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Develop, manufacture and service aircrafts in the digital age
T.Chevalier - Digital Design Manufacturing and Services Program
Airbus
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Digital Age | The change

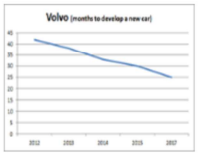
- **Speed**

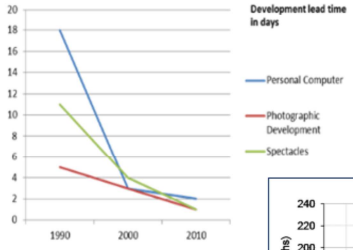
  incremental [time reduction @ fixed complexity] or [complexity increase @ fixed time]

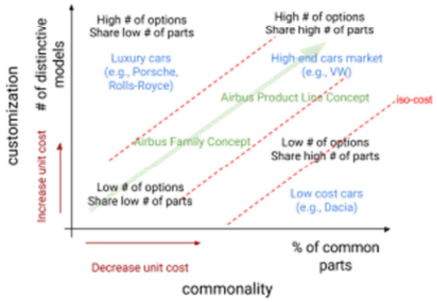
  ➔ drastic development lead time acceleration or complexity increase

  - innovation on usage with limited technology improvements (e.g. iPhone, various C2B2C)
  - platforms (e.g. VW MQB)
  - devops (e.g. GAFA's release rate)

Audi A3 Mk3
Audi TT Mk3
Audi Q2
SEAT Ibiza Mk5[
SEAT León Mk3
SEAT Arona
SEAT Ateca
SEAT Tarraco
Škoda Octavia Mk3
Škoda Superb B8
Škoda Karoq
Škoda Kodiaq
Volkswagen Arteon
Volkswagen Atlas / Teramont
Volkswagen Golf Mk7
Volkswagen Golf Sportsvan
Volkswagen Jetta MK7
Volkswagen Lavida
Volkswagen Passat Mk8
Volkswagen Polo Mk6
Volkswagen T-Roc

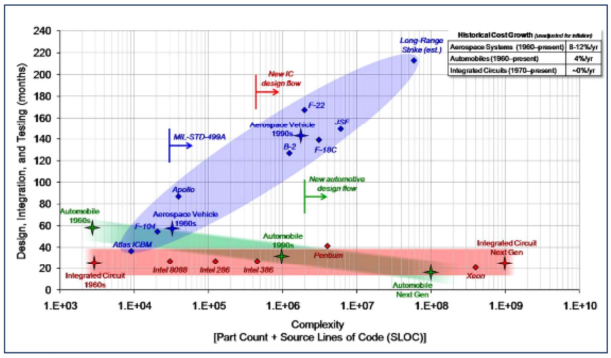






High-performing IT organizations report experiencing:

State of DevOps report 2016



source: DARPA

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Digital revolution amplitude is considered similar to industrial revolution in development cost & lead time

Speed of development or adaptation of new products first

➔ **DevOps** : Google over 3500 release per day, Amazon approximately every 11 seconds

➔ **Product lines** : VW MQB platform, approx. 7 times the cost of a model,
but over 30 models built on it with 30% to 50% cost and lead time reduction per model, 80%+ for derivatives

