



More than Particles

**HOW ACCELERATORS CAN SPEED
UP ADVANCED MANUFACTURING**

... AND WHAT'S NEXT

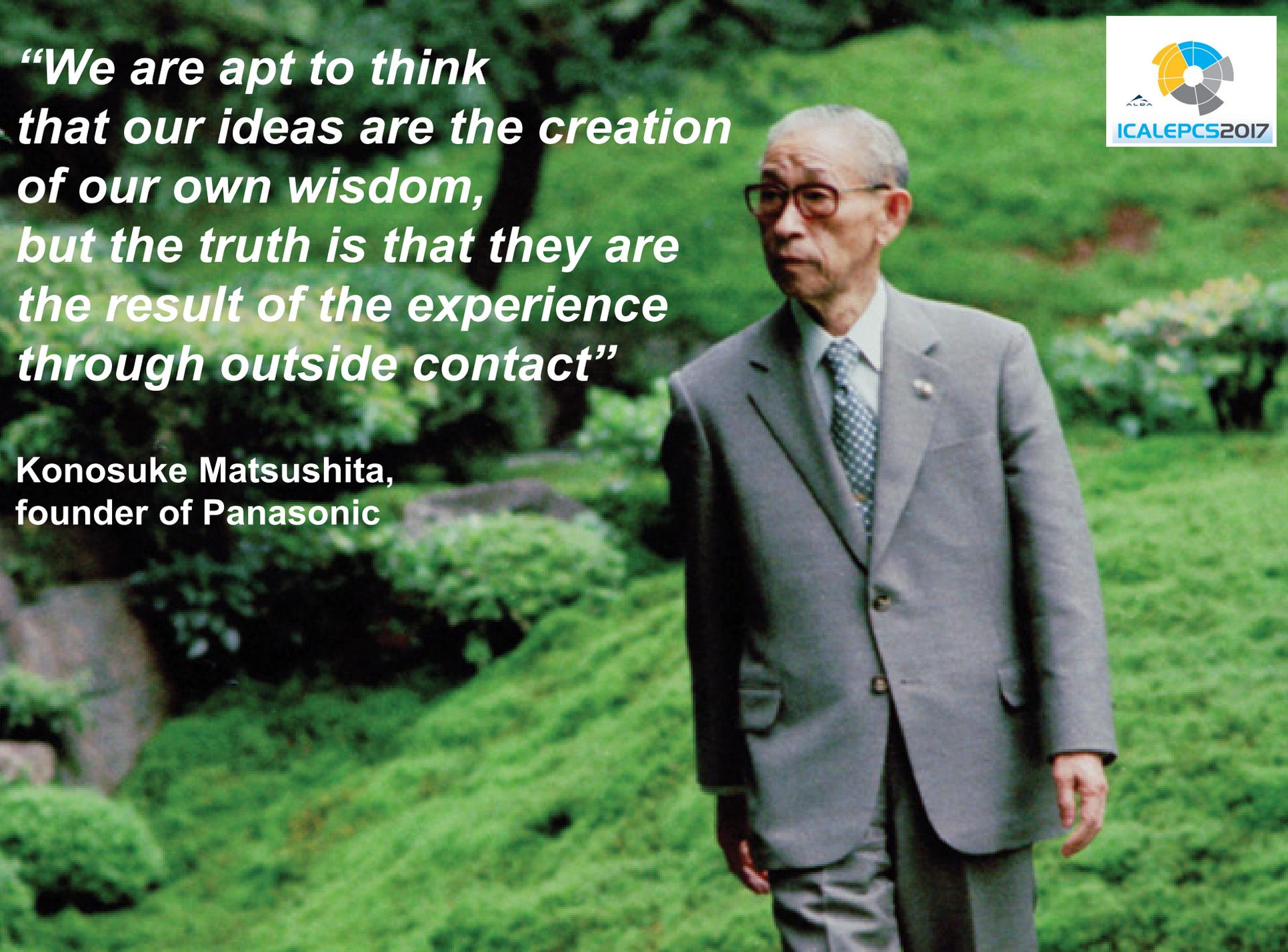
Dr. Gregorio Ameyugo,
Deputy Director, CEA LIST
Paris-Saclay

