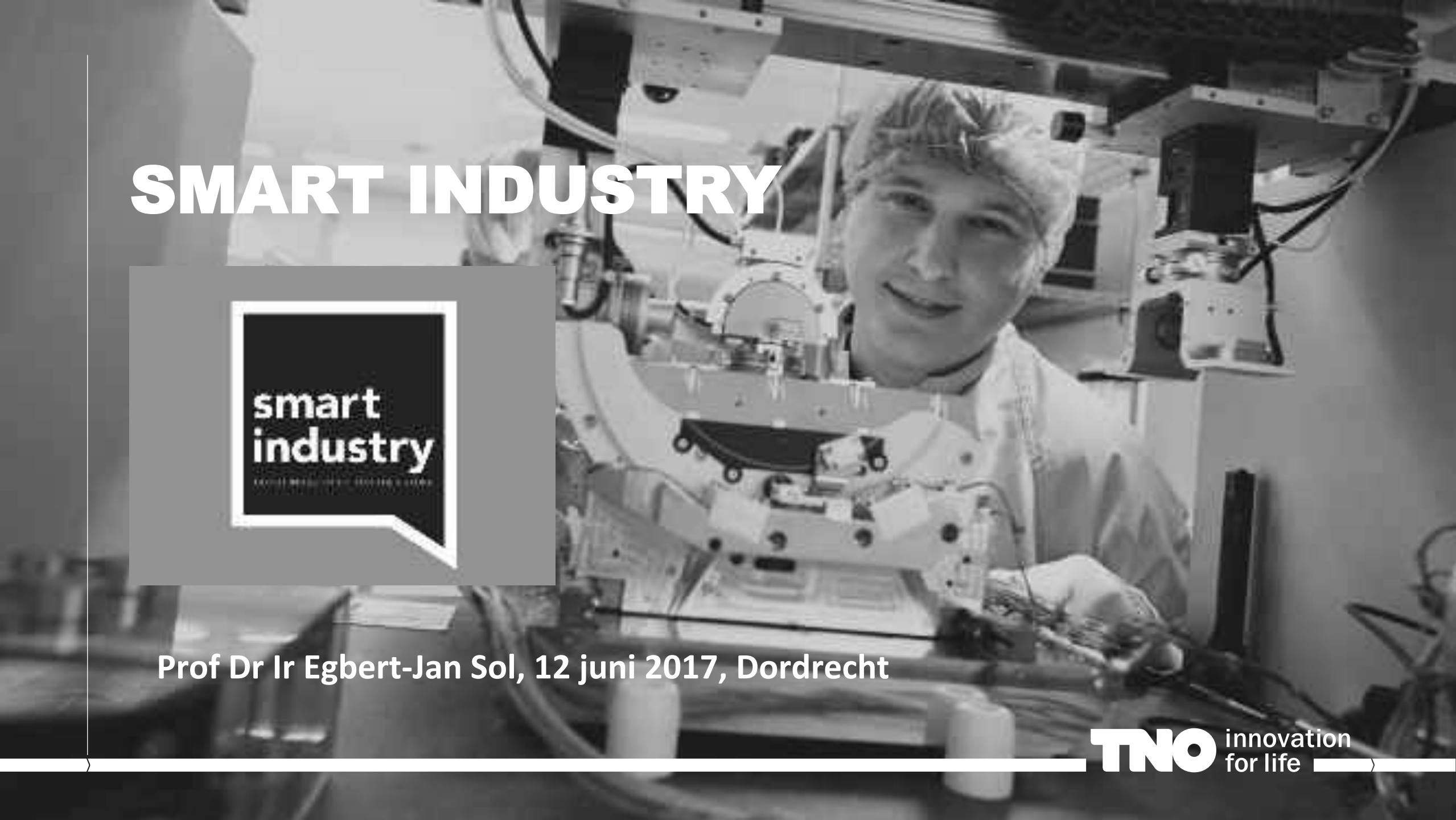
SMART INDUSTRY

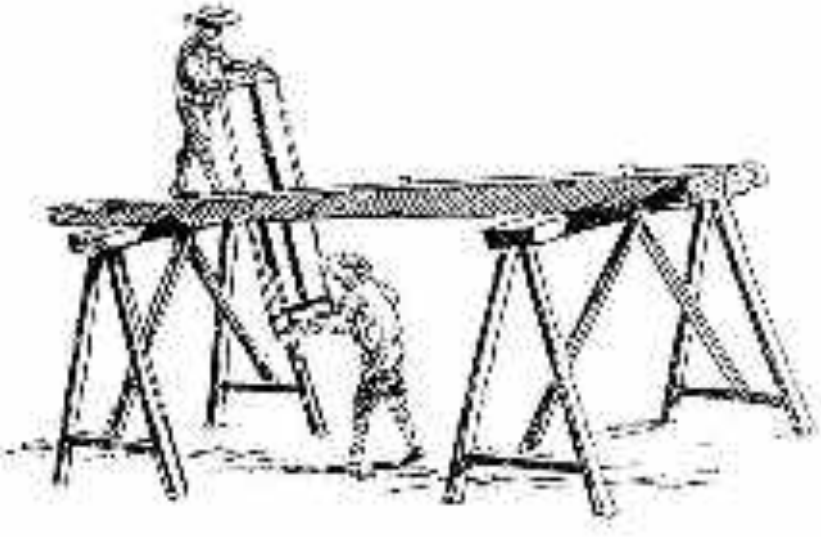


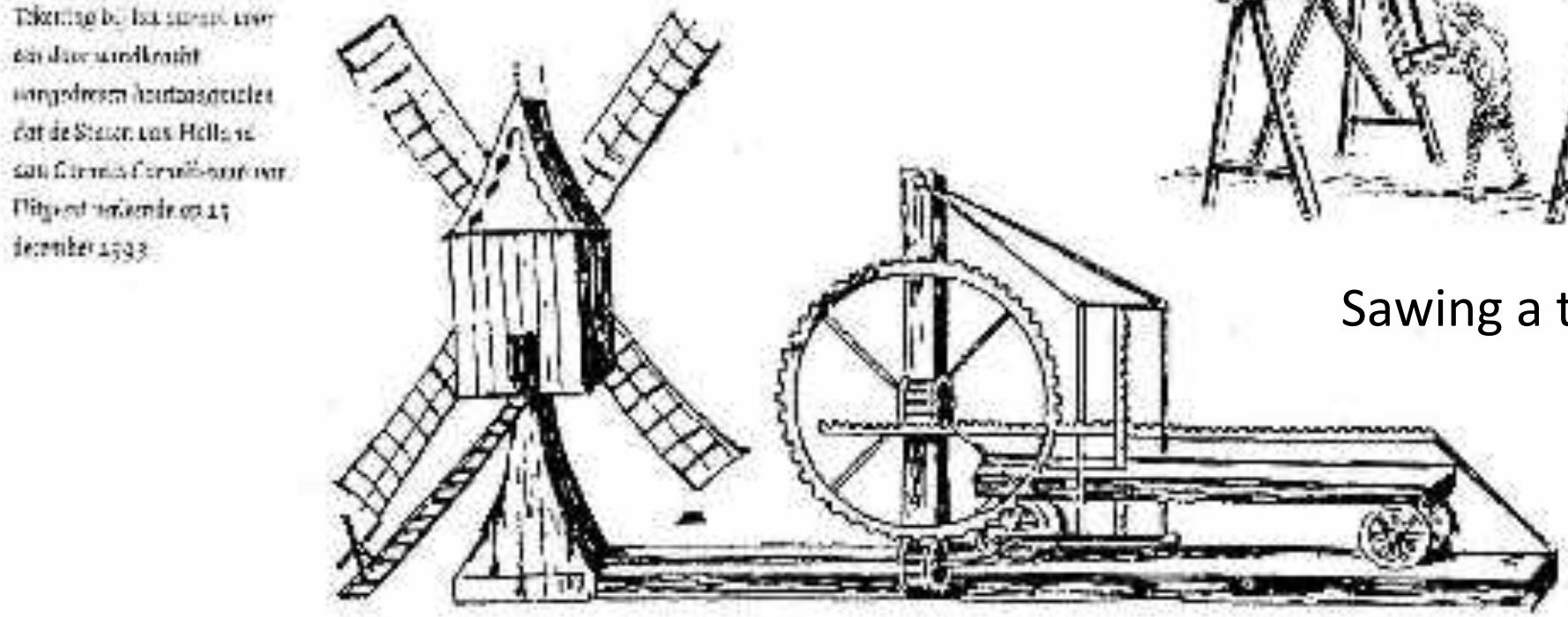
Prof Dr Ir Egbert-Jan Sol, 12 juni 2017, Dordrecht