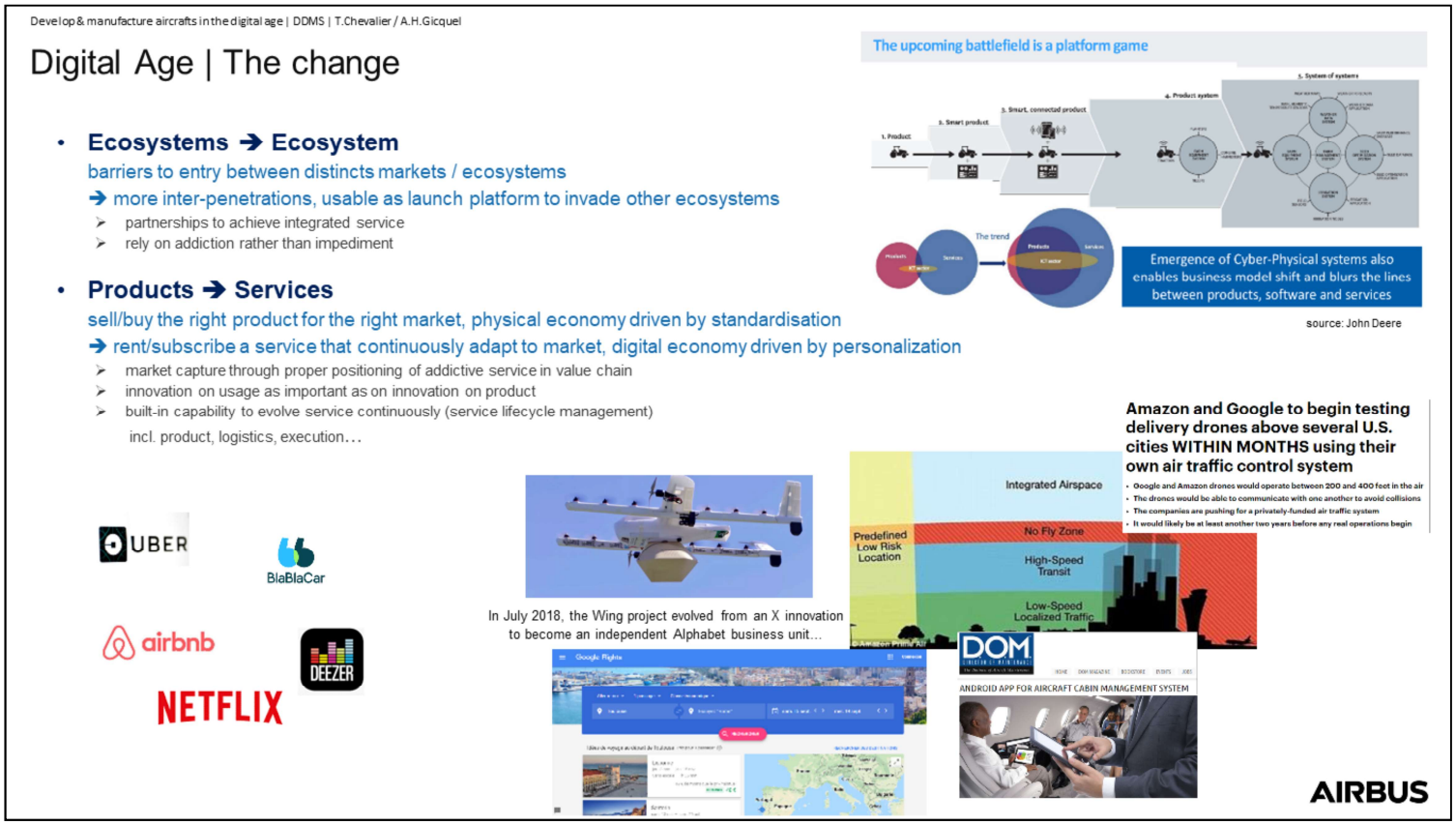
Aeronautic seem stuck to increase cost & lead time with complexity,

which is not the case for other businesses

➔ weight for aeronautics is speed for software development, no such silver bullet as Moore's law

Absolute need to put ourselves on new digital basis

to be able to sustain competition acceleration in this new world



Digital revolution amplitude is considered similar to industrial revolution in integration of ecosystems

➔ industrial revolution was integrating technologies and modularizing the products, we do it on ecosystems

➔ seen tractors with no-one on board ploughing a field ? seen drones investigating crops or grapes development status ?

➔ new farms have their little Cape Canaveral room, with the farmer piloting automated tractors & drones operating on various fields simultaneously

Digital revolution amplitude is considered similar to industrial revolution in moving to services

➔ industrial revolution was moving from artisanal to serial - product as a commodity - we move from products to services - personalization as a commodity

➔ rule by addiction, not any more necessarily technology e.g. Facebook

➔ in the 90's, hotels were sub-contracting the building of their website to freelance webmasters, "not my core business" they said
now, most of them have 80% of their customers booking through internet booking systems, they became sub-contractors of the websites…

➔ and even the centralized websites (B2C) have difficulties with AirBnB (C2B2C)… until blockchain systems will allow for C2C and Uberize Uber :-)

Google is an excellent example of how to traditional aeronautic ecosystem is besieged, with