12 October, 2017



***“We are apt to think
that our ideas are the creation
of our own wisdom,
but the truth is that they are
the result of the experience
through outside contact”***

**Konosuke Matsushita,
founder of Panasonic**



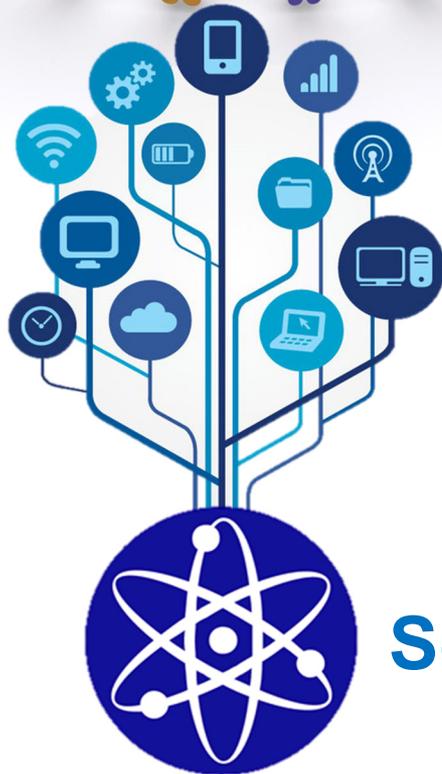
Particle accelerators and Advanced Manufacturing testbeds

... no connection?





*New infrastructures,
instruments and tools
enable scientific
discoveries... but also
progress in other areas*