TNO innovation for life

Cornelis Corneliszoon van Uitgeest

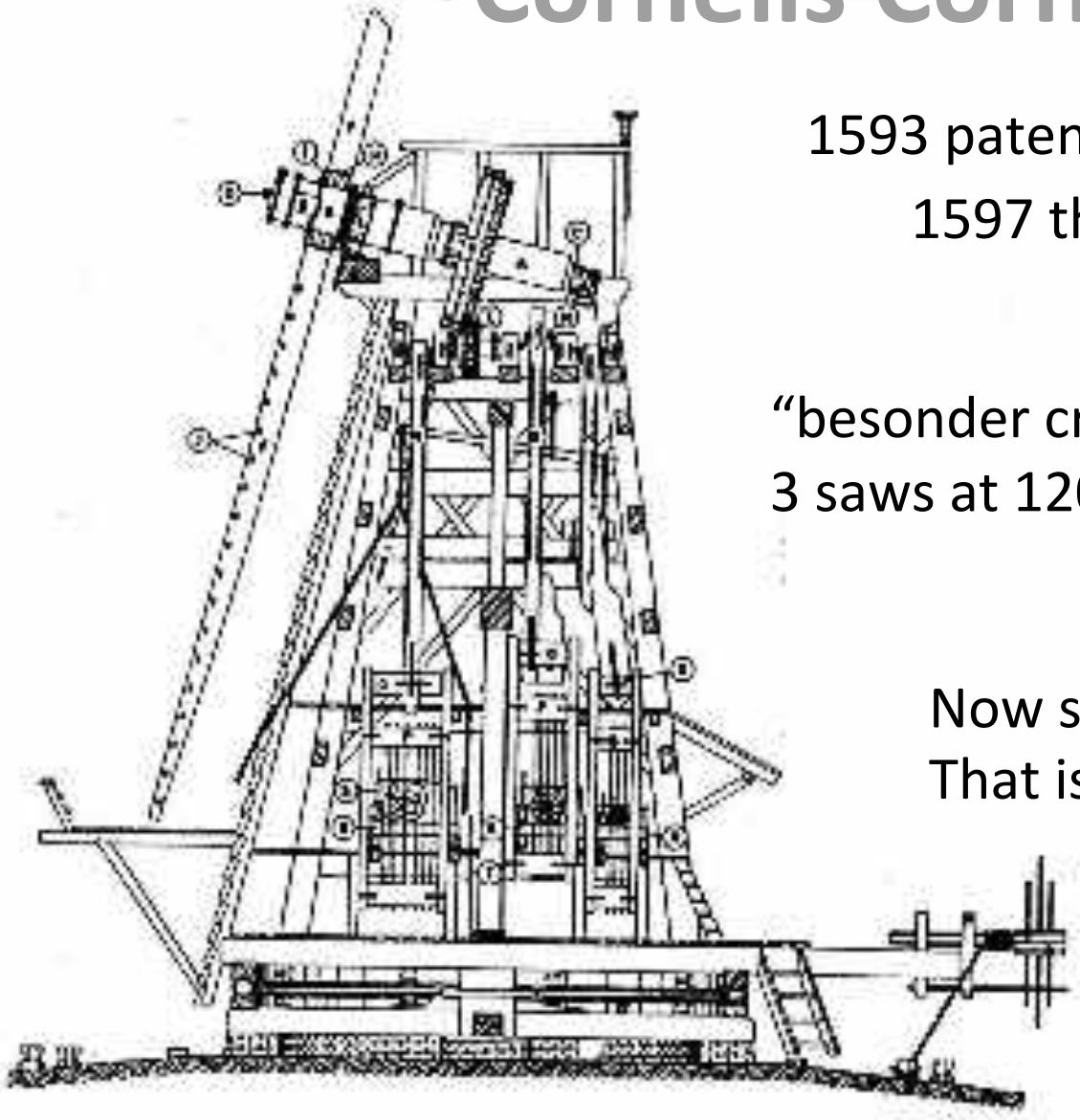
Inventor (1593) enabling Holland's Golden Age (1600-1750)





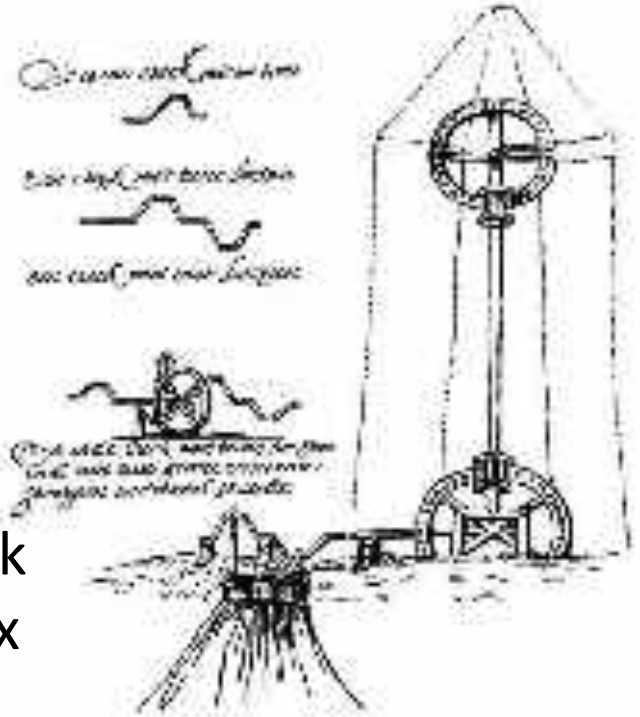
Sawing a tree took 2 men 30 weeks

Cornelis Corneliszoon van Uitgeest



1593 patent sawing mill – did not work

1597 the improved crankshaft



“besonder creckwerk”

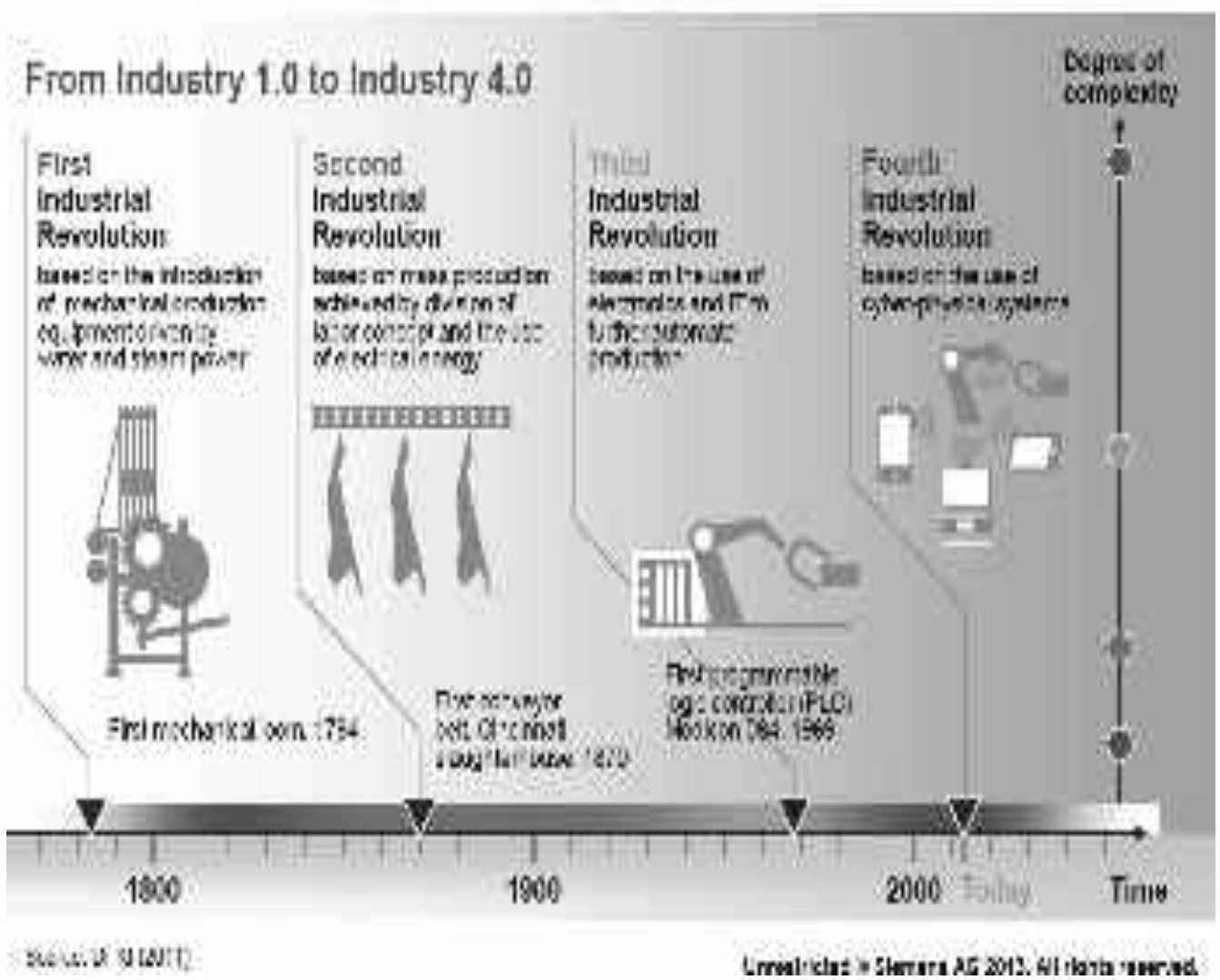
3 saws at 120^{o}

Now sawing a tree took 1 week

That is an improvement of 30 x

By 1670 the Dutch had more then 5000 windmills and world largest fleet

(Industrial) Jobs are changing faster



1600 Saw Mill
180 years, 6 generations

1780 Steam Engine
110 years, 4 generations

1890 Conveyor belt Mass prod.
70 years, 3 generations

1960 Mainframe, PLC, Robots
40 years, 1 generation

2000 Internet (of Things)
?? 25 years, < 1 generation

2025Servitization/Sustainability
Agile/Metropolitan Manuf.