➔ a consistent approach across several ecosystems

➔ a systematic positioning as close as possible of the final consumer

➔ building alliances - even between big GAFA's - to better storm market and be first to create addiction

We absolutely need to move toward similar mindsets to survive, and design platforms able to support quick integration of various ecosystems, quick development / evolution of new services
(not same aircraft for 30 years e.g; A320 still using Z80 microprocessors and IFE systems looking weird in most airliners)

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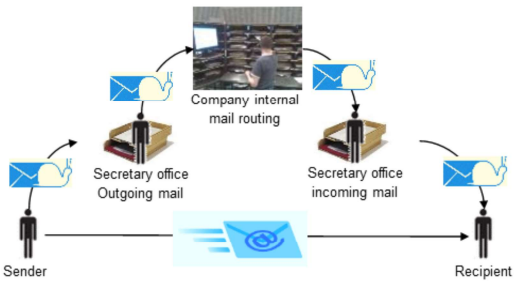
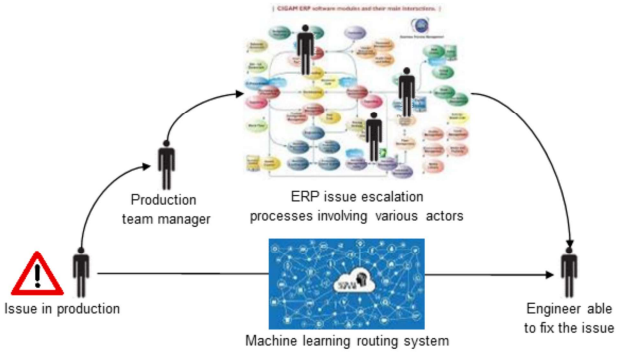
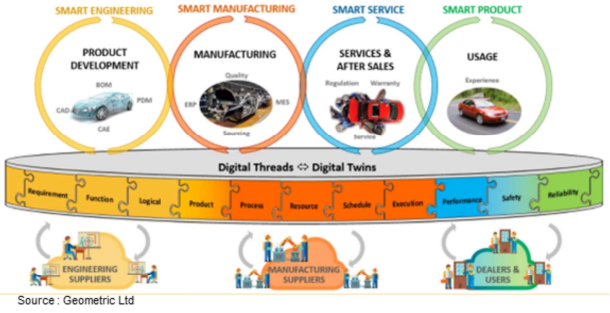
Digital Age | The change

- **Hierarchical ➔ Flat**
  find through organization/classification ➔ find through search/machine learning
  - digital continuity is a bus, not a hard wired system
  - digital continuity should spans all the data ecosystems
- **Fixed ➔ Dynamic**
  predefined formalized process/workflow ➔ on the fly optimized routing of actions
  - dynamic development plan, built specifically from target objectives
  - all data exposed, to be freely & dynamically analysed / used / combined in appropriate way







Source : Geometric Ltd

Digital Thread

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Digital revolution amplitude is considered similar to industrial revolution in revolutioning how organizations optimize their efficiency

➔ industrial revolution was able to scale thanks to highly standardized tasks and processes hierarchically organized - Taylorism and Fordism