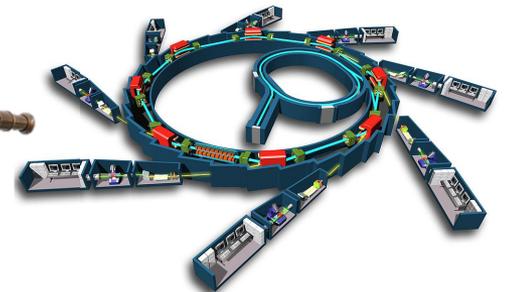


Technology

Science



Instruments



Industry 4.0

*The fourth industrial revolution is
being enabled by a digital revolution*



Industry 4.0

The fourth industrial revolution is being enabled by a digital revolution

1st industrial revolution

1775 - Vapour

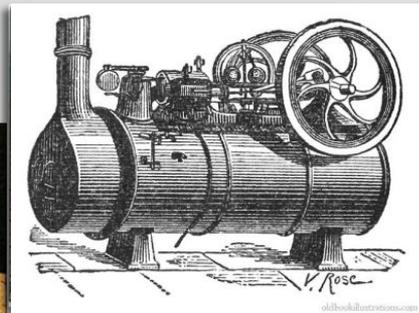


Industry 4.0

The fourth industrial revolution is being enabled by a digital revolution

1st industrial revolution

1775 - Vapour

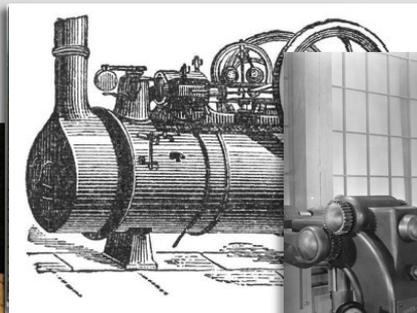


Industry 4.0

The fourth industrial revolution is being enabled by a digital revolution

**1st industrial
revolution**
1775 - Vapour

**2nd industrial
revolution**
1900s -
electricity



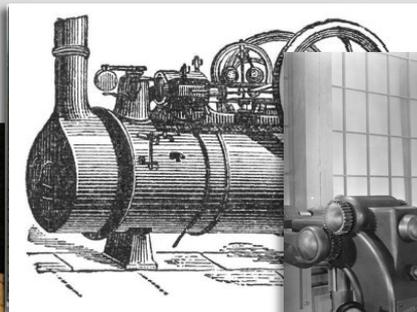
Industry 4.0

The fourth industrial revolution is being enabled by a digital revolution

**1st industrial
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1775 - Vapour

**2nd industrial
revolution**
1900s -
electricity

**3rd
industrial
revolution**
1960s -
robotics



Industry 4.0

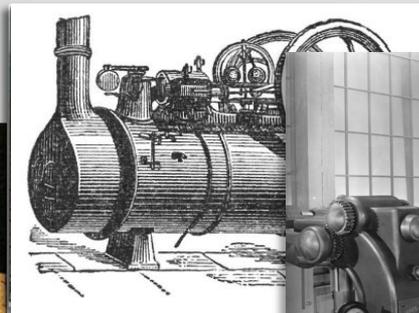
The fourth industrial revolution is being enabled by a digital revolution

1st industrial revolution
1775 - Vapour

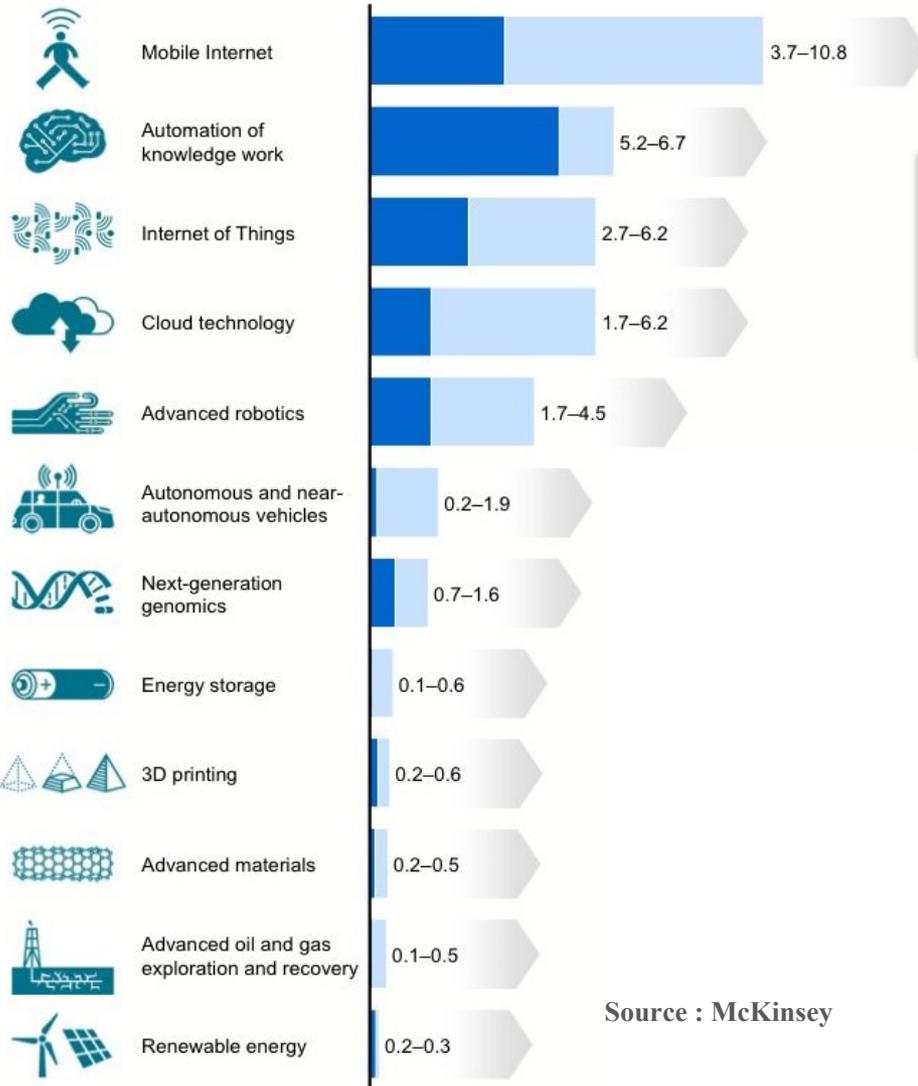
2nd industrial revolution
1900s - electricity