Message: Continuous learning

Capabilities = Knowledge + Experiences + Skills

Δ Capabilities = Capabilities $_{year}$ - Cap. $_{year\ -\ 1}$

$$\textbf{L = Learning of Learning rate} = \frac{\Delta \text{ Cap.}}{\Delta \text{ Time}}$$

Job requires Capabilities

Changes in job requirements

$$\textbf{C = change rate of jobs} = \frac{\Delta\ (J_{year} - J_{year\ -\ 1})}{\Delta \text{ Time}}$$

L >> C

If jobs contents remains the same over years of even a whole working life C= 0

If you don't improve your capabilities (L = 0) and the jobs content evolves (L= 0, and C >0),

you ultimately will lose your job

e

Content

Introduction and main Message L>>C

Worsening the challenges or interesting times ahead towards 2031

- predictable baby-boom bubble consequences

- predicting (smart) products & servitisation

- predicting (smart) manufacturing -tomorrows factories

Implementing Smart Industry

fieldlabs for innovating and (life-long) learning

Conclusion

Never every in mankind: everyone's job changes completely within working life

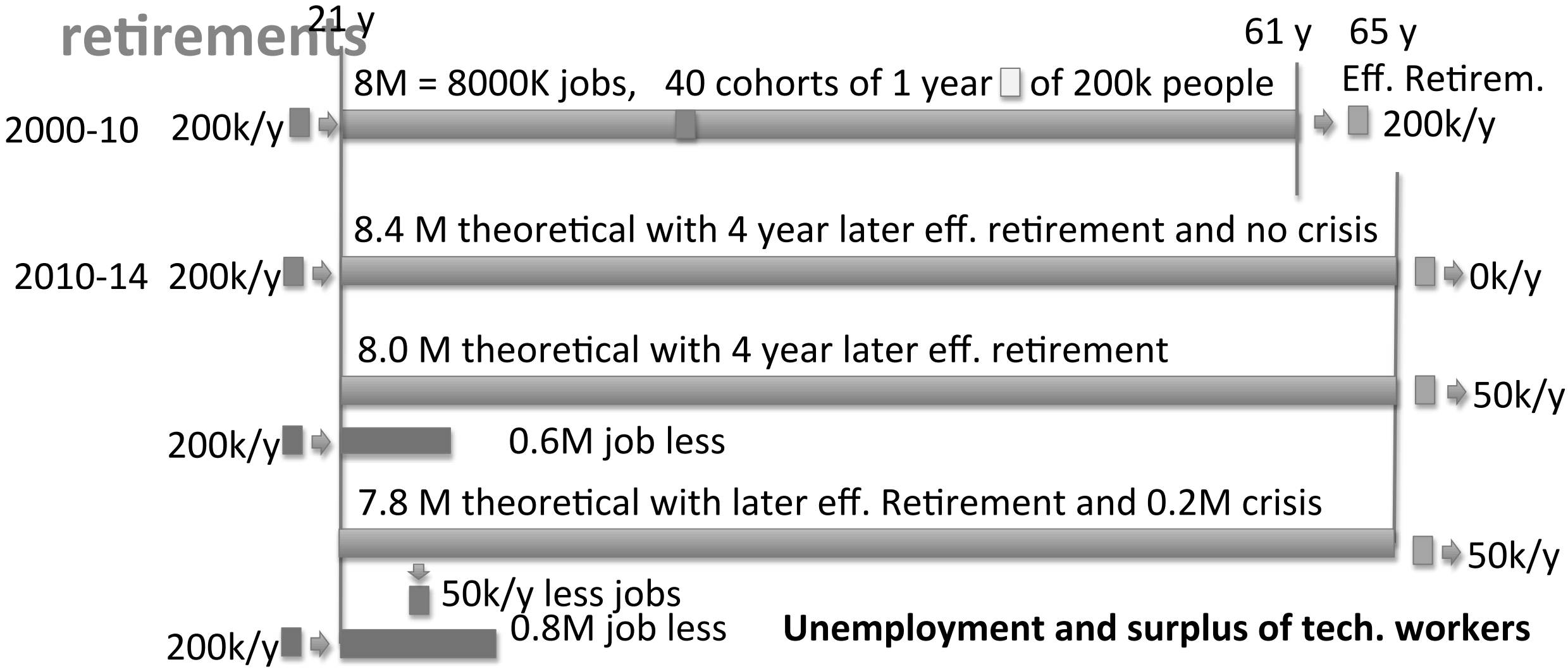
Industrie 4.0 of Smart Industry (in Netherlands): acceleration of digitalization of industry

but we also see Smart Health, Smart Mobility, Smart Finance (FinTech), Smart Grid

Smart Society: in which not only industrial jobs, but all jobs will face digitalization

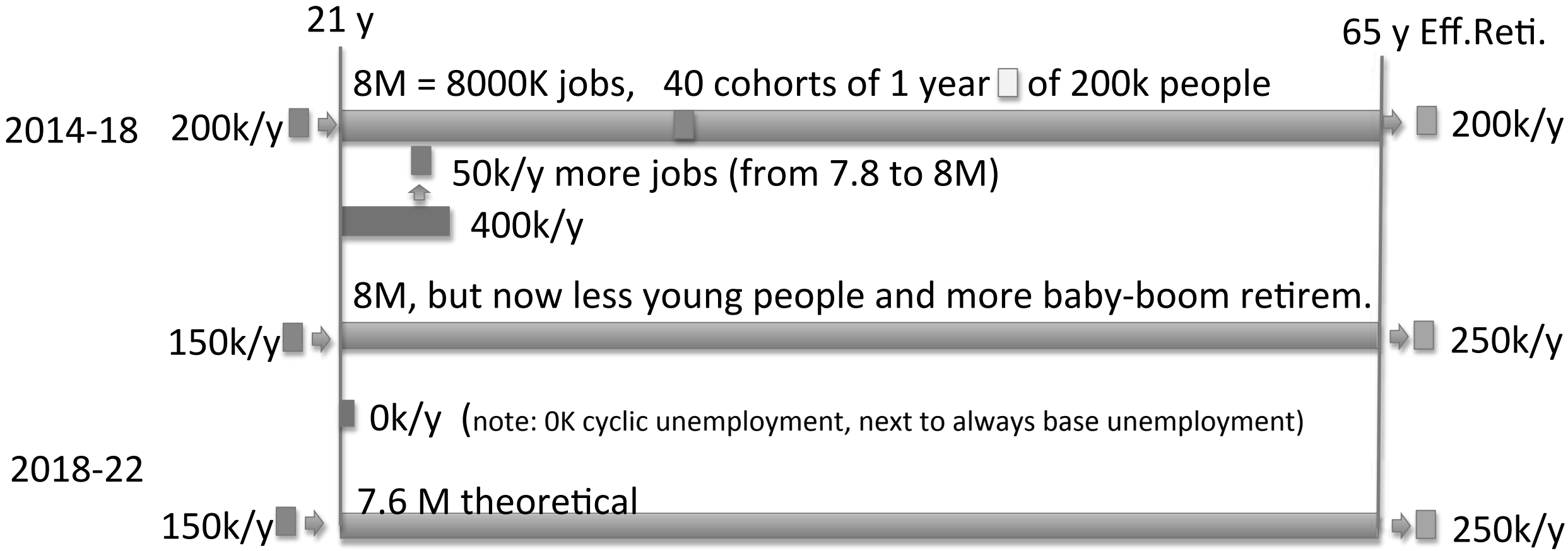
The Pipeline – till today (theoretical figures)

4 years no (of 8 years 50%) less retirements



The Pipeline – tomorrow (theoretical figures)

empty resource pool (if match) and growth



Economic tension: 400K unfilled jobs while digitalization accelerates

"You can't afford to loose any 35+ technical schooled employee due to L <<"C"

Everyone's job changes completely within working life and we can't afford to lose skilled people

35 years and above did not got Internet before 1997 at high school when they were 15+