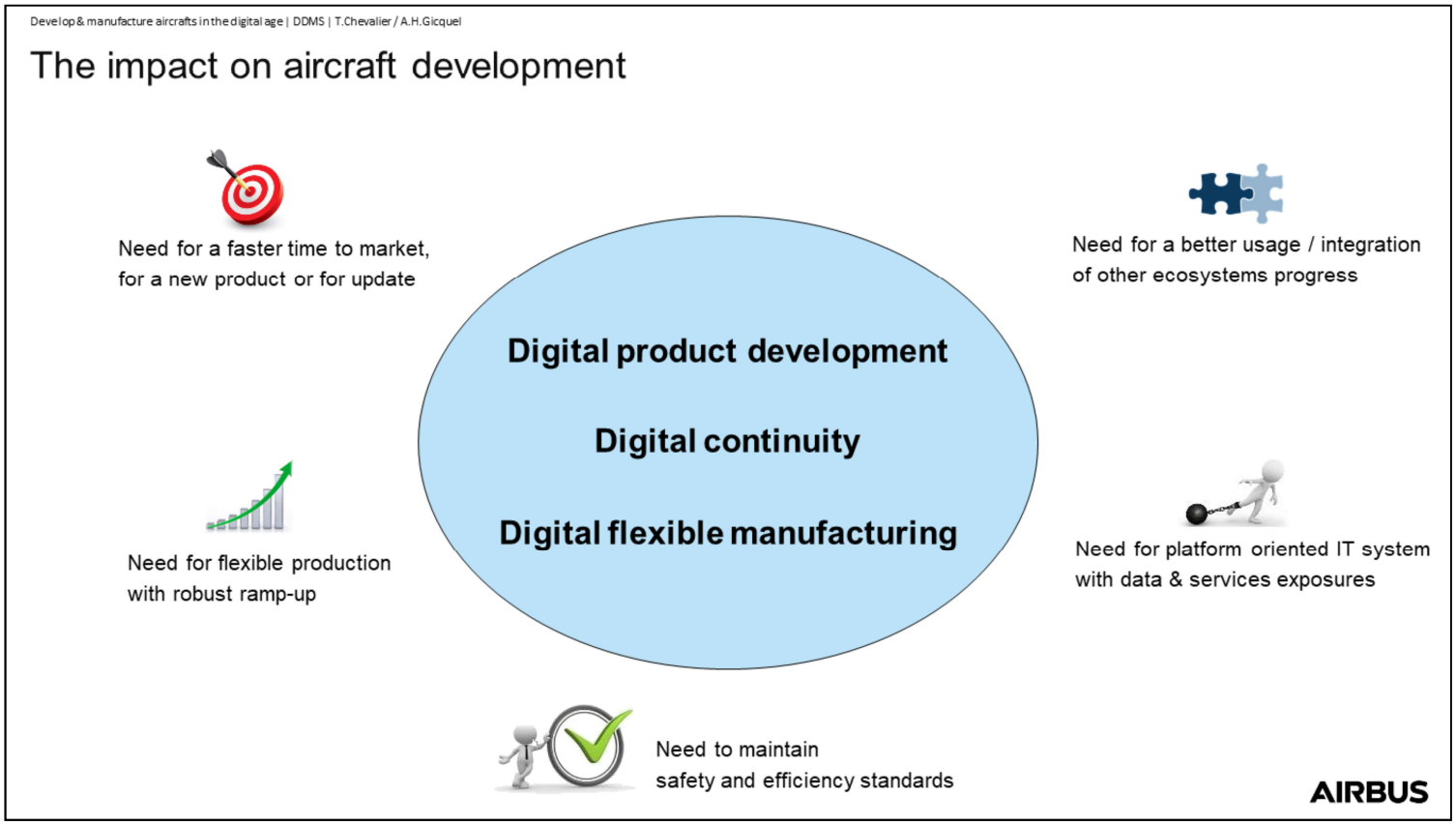
➔ we go now for direct interactions, bypassing hierarchical organization & processes thanks to scalable electronic enabled point 2 point relationships

Digital revolution amplitude is considered similar to industrial revolution in revolutioning how organizations optimize their efficiency

➔ industrial revolution was moving from individual complete craftmanship to splitting the work between specialized actors working on highly standardized products

➔ we go now again for specialization and personalization, bypassing need for standardization through smart combination of options & processes

Absolute need to put ourselves on new digital continuity basis to be able to sustain competition acceleration in this new world



Think system of systems

- SE and MBSE for speeding intial design and further updates
- Product lines for mastering variety at a limited cost /ramp-up
- Holistic integrated design

Flexible Digital factory

- digital factory operating system incorporating C3I & analytics in a modular framework
- flexible factory with maximum usage of generic jigs a tools (e.g; cooperative robits)
- flexible piloting of local work units mixing robots, humans and smart toolings

Holistic digital continuity

- reconciliating product lifecycle, value chain and enterprise processes axis
- allowing easy in context feed of other area / phases data
- allowing wide analytics to be performed easily