3rd industrial revolution
1960s - robotics

4th industrial revolution
2010s – Connected cyberphysical systems



Advanced Manufacturing: economic impact measured in \$trillion by 2025



More flexible, agile, robust manufacturing systems

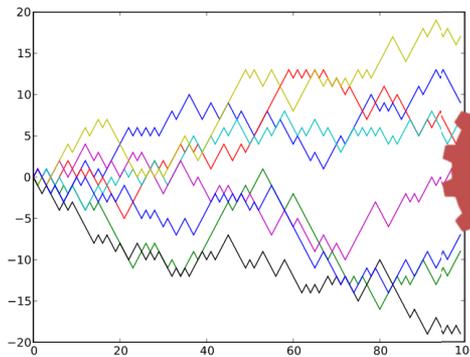


What's in it for us?

Source : McKinsey

Industry 4.0 What's in it for us?

Market changes → Product → supply chain → manufacturing networks → **reaction**



In our hyperconnected world, market preferences change fast ... and companies struggle to adapt

Industry 4.0 What's in it for us?

Change is hardest for small companies: in Europe, 2/3 of private sector jobs and 85% of job growth



Need knowledge, money and ability to take risks

It is easier to move bits than atoms – a physical manufacturing footprint is a source of wealth

Industry 4.0

Our efforts at



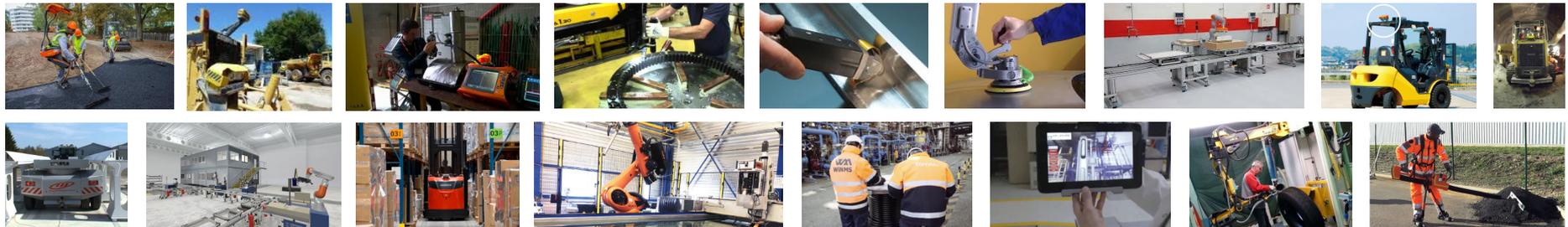
- RESEARCH AND TECHNOLOGY INSTITUTE
- ROBOTICS, CYBERPHYSICAL SYSTEMS AND ARTIFICIAL INTELLIGENCE
- 200 INDUSTRIAL PARTNERSHIPS
- NEXT TO SOLEIL IN PARIS-SACLAY CAMPUS



+20 PILOT PROJECTS IN FRENCH FACTORIES

TECHNOLOGIES IN SERVICE IN OVER 40 COUNTRIES

ALL INDUSTRIAL SECTORS



Industry 4.0

What are we trying to accomplish?

- Accelerate deployment of new technologies
- Involve value chains, not individual companies
- Develop and demonstrate flexible, agile production systems
- Reduce time and cost to change production line
 - Product
 - Rate