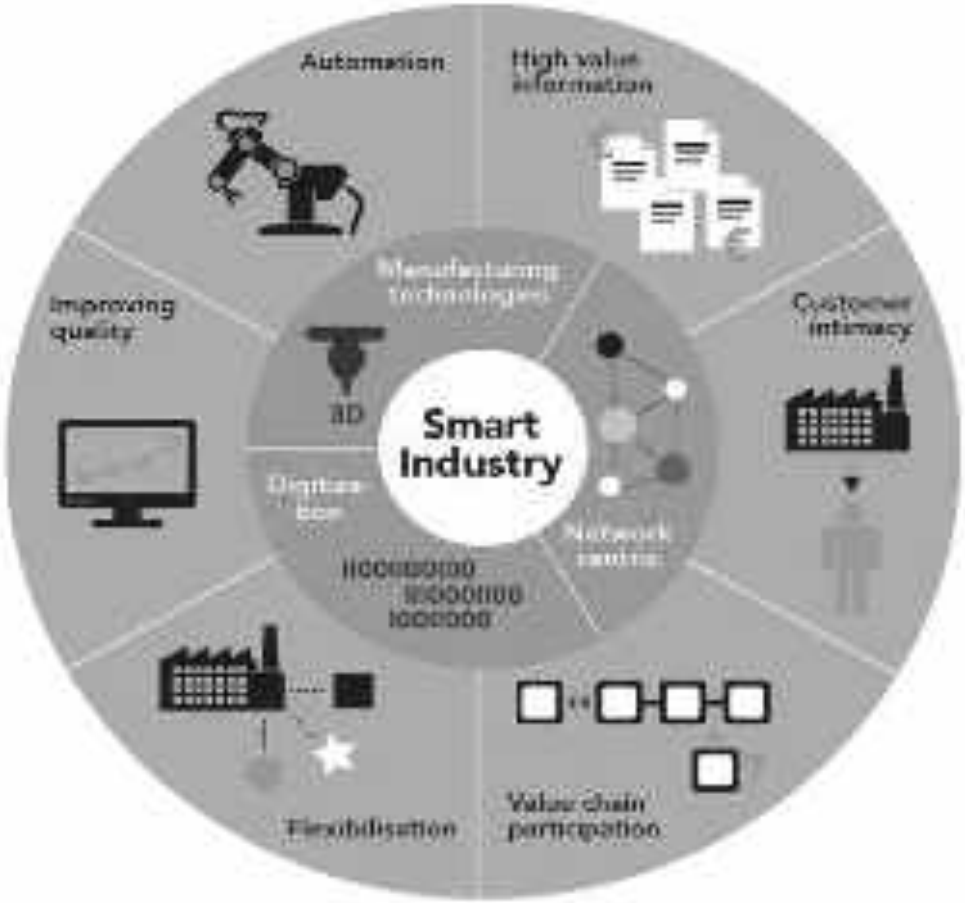
35 year today implies retirement at 70 year, still 35 working years to go

Where do we have to (re-)train every one between 35-60 year for?

smart industry

DUTCH INDUSTRY FIT FOR THE FUTURE

www.smartindustry.nl/en/



FME CWM

DUTCH TECHNOLOGY

Ministry of Economic Affairs

TNO innovation for life

VNO NCW

Towards Smart Products and Services

Cost driven

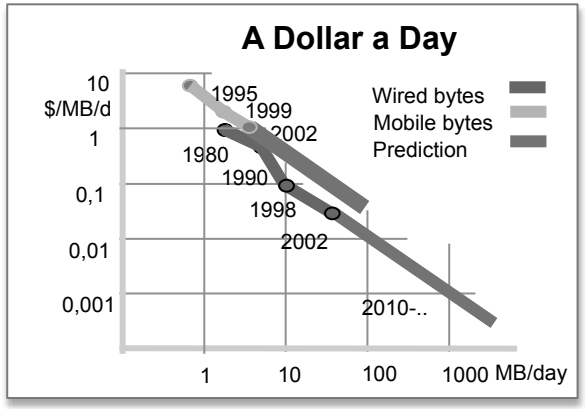
Traditional industry – Mass

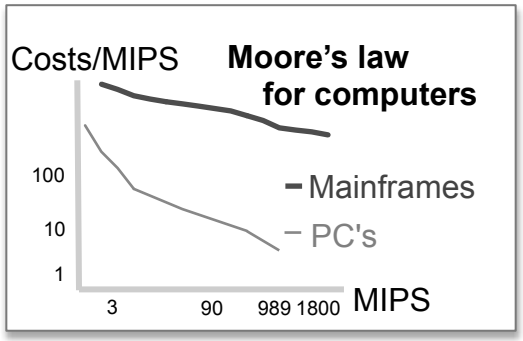
Competition driven by use of Information

ICT industry

Selling Boxes	Total cost of ownership	Customization	Solution Selling

4 Generations in ICT



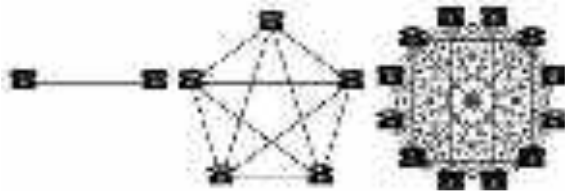


			Platforms web/cloud (Google)
		Comm. (Telco's)	Death of distance
	Softw. (Micro-Soft)	Softw.	Open Source
Mainframe Hardw. (IBM)	PC Hardw.	Mobile Phone Hardw.	Micro-systems
75-85	85-95	95-2005	2005-2015

Platforms with Services

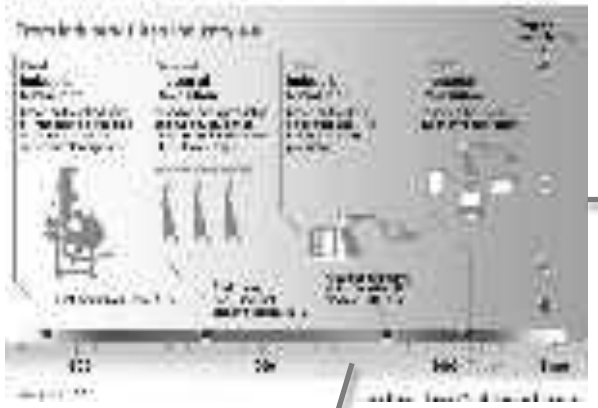
- Monitoring & Simulation (Digital Twins)
- Use of Big Data & Physical Models
- Apps & Services (Predictive Maintenance)

Moore's law for electronics &
Doubling transistors/sq mm2 every 18 months
Metcalfe's law for networks
the value of a network is proportional to (n^2) the square of the number (n) of connected users



2->4
5->25
12->144

4th Industrial Revolution = Smart Industry: acceleration of digitalization in Industry

