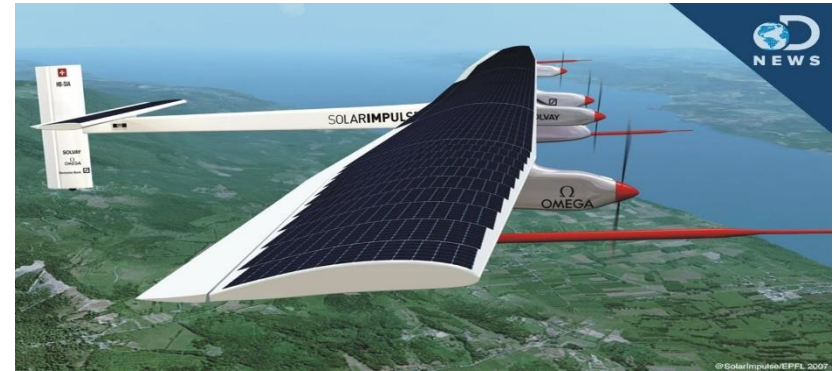
Cenário 2 – longo prazo

- A Indústria 4.0 elimina a maioria dos empregos
- O que fazer com o mercado do trabalho?
- Se não há trabalhadores, vai haver consumidores?
- O que fazer com a remuneração extra das empresas?
- Que economia para:
 - Desenvolver as pessoas
 - Distribuir riqueza e ajustar desigualdades
 - Criar infraestruturas e sistemas comuns
 - Desenvolver novo conhecimento e inovação



O que falta

Está tudo por fazer!



Os perigos

Desemprego



Recessão



Homem vs. Máquina



CONCLUSÕES

Conclusões

A 4ª Revolução Industrial

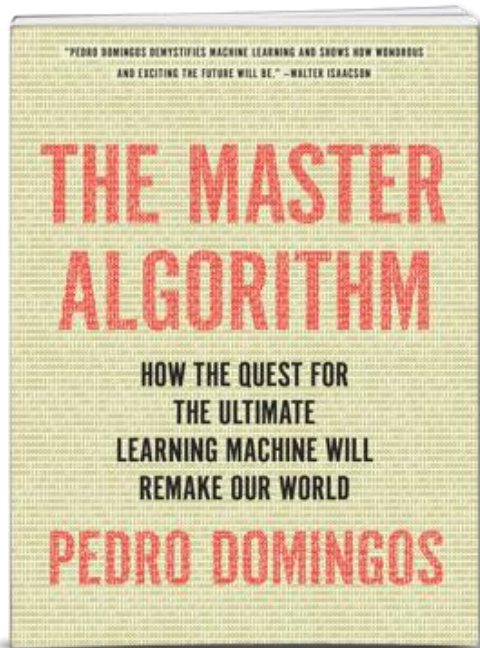
Construímos um “novo mundo” - digital

- Tudo tem um rasto digital
- Tudo tem “iteratividade” e está conectado
- Automação e “Inteligência Artificial”
- **Integração mundo físico e digital, homem e máquina**
- Aumento da **produtividade, crescimento**
- Precisamos de tempo, investimento e mudança processos
- **Relação trabalho vs consumo → Nova Economia?**

Estamos a construir as bases para:
a industria sem trabalhadores, o homem-cyborg?

A 4ª e/ou 5ª Revolução Industrial

Alguns investigadores Portugueses



Recomendo que vejam:

The Next Hundred Years of Your Life | Pedro Domingos | TEDxLA

https://www.youtube.com/watch?v=r2YiRiLAU_Y&t=363s



A 4ª Revolução Industrial



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