Industry 4.0

The



story



Industry 4.0

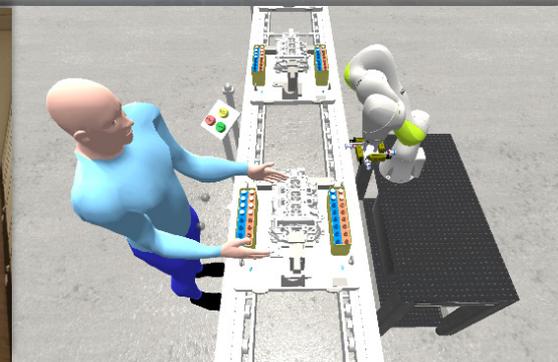
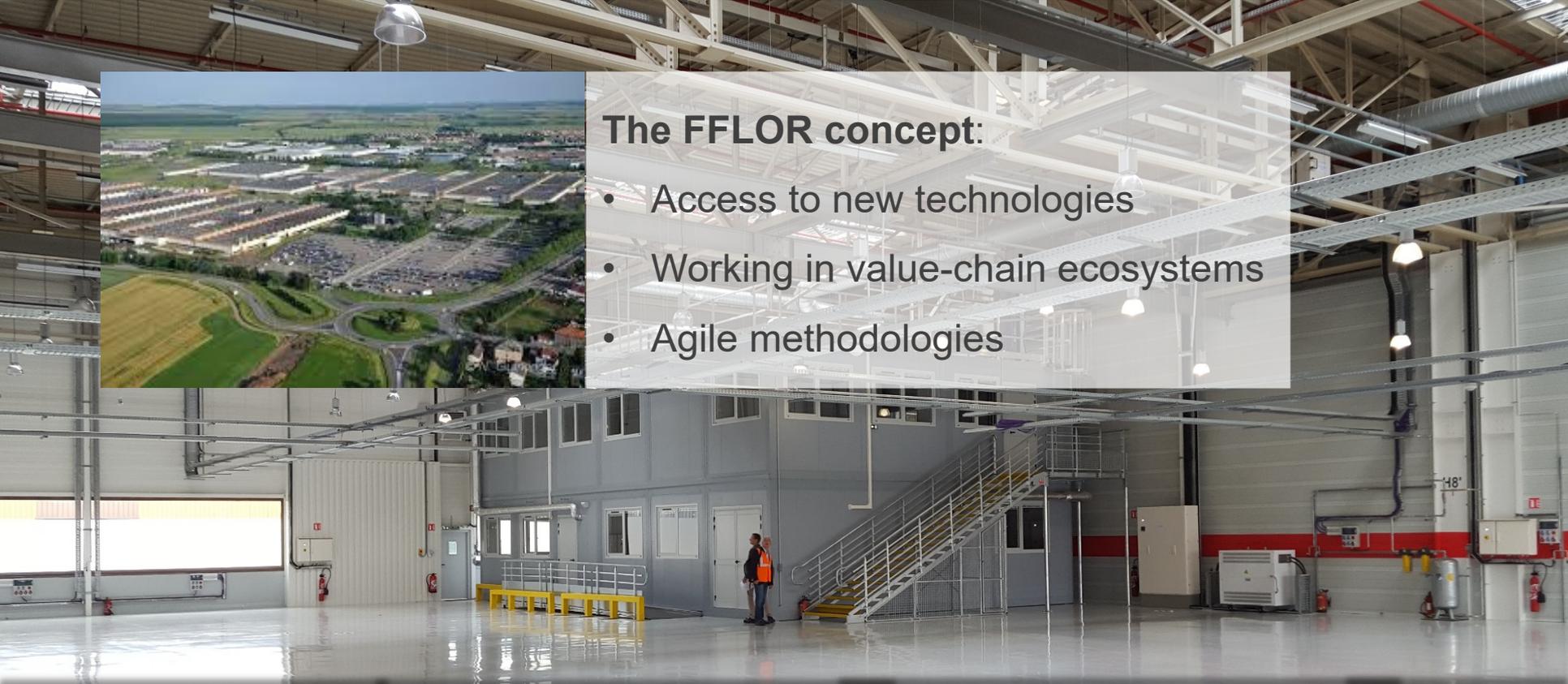
The FLOR story

FUTURE FACTORY @ LORRAINE



The FFLOR concept:

- Access to new technologies
- Working in value-chain ecosystems
- Agile methodologies



Industry 4.0

The



story



- Inaugurated Jan 2017
- 12 partners from across Europe
- SMEs and large industrial groups
- Defining together concrete agile, flexible manufacturing processes
- Building pilot lines



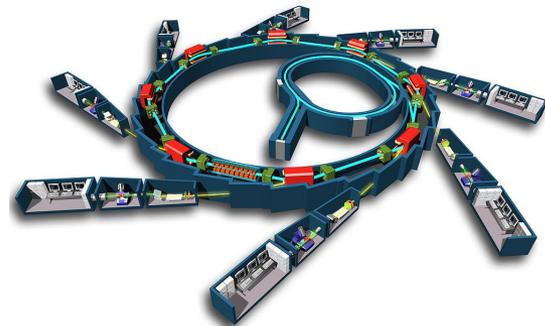
We have similar problems



- Cyberphysical systems for manufacturing experiments
- Digital supervision to configure pilot cells and lines
- Systems modularity, service-based approach to reconfigure processes quickly



- Cyberphysical systems for scientific experiments
- Digital supervision to monitor operations and experiments
- Systems modularity, service-based approach to reconfigure processes quickly



It always comes down to the people...