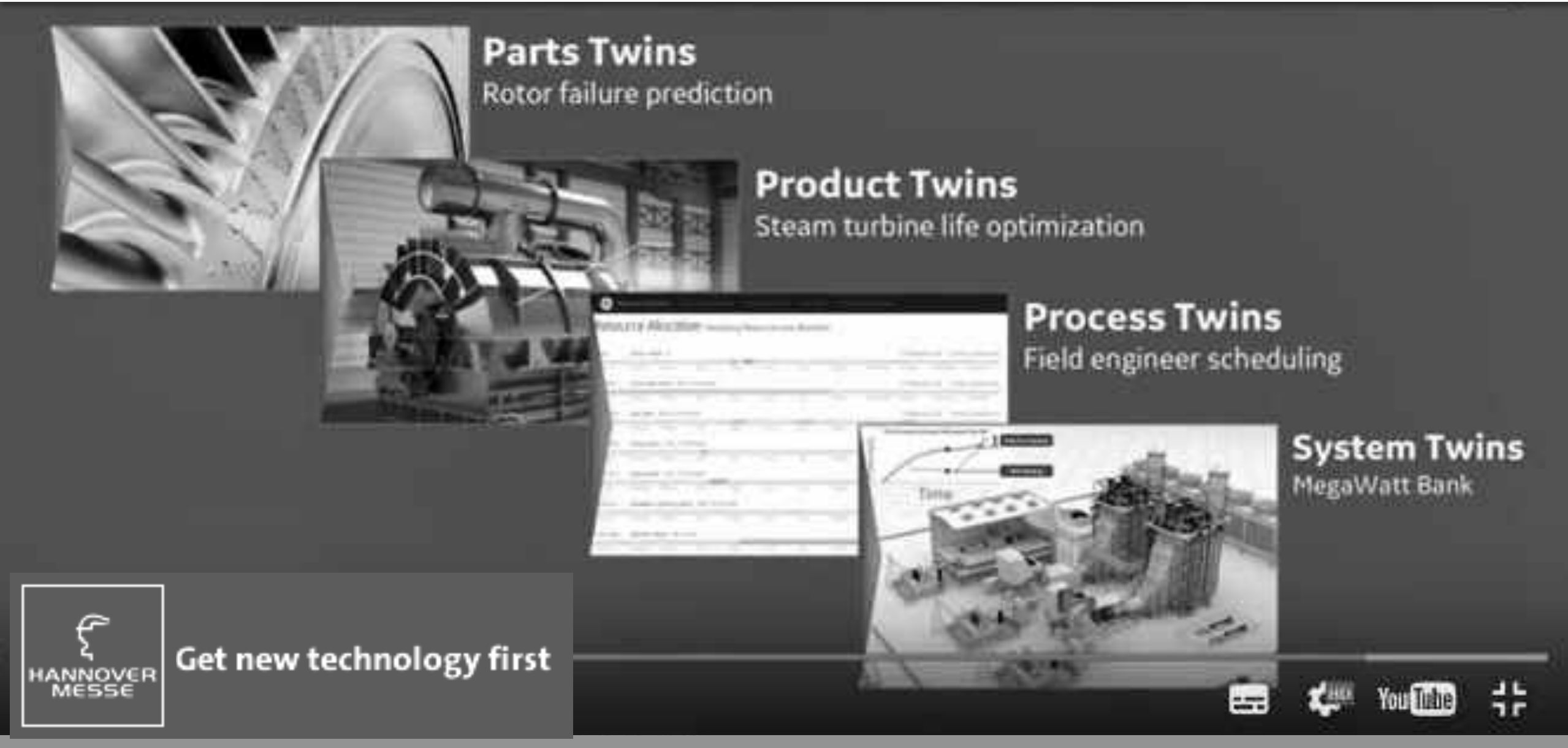


Goal of the 4th indus. Rev. in Manufacturing:
of (Smart) Products

Lot size n=1 for the price of mass produced, produced (and recycled) in flexible, highly automated, zero-defect, smaller fabs , close to the customers:
Metropolitan or Agile Manufacturing

Goal of the 4th Indus. Rev. in Process Ind.:
Improved performance by (smart) services by interconnecting many sensors, physical models and big data technologies for (smart) production and monitoring and maintenance

Digital twin: Parts < > Products < > Processes < > Systems:
Simulation, prediction, integration



Twin of a steam turbine

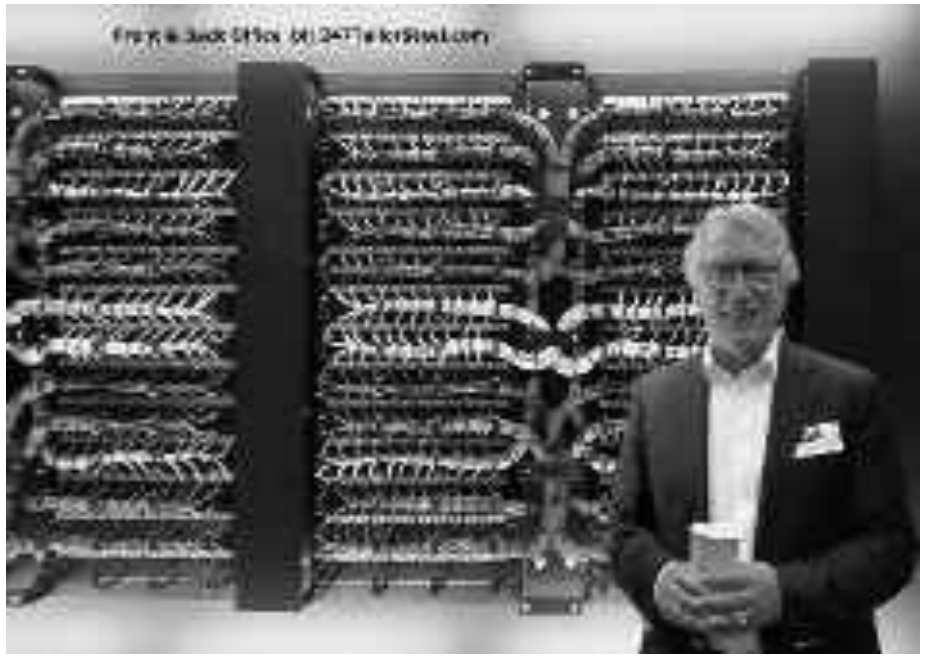
Gamechangers in Steel suppliers: 24TailorSteel.com or DeCromvoirtse.nl

Steel vendors of yesterday

Today software driven companies

Series of 1 − any size laser cutting & bending

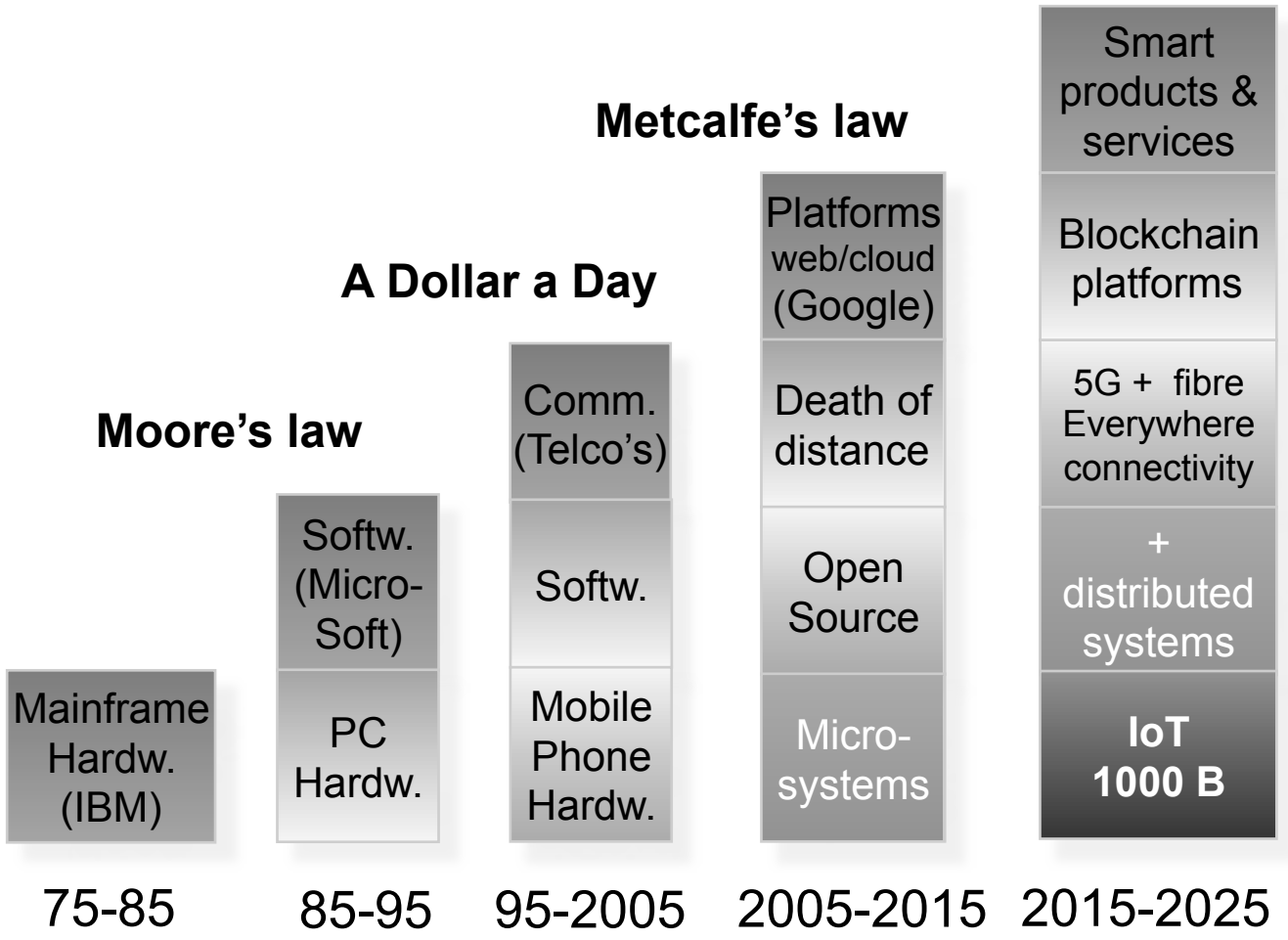
Upload drawings, get prices and delivery time back



Downstream companies change from stock to order driven

24TailorSteel.com = 2007-2017 6 FTE to 200+ and growing 30% annual

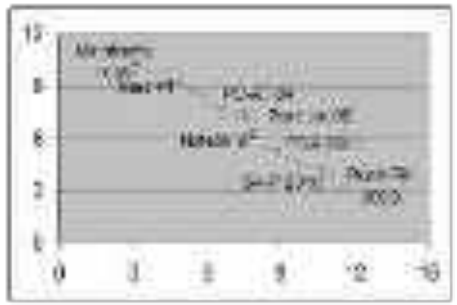
Smart Products: Personalisation
Smart Services: Servitisation of capital goods