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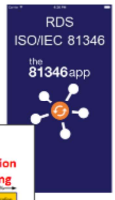
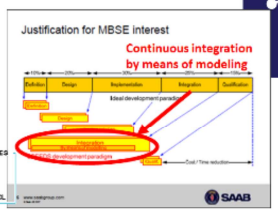
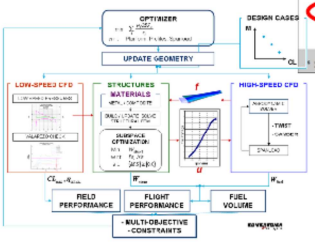
Digital product development tracks

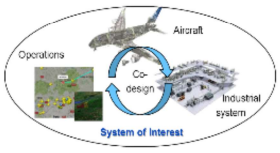
System Engineering, Model Based System Engineering, Model Based Engineering

- Saab on Skeldar V, then Boeing with Saab on T-X training aircraft, successful in "breaking the cost curve"
- Bombardier efficient large multi-disciplinary optimisation of C-series
- Airbus Digital Design Manufacturing & Services initiative
- Mixing distributed bottom-up semantic SE tagging through RDS, with classical top-down SE/MBSE approach









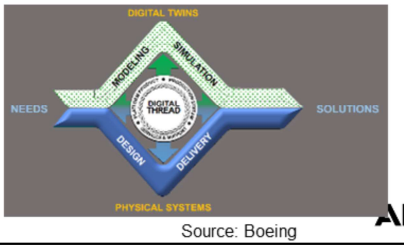
Think system of systems

Co-design

- Boeing reported to model manufacturing since 20+ years now, and started to include service thinking upfront with B787
- Airbus started to model manufacturing more precisely for A350, and services with A320Neo and Skywise
- Capability to integrate very large # of models

Continuous integration

- Boeing's "diamond" model
- Boeing doing DMU continuous integration after 787, Airbus after A380
- Both thinking to expand toward more holistic continuous integration, especially using distributed hybrid system testbenches



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Source: Boeing

SE, MBSE, MBE

- System Engineering <> Software, need to move to Component Based Architecture just like when moving to COM / Java / ADA
- Multi-view configuration management
- RDS
- Surrogate models

Co-Design

- took years to develop A/C architects, able to handle high level future projects or architecture view BEFORE we dive in detailed design
  avoiding detailed design trial & error
- need similar step back from detailed manufacturing & detailed operations
  and need time to train architects
- large # of models handling & combination through GEM's

Continuous intergation

- DMU continuous integration principle
- Distributed hybrid test benches / Virtual Hybrid Testbench New Generation
- Right All Time rather than Right First Time

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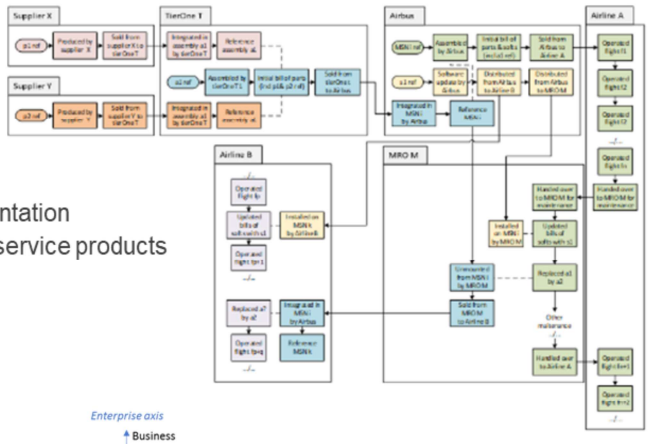
Digital continuity tracks

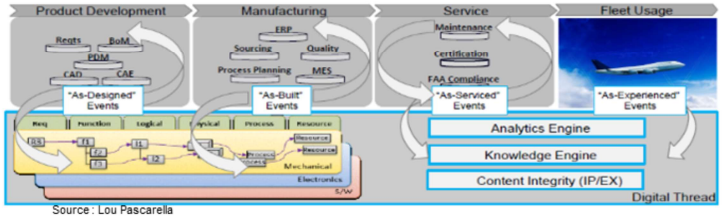
Configuration management of in-service products

- Many initiatives in the US by Boeing, GE… and Airbus with Skywise
- Digital Twin opportunities explored by many actors,
  but needing distributed, politically neutral, safe and auditable implementation
- Automotive actors ahead in detailed configuration management of in service products