TANGO  NEXEYA

Pascale Betinelli



Contrôle Camera

Colis

Lecteur de code barre ●

5000159 303774

Type de Code Barre: EAN13

DecodeImage

Nb de code barre lus: 105.0

Robot

Position Articulaire			Position Articulaire		
x	105.0	rx	105.0	a1	105.0
y	105.0	ry	105.0	a2	105.0
z	105.0	rz	105.0	a3	105.0
Vitesse / Accélération					
xTSpd	105.0	rxTSpd	105.0	linTSpdStp	105.0
yTSpd	105.0	ryTSpd	105.0	TAccStp	105.0
zTSpd	105.0	rzTSpd	105.0		



Block list

- Begin/End
- Begin
- End
- Branch
- Branch
- Debug
- Subsequence
- Macro
- Tango
- Commande tango
- SetTangoAttr
- WaitTangoAttr
- Time
- Init
- Wait
- User
- MyCustomAction

Property	Value
BlockID	Wait_colis_at...
ID	Wait_colis_at...
tick	0.0
Iteration	1
Module	sequence.actio...
device...	c_auto_01/conv...
attr_name	zzz_Detection_...
type	bool
value	true
timeout	1000.0
Extra	
Y	125
X	379

Nb	Date	Thread	Sequence	Type	ID	Level	Message
53	16:12:00.792	Thread 31	New sequence	BEGIN	Begin	INFO	
54	16:12:00.793	Thread 31	New sequence	ACTION	Start conveyor	INFO	PreRun
55	16:12:00.803	Thread 31	New sequence	ACTION	Start conveyor	INFO	Run
56	16:12:00.806	Thread 31	New sequence	ACTION	Start conveyor	CRRCR	Unable to set depart_attr_cycle to true
57	16:12:00.808	Thread 31	New sequence	ACTION	Start conveyor	WARNING	Run returned false on execution 1
58	16:12:00.808	Thread 31	New sequence	ACTION	Start conveyor	INFO	PostRun
59	16:12:00.808	Thread 31	New sequence	ACTION	Start conveyor	WARNING	PostRun returned false
60	16:12:00.809	Thread 30	New sequence	STOP	Thread 30	INFO	

Address 48 - C:\AUTOLOG\LOG\NEXEYA\TANGO\DATA_01

Properties

Iteration 1

Module sequence.actio...

Parameters

device... c_auto_01/conv...

attr_name zzz_Detection_...

type bool

value true

timeout 1000.0

Extra

Y 125

X 379

Subsequences

New sequence

And logical

Default general

From gen_page

Mode manual_page

Mode supervision

cycle_attr_cycle

depart_attr_cycle

init_attr_cycle

iteration_attr_cycle_1

iteration_attr_cycle_2

iteration_attr_cycle_3

iteration_attr_cycle_4

iteration_attr_cycle_5

iteration_attr_cycle_6

iteration_attr_cycle_7

iteration_attr_cycle_8

iteration_attr_cycle_9

iteration_attr_cycle_10

iteration_attr_cycle_11

iteration_attr_cycle_12

iteration_attr_cycle_13

iteration_attr_cycle_14

iteration_attr_cycle_15

iteration_attr_cycle_16

iteration_attr_cycle_17

iteration_attr_cycle_18

iteration_attr_cycle_19

iteration_attr_cycle_20

iteration_attr_cycle_21

iteration_attr_cycle_22

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iteration_attr_cycle_84

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iteration_attr_cycle_86

iteration_attr_cycle_87

iteration_attr_cycle_88

iteration_attr_cycle_89

iteration_attr_cycle_90

iteration_attr_cycle_91

iteration_attr_cycle_92

iteration_attr_cycle_93

iteration_attr_cycle_94

iteration_attr_cycle_95

iteration_attr_cycle_96

iteration_attr_cycle_97

iteration_attr_cycle_98

iteration_attr_cycle_99

iteration_attr_cycle_100

Contrôle Camera

Colis

Lecteur de code barre

Type de Code Barre EAN13

DecodeImage

Nb de code barre lus 105.0

Installation

Robot

FFLOR runs on TANGO!