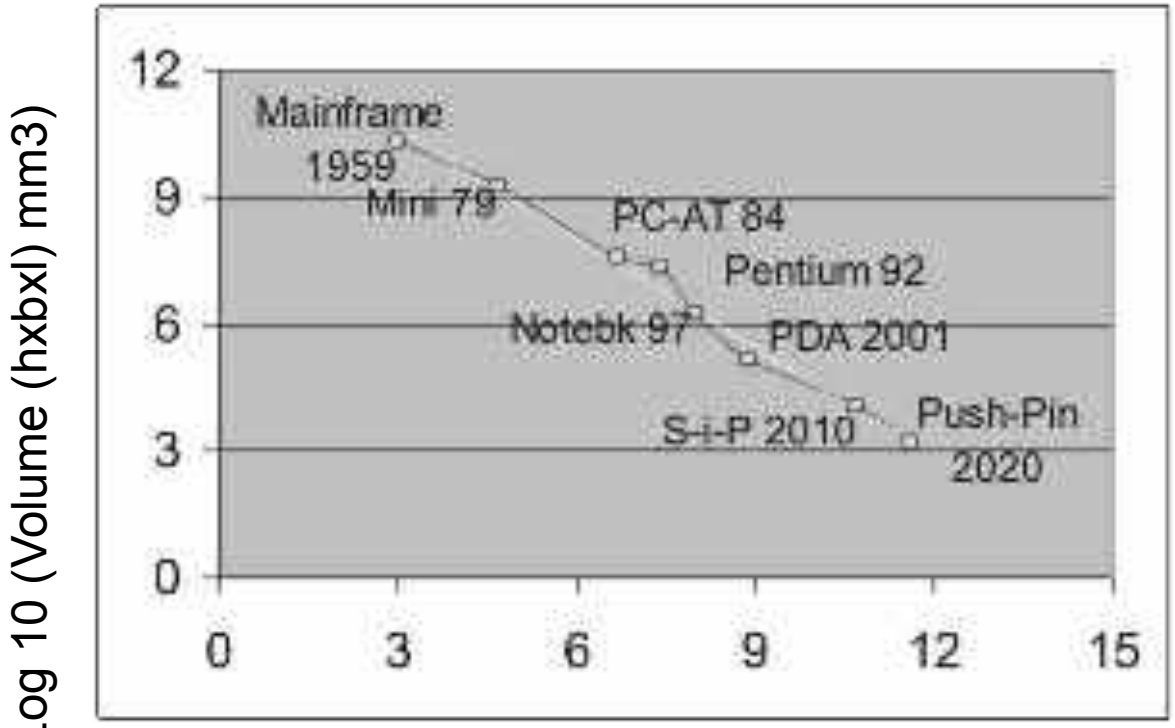
Personal Products
- Personal Bank (bitcoin)
- Personal Medicine/Food
- Personalized Transport
- Personal "Facebook'

Hype of 2016:
Blockchain will replace monolithic, web portals platforms as Uber/Airbnb

Intelligent push-pins and flexible elec. with PC power



Learning curve for smart devices (from mainframe to ambient push-pin computer)



Log 10 (Cum. Amount of devices) 6=1M, 9=1B

Note: SiP = System in a Package

9 = 1B 10x10x10 cm (1 liter) devices by 2000

10 = 10B 5x5x5 cm PDA/phones by today

11 = 100B 1 cubic” (2,5 cm) devices by ? 2010

25 mm x 25 mm x 25 mm

1 mm thick x 125 mm x 125 mm

12 = 1000 B 1x1x1 cm devices by ? 2020

1 - Evolution of Additive Technologies

- **Generation 1**: 10 -2 years ago – rapid prototype becomes additive manufacturing
  - Powder Bed Fusion, Selective Laser Sentering, Stereo Lithography, Jetting
  - M**ono materials**
    - **Metals**
    - **Polymers**
    - Ceramics – dental, high-tech
    - Food – chocolate, cookies (sugar), spaghetti, etc.
  - additive, but slow manufacturing as well as low-cost personal 3D printing

Air Flow housing – Metal(Powder bed)

Car parts (polymer)

Food (chocolate) printing

2 - Evolution of Additive Technologies

- **Generation 2**: 2012-2020 additive manufacturing become standard technology
  - **Multi-material printing**
    - Multiple printing head for plastics & metal tracks printing for free form embedded electronics in smart devices (IoT) without a rigid PC
    - Carousel printing for high speed, series-of-1, 6 in instead of 6 hour jobs
  - Personalized food printing – exact dosing for e.g. baby & elderly diets

