Valmistavan teollisuuden digitaalinen tulevaisuus / Digital future of the manufacturing industry

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Outline

• Why digital?
• Past…
  – The rise of “services” / service economy
  – Technology timelines
  – Looking to our century from 1990
• A way to co-evolve: match of product and equipment
• Digital future through web service-inspired manufacturing systems
Why digital?

“Any customer can have a car painted any color that he wants so long as it is black.”

Today:
Through digitalization we can explore and bring more options for customers.

Henry Ford
"70 per cent of the labour force was employed in agriculture and just under 10 per cent in forestry."

The rise of “services”: Finland

source: www.statista.com
60s: PLC born
ARPANET

70s: Terminals, Networking, PC

80s: Networking (MAP) Ethernet

90s: IEC61131-3 the Internet

00s: IEC61499 Web standards
Past: Technology timeline (2)

60s: Teletype
    ARPANET

70s: Graphics terminals, Unix
    Ethernet

80s: GUI
    Ethernet

90s: Smartphone
    the Internet

00s: Cloud computing
    Web standards

Technology -agnostic Cloud

cluster
ccontroller
dumb
terminal
dumb
terminal
printer
21st Century Socio-Economic Trends

• New consumer demands
  • Higher quality design
  • Customized products
  • Lower cost per function
  • Shorter delivery cycles

• Globalization of:
  • Markets
  • Manufacturing
  • Products standards
  • Process standards

Source: "Joint International Research Programs into an Intelligent Manufacturing System," Ver.3
IROFA, Tokyo, January 1990
Technological Barriers

- **Islands of Automation**
  - Difficult to integrate
  - High cost of technology transfer

- **Lack of Systematization/Standardization**
  - Lack of standardized interfaces
  - Insufficient base of reusable technology
  - Requires highly skilled, specialized labor
  - High training cost

- **Barriers to:**
  - Product customizability
  - Shorter design/delivery times
  - Globalization

Source: "Joint International Research Programs into an Intelligent Manufacturing System," Ver.3
IROFA, Tokyo, January 1990
Digital manufacturing: Where to start?

How many... bytes, hertz do you see for the following picture? (And where/when those can be useful and efficiently used?)

- Resource management
- Production plan
- Process control
  - Controllers?
  - Networks?
  - Control programs?
  - Protocols?
  - Supporting / Supervisory applications?
  - "Digital twins"?
  - CAD/CAE/CAM models?
  - Simulation models?
  - Manuals?
  - Sensors?
  - Actuators?
  - Data formats?
  - Software tools (frameworks)?
  - Required operations cycle times?
  - ...
Co-evolution through digital worlds

Check the properties of the product / part.
Check the performance of a manufacturing system.
Design for ‘X’ (assembly, quality, resourcefulness, ...)
Co-evolution through digital worlds: Approach

Putonen, Lobov, Lastra, “Semantics-Based Composition of Factory Automation Processes Encapsulated by Web Services” (LINK)
Standard example: Web Ontology Language (OWL)

“Ontologies are *formalized vocabularies of terms*, often covering a specific domain and shared by a community of users.” (+ or by a “community” of machines)

Mapping product needs and production capabilities:

- [https://www.w3.org/TR/owl2-overview/](https://www.w3.org/TR/owl2-overview/)
Standard example: Web service

“A Web service is a software system designed to support interoperable machine-to-machine interaction over a network. It has an interface described in a machine-processable format”.

- https://www.w3.org/TR/ws-arch/

Service oriented Architecture:

The development of the Internet and the Web gave us standards for information representation and integration.
Implementation example: Functions defined as (micro)services [eScop project]

Physical devices, generic representation models and rules for service composition
Future: From product *customization* to tools/processes *customization*

- Digital manufacturing: from *product* customization to the customization of engineering / runtime / maintenance / … *processes*.
  - APIs to extend existing tools
  - Tool as a service.
Future: From product customization to tools/processes customization

Vision

Past:
A set of standards developed to allow dynamic integration of complex information systems.

Present:
First tools (tools frameworks) got mature also providing APIs to manage complex manufacturing projects (e.g. CAD/CAM).

Digital Future:
Assistive engineering with more extensive runtime reconfiguration of manufacturing systems will become possible through the use of semantic and extendable standards.
Questions / Suggestions

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