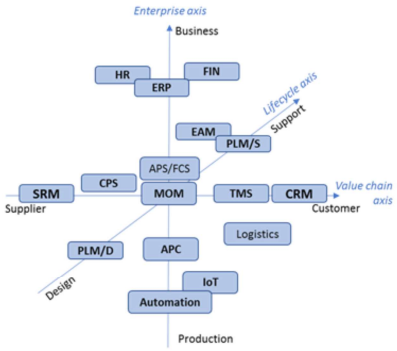
Connecting the different axis of continuity

- Last years IT technologies now make such master models possible
- Airbus Master Data Model cross-axis connexion initiative
- Allow context feed of other area / phases data,
  as well as wide analytics to be performed easily



Source : Lou Pascarella

Holistic digital thread along product axis



HR : Human resources
ERP : Enterprise Resource Planning
FIN : Finance
EAM : Enterprise Assets Management
PLM : Product Lifecycle Management
APS : Advanced Planning & Scheduling
FCS : Finite Capability Scheduling
SRM : Supplier Relationship Management
CPS : Contract Payment System
MOM : Manufacturing Operations System
TMS : Transaction Management System
CRM : Customer Relationships Management
APC : Acquisition & Production Cost
IoT : Internet of Things

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Digital twins

- Distributed ledger as opportunity, completin neutrality of chisen solution by using an OpenSource implementation through Hyperledger
- Not a technology blocker, but CONOPS to be clarified and agreed

Digital thread

- Product management vs Project management, linking PBS, OBS, WBS…
- Indexation + Triple store + Cloud + REST API's : much more standardized and incrementally working than old warehousing solutions
- SPARQL to explore, then build re-usable Design to X (D2Cost, D2Operability…) views
- Service analytics for origin of discrepancies (change of manufacturing process, provider…)
- Feedback loops to design (from manuf or from operations)

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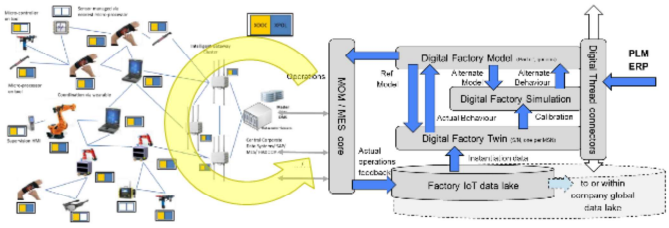
Digital flexible factory tracks

Digital Manufacturing Operating System

- Factories extended enterprise system of systems mastery, need a robust, multi-channel, fault-tolerant, scalable and secure fog C3I
- Smart tools and devices explosion and rapid evolutions mastery, need a scalable and modular integration capability
- Analytics capability - especially for predictive maintenance - need a ability to spawn local streams analytics agents anywhere
- US DMDII, EEC Industry 4.0 / Usine du Futur…

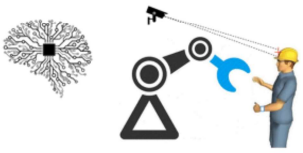


Factory digital twin

- Combining dynamically updated model trying to stick to nominal production plan under constraints, with real feedback from shopfloor

Flexible artificial intelligence powered local work cells

- Moving from back-office fixed operations scheduling based on large specialized jig and tools, to combination of cooperative more generic robots
- To edge dynamic determination of how to get workcell job done, based on available changing mix of robots, humans, sensors, smart tools
- CNRS LAAS (Laboratoire d'Analyse et d'Architecture des Systèmes), GoogleX robotics…



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Digital manufacturing operating system

- DOS analogy :
  - SmartTools & all <> disk or interfaces controllers,
  - MES or analytics as programs using DOS
  - Airbus CITAR , with semantic to have layered levels of abstraction : meaning is built as info elementary info are aggregated

Factory Digital Twin

- Need to get the ACTUAL manufacturing activities model, or comparing actual feedback with nominal model
- PERT under constraint

AI for local workcells

- Harness change of smart tools - now rented to mitigate impact of too fast changes

Thank you

- individual methodologies (e.g. semantic linking, product line engineering…) and technologies (e.g. ALM, AI, IoT, blockchain…) progressing fast and providing many opportunities

- even bigger opportunities in their combination, sometimes just in the usage :-)

➔ but a huge part of the success to use all that is in the management of the change !

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