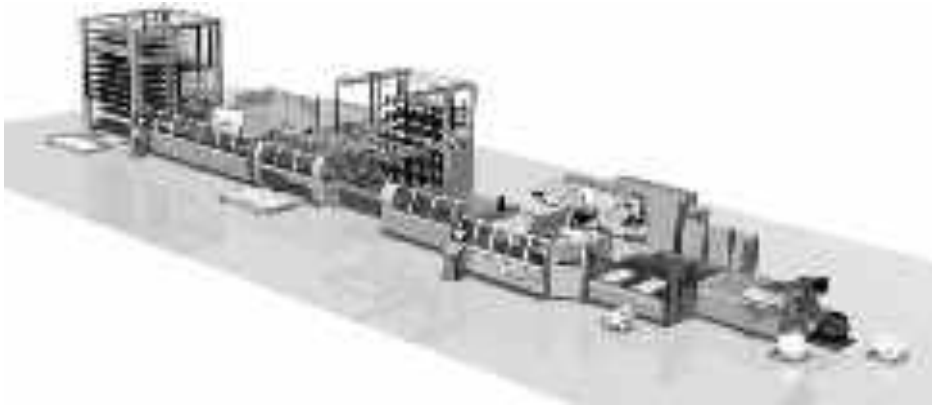
PrintValley machine

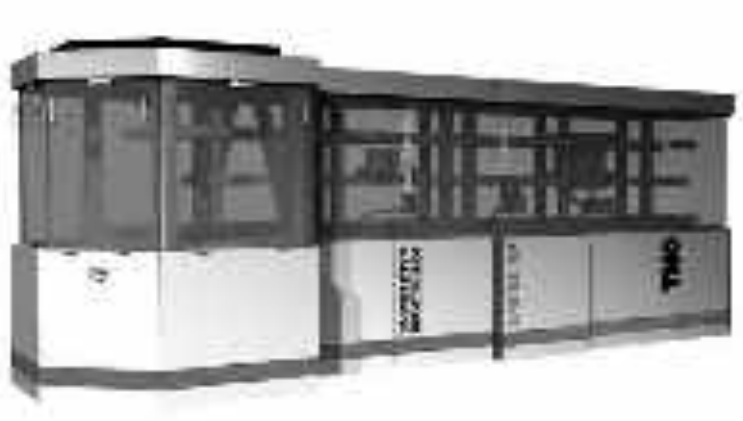
Multi Material (3 polymers in 3D

INNOVATION LANDSCAPE

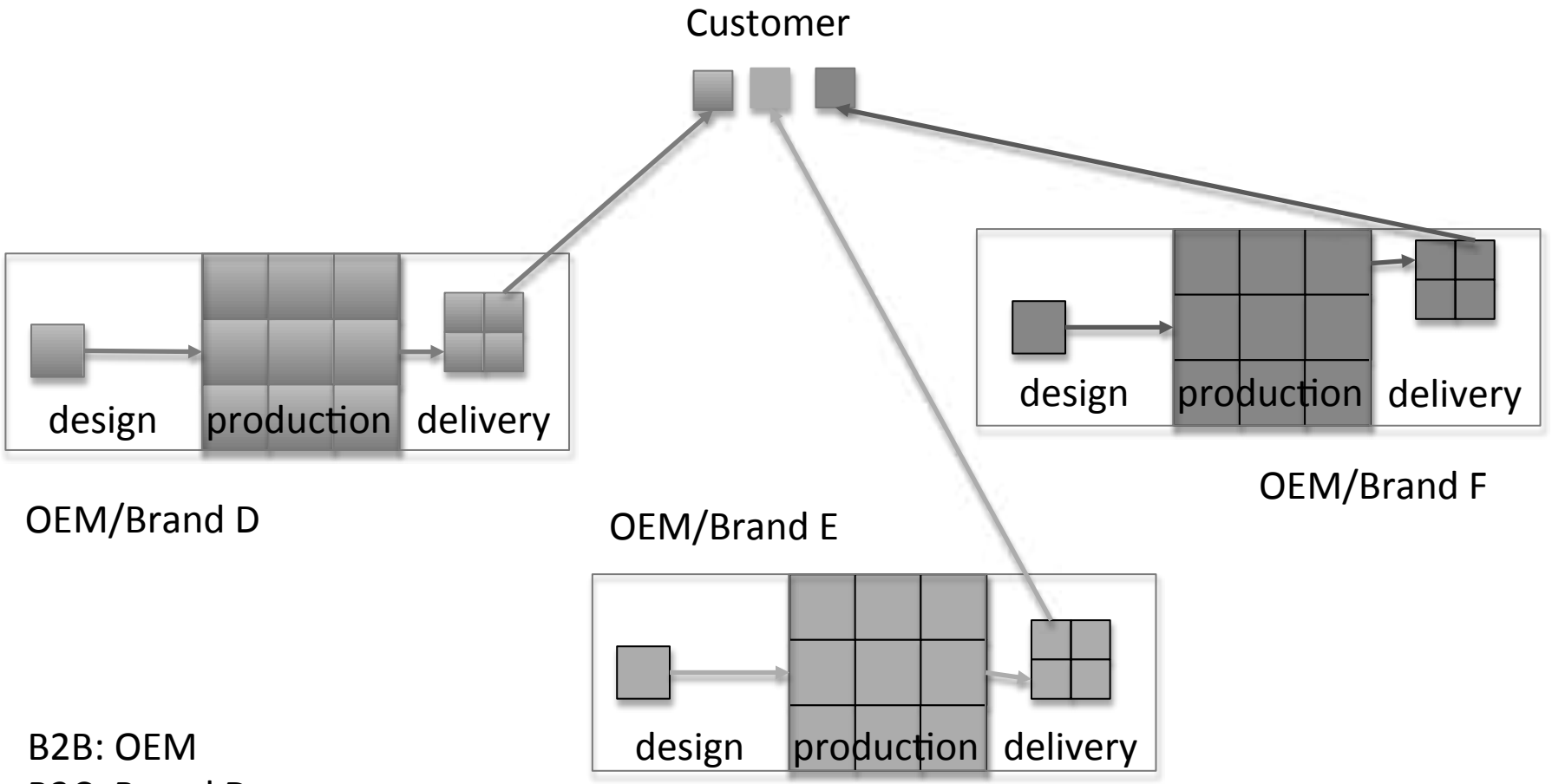
3 - Evolution of Additive Technologies

- **Generation 3**: by 2020
  - MAMA - **Metropolitan Additive Manufacturing architecture**
    - Modular flexible factories (with AM) which manufacture single (web) ordered products for multiple vendors and deliver it at your doorstep in 2 hours
    - Research - From multi-material to graded and sensing/actuation materials
  - Use case: Upon a customer order, download the file to the location closest to the customer, manufacturing with AM, robotic assembly etc the product and deliver it 2 hours latter.





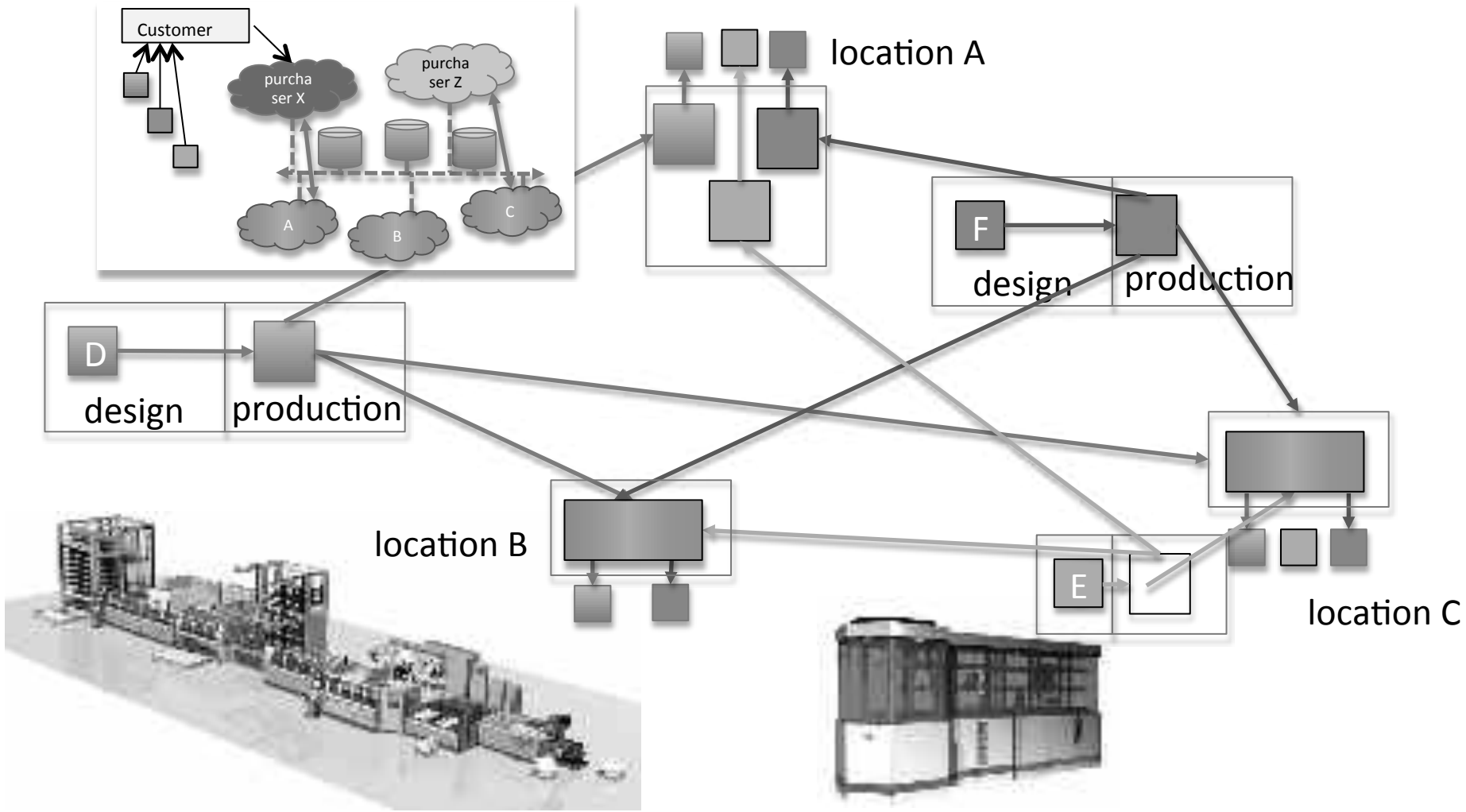
Today's manufacturing Factory 3.0 has economy of scale (yesterday in Europe, today in China)



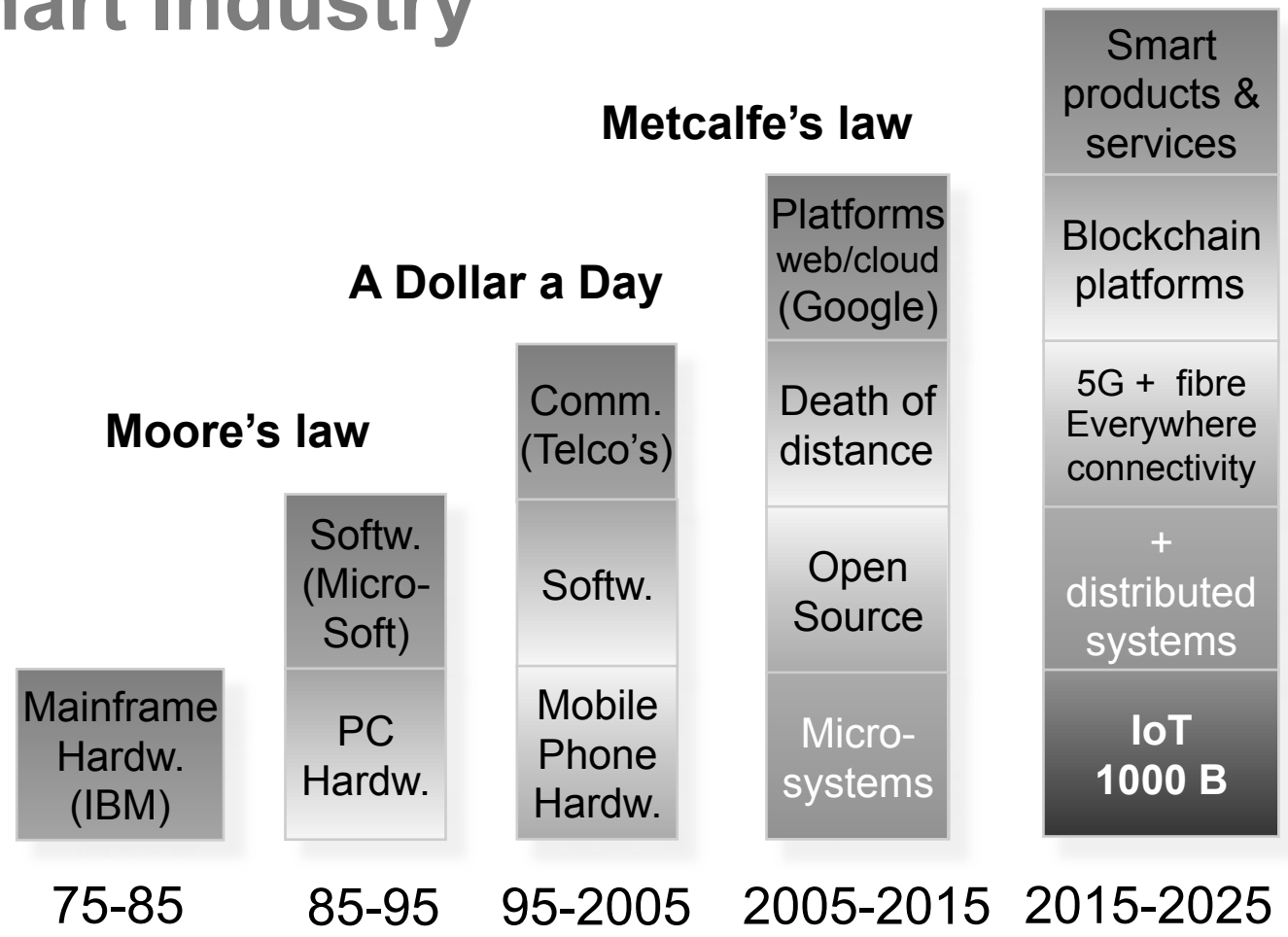
B2B: OEM
B2C: Brand D

Factories 4.0 in metropolitan area –flexible factories (smaller factory, close to the customer with jobs-back-to-town)