- Quick connection between cyberphysical systems
- Services approach
- Graphic tools for reconfiguration
- ...



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- Wait
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Subsequences

New sequence

Nb	Date	Thread	Sequence	Type	ID	Level	Message
53	18:12:00.792	Thread 31	New sequence	BEGIN	Begin	INFO	
54	18:12:00.793	Thread 31	New sequence	ACTION	Start conveyor	INFO	PreRun
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60	18:12:00.809	Thread 30	New sequence	STOP	Thread 30	INFO	

Console Logs | Local Logs

Address 48 - C:\AUTOLOG\CONVEYOR\MAC_DATA_01

File Menu | Parameters | Help

C:\AUTOLOG\CONVEYOR\MAC_DATA_01

C:\AUTOLOG\CONVEYOR\MAC_DATA_01

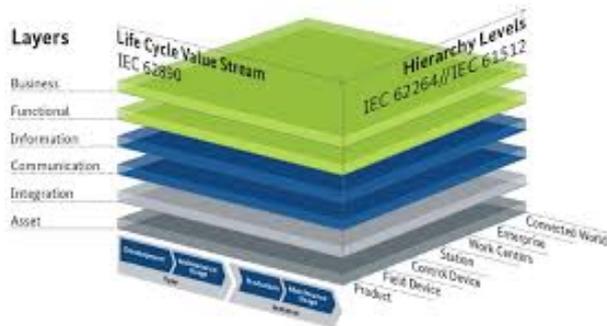
Parameters and settings

- And_logger
- Debug_general
- Trig_in_ports
- Mode_manual_in_ports
- Mode_supervision
- cycle_in_cycle
- depart_inlet_cycle
- wait_action
- location_buiter_1
- location_buiter_2
- location_buiter_in_order_tango
- location_inlet
- location_out_buiter
- location_out_inlet
- mode_manual_supervision
- 200 Detection novelle porte 1
- 201 Detection novelle porte 2
- 202 Detection novelle porte 3
- 203 Detection novelle porte 4

Scale | Log

Beyond FFLOR?

Referenzarchitekturmodell Industrie 4.0 (RAMI 4.0)



...

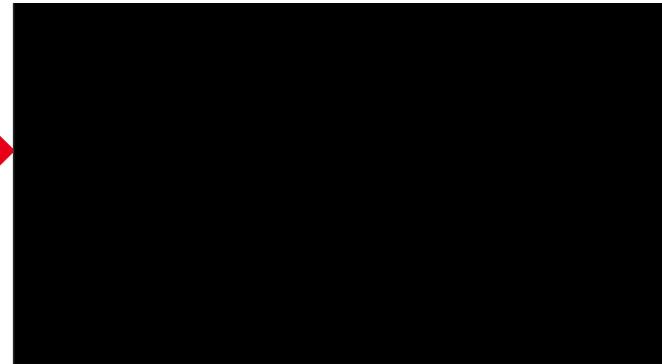
Industry 4.0 standards emerging but not yet stable

Direct application or « borrowing » concepts: the benefits are still there

Two examples: #1

Improve productivity

Machine workshop



Existing process:

- Manual loading / unloading of machines
- Small margins, impossible to compete internationally

New process:

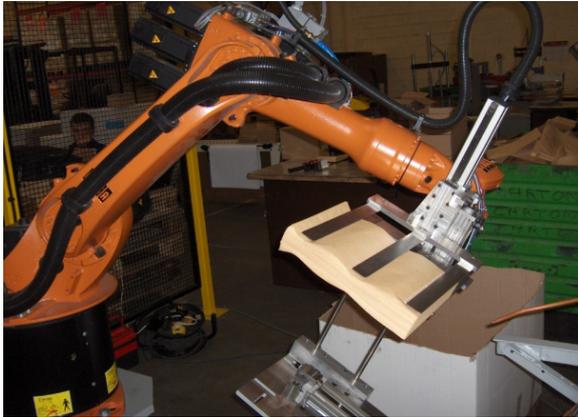
- Automatic loading and unloading
- Plug and play!
- Machinery left running overnight
- Productivity > +50%

Two examples: #2 – furniture industry



Reconfigure line quickly

Packaging line



TANGO



Existing process:

- Easy tasks already automated
- Manual packaging
- Low productivity on manual line
- Low flexibility on auto line

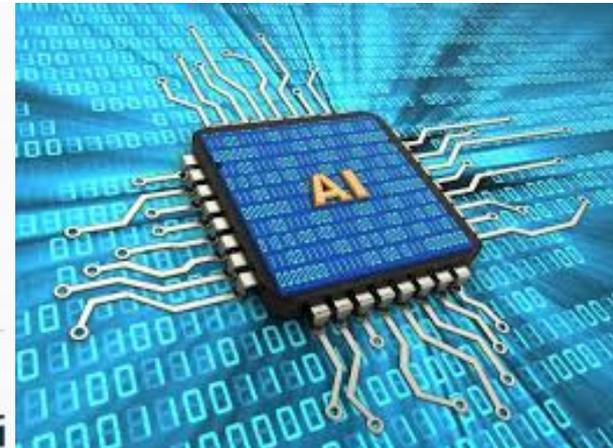
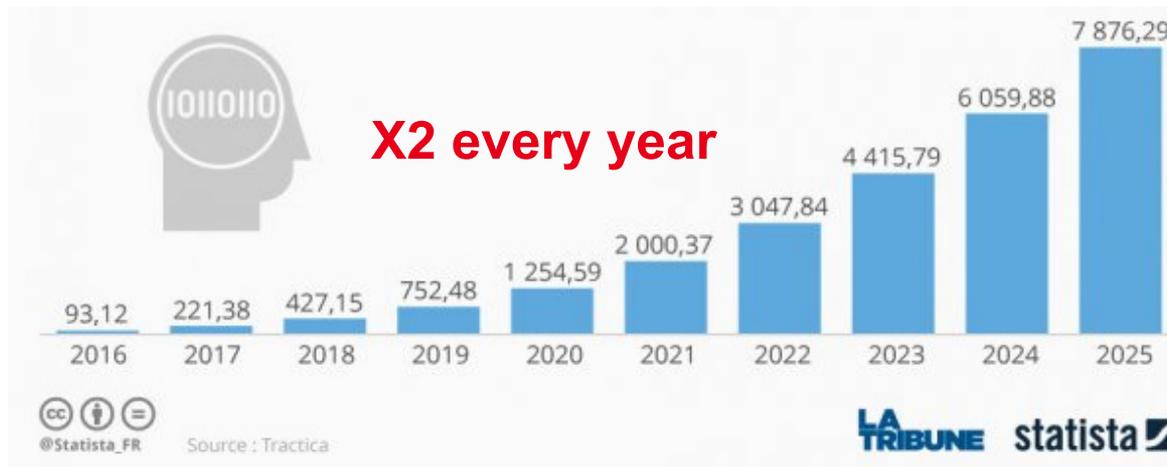
New process:

- On-demand automation
- Easy to reprogram
- Flexible, productive hybrid line

Industry 4.0 ... what's next?

- Artificial Intelligence → **More flexible, robust automation, decision support**

Impact of AI in Europe



- **5-year plan**
- >1000 m € for R&D
- 250m€ for startups
- First initiative:
DigiHall – Paris-Saclay



Industry 4.0 – connectivity, artificial intelligence, agile value networks, flexible systems, collaborative robotics...

What's in it for **humans** ?

Leave robot jobs to robots

→ more human jobs for humans



We are wired to explore, experiment, build, imagine and create...



No activity is more human than looking for solutions to difficult problems in unexpected places... or looking for unexpected problems that our solutions could solve.

Thank you!