Customer ordering at web



Smart Services: Servitisation of capital goods
Smart Products: Personalisation
Smart Industry



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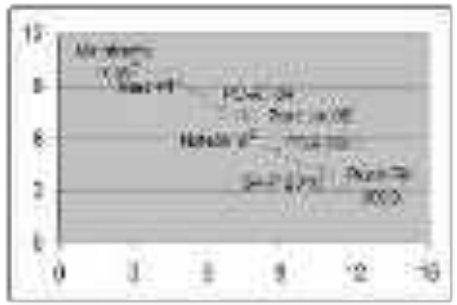

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fieldlabs for innovating and (life-long) learning

Conclusion

Smart Industry Action plan

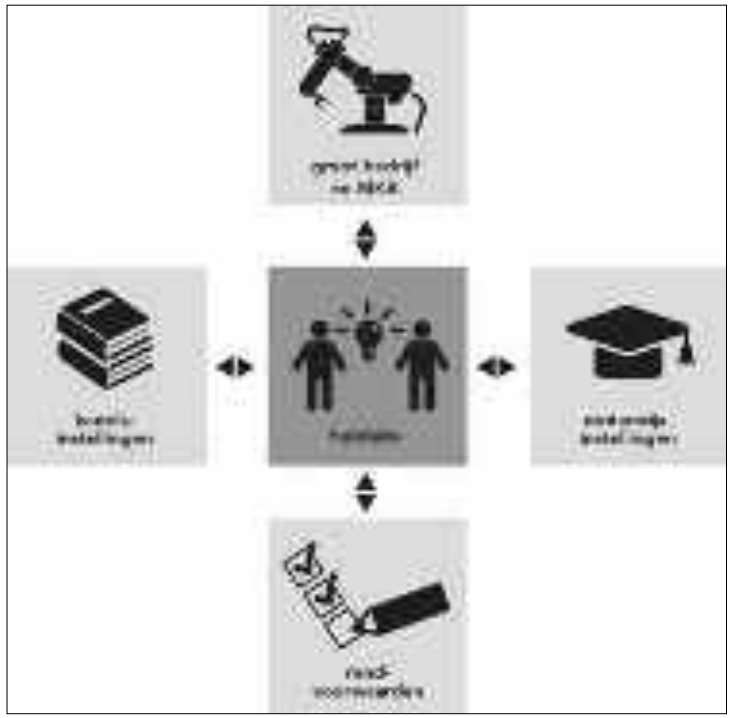
	ACTION LINE 1 CAPITALISING ON EXISTING KNOWLEDGE
1	**'The Netherlands Smart Industry land'.** Informing a wide target group, including the business community, about Smart Industry developments, aimed at insight and support.
2	**Entrepreneurs get to work.** Entrepreneurs get to work more quickly with new business propositions, supported with information, coaching and advice aimed at cooperation and knowledge valorisation.
	ACTION LINE 2 ACCELERATING IN FIELD LABS
3	**Sample Field Labs at the start.** The aim is to have 10 Field Labs ready to go as soon as possible. Business plans must be detailed, consortia built up and financing arranged.
4	**Second instalment Field Labs.** There is a need for additional Field Labs. These Field Labs will be made ready for operation in 2015.
5	**Monitoring and knowledge exchange.** Investments will be made in getting to know Field Labs and spreading knowledge to education and the broad business community.
	ACTION LINE 3 STRENGTHENING THE FOUNDATION
	3A KNOWLEDGE
6	**Strengthening R&D incentive in Field Labs.** One component of the Field Labs is investing in research themes that are directly linked to the Field Labs. This takes place via the leading sectors, among others.
7	**Smart Industry research agenda.** For the somewhat more distant future, a long-term research agenda will be set up with the top sectors in cooperation with universities, TO2, STW and NOW, among others.

Smart Industry (line 8-14)

	3B SKILLS
8	**Human capital development within companies.** Together with companies and employees, actions will be performed in the area of employee pools and task rotation. Courses will also be offered to promote sustainable employability.
9	**Regional approach in connecting the business community with schools.** To coordinate the needs of companies and the offer from schools, Smart Industry research groups will be set up and modular educational blocks will be offered.
10	**Learning without interruption.** The relevant educational programmes from primary education to scientific education and dual education will be adapted to the needs of Smart Industry in future.
11	**Social innovation.** There will be a social innovation action programme aimed at Smart Industry to equip the organisation as well as the employee of the future for Smart Industry in future.
	3C PARAMETERS (ICT)
12	**Big data, big trust.** The development of technical solutions, business models and forms of cooperation that simplify the exchange and use of data.
13	**Software action plan.** Carrying out a research programme aimed at the development of software tools, with a view to chain cooperation, standardisation and interoperability.
14	**Cyber security.** Building on a robust and secure ICT infrastructure for Smart Industry.

Smart Industry Fieldlab

Fieldlab: *An industrial environment where Smart Industry solutions are developed, tested, implemented as well as where people can learn to apply them.*



Criteria for a Smart Industry fieldlab
- Innovation eco-system
- Regional focus
- Radical innovations
- Interconnect higher & vocational education
- Training Human Capital
- Identification and application of new rules & standards
- Location with a program manager
- Program with 3+ year plan and multiple projects on innovation and education

Front & Back Office bij 247TailorSteel.com

8. SMART CONNECTED SUPPLIER NETWORK

Fieldlab's goal is to achieve more efficient information exchange in the supply chain by means of standardization and interoperability. Starts with ERP software. Partners: Brainport Industries, KMWE, NTS Group, Eurotechniek, MKG, Isah, TNO. Location: Eindhoven.

4. SMART BENDING FACTORY

State-of-the-art factory for laser-cutting and bending of steel, fully driven and controlled via internet. Goal: lowering 'total-cost-of-ownership' by 20% and accelerating the 'time-to-market' by a factor of 5. Partners: 247TailorSteel, Gunnebo, Inndose, Staja, Viscon, Jansen Metal Products, ROC Graafschap College, Anton Tijdink Educational Institution. Location: Varsseveld.

SMART INDUSTRY FIELDLABS

2015 - 2017

SMART INDUSTRY FIELDLABS –STATUS DEC 2016

Dutch Digital Innovation and Skill locations

Clusters toward Digital Innovation Hubs

Digitalization - 4 + 1 (full + aspirant)
- Achterhoek: Smart Bending Factory
- Eindhoven: Smart Connected Suppliers Networks
- Eindhoven: HighTech Software centre
- Hengelo: the Garden cybersecurity
- Groningen: 5G

Additives Manufacturing - 5
- Eindhoven: 3D multi materials
- Rotterdam: RDM metal (WAAM (wire add)
- NO-polder(NLR): metal printing (deposi.)
- Haarlem: polymers
- Utrecht: medical

Maintenance - 3+2
- CAMpione, CAMINO, SMASH, (AMICI, CAPELLA)

Polymers - 4
- Marknesse: NLR/Fokker (robotics)
- IJpenburg: Airborne/Siemens
- Enschede: TPC-NL (thermo plastics)
- Woensdrecht: composite repair

Design: Ultra Personalized P&S

Agro/Food: 3
- Friesland: Smart Dairy Farming,
- Westland: Freshteq.nl (greenhouses)
- Reuzel: Precisie Akkerbouw

Robotics/Zero-defect 4+1
- Noord Nederland: Region of Smart Factories+Added
- Zuid-Nederland: Flex Manufacturing
- Enschede: Smart Welding Factory
- Harderwijk: Robotic Training at AWL

Social innovation (all/skills) 2
- Hengelo, Dordrecht: Duurzaamheidsfabriek

FinTech/Smart Finance/Blockchain (i.o)
- Heerlen:Techruption
- Rotterdam: (Container logistics in BC)

Defense (Amersfoort): Smart Base

Everyone's job changes completely within working life and we can't afford to lose skilled people

Our school system is for initial education (4-24) with a huge budget from ministry of education

Politicians have not assigned a similar budget for continuous education for 35-65 year people

Mainstream thinking: Continuous education is for employers and employees - in industry,

but the whole society is facing digitalization and rapid job evolutions

Higher educated people were good a school and capable of (self) learning,

They create their own L>>C, but what about (technical) people with vocational training who often didn't like the school banks and whose demand remains high

we need to create industrial/realistic work environment learning environments