DSEquipment

Towards the digital spare equipment

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Context – the challenge

- Large industrial investments often involve **systems with long lifecycles**
  - Process industry, oil and gas, energy production, etc.
  - Spare parts and equipment are needed during planned or unplanned maintenance actions
- The **availability of spare parts and equipment in reasonable time is critical** to keep the plant running
  - Often there is a need to stockpile spare parts and equipment
- Often equipment vendors have difficulty in supporting very old equipment

Digital Spare Equipment – DSEquipment

- The basic concept is to have **the information needed** to reproduce, in small-scale, spare equipment → Digital Spare Equipment
  - Mechanical, electrical, electronic and software aspects taken into account
- **DSEquipment:** The information to reproduce the parts and components of the equipment and assemble them needs to be based on explicit information, such as open standard data formats
  - What information is needed and in what form?
  - What components and platforms can we assume to be available in e.g. 30 years (e.g. nuts and bolts etc., IEC 61131 PLCs)?
- **Ambitious goal** with interesting **technical challenges** and significant **impact to industrial business ecosystems**

Example use case workflow

When the plant is designed:

Owner/Operator wants a key equipment “EQP-A” to be future-proof, compatible with the DSEquipment certification.

Equipment vendor designs a version of the “EQP-A” using open data formats that can be produced in small scale beyond the lifecycle of the mass-produced version.

The digital version of the “EQP-A” is sent to a trusted third party small scale manufacturing service for producing a proof of concept version. If this version is functionally equivalent to the large-scale production version, the “EQP-A” is certified as a DSEquipment.

The DSEquipment data of “EQP-A” are stored in a trusted secure location (e.g. government agency or secured digital service).

After a long time in the plant’s lifecycle:

Owner/Operator wants a spare equipment of “EQP-A”.

The equipment vendor cannot provide the spare part (at all or not in reasonable time) or prefers to use the DSEquipment version.

The “EQP-A” vendor can produce the DSEquipment or, according to the agreement between the O/O and the equipment vendor, the O/O has the right to release the DSEquipment data and order a spare part from a trusted external service provider.

The process is back and running using the small-scale manufacturing version of “EQP-A”.

DSEquipment – Business cases

- For the Owner/Operator using DSEquipment
  - Provides a layer of protection against lack of spare parts for long lifecycle plants
  - Enables more flexibility when choosing an equipment vendor, more competition

- For the equipment vendor using DSEquipment
  - Provides a way to produce spare equipment beyond the lifecycle of the mass produced version
  - Provides future-proof reference material for the design and operation of the equipment

DSEquipment – Example

Pump and an actuator + controller

- Definition of the actuator interface to SCADA (e.g. OPC UA) and to the pump
- Controller enclosure (3D printed)
- Printed circuit board design, component list and board assembly instructions
- Microcontroller architecture/technology definition (e.g. IEC 61131-3 PLC)
- Control software in a standard language (e.g. IEC 61131 Structured Text)
- Standard pump selection with given interface to actuator and minimum specifications
- Overall assembly and mounting instructions

Examples of standards and open specifications

Mechanical design

- ISO 10303 Standard for the Exchange of Product model data (STEP)
- STL file format, stereolithography CAD, 3D printing
- ISO and ASTM International “Additive Manufacturing Standards Structure”

Electronic design

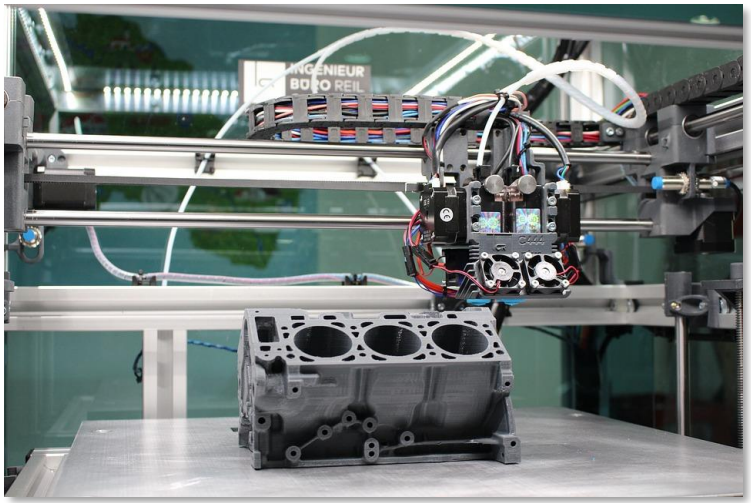
- Gerber X2 format for PCB design, IPC-D-356 netlist descriptions
- IEEE 1801-2013 – IEEE Standard for Design and Verification of Low-Power Integrated Circuits

Software

- ANSI C C18 ISO/IEC 9899:2018, C++ ISO/IEC 14882:2017(E)
- IEC 61131 PLCOpen XML, IEC 61499 XML

Computational HW

- IEEE 1076.1 VHDL Analog and Mixed-Signal (VHDL-AMS)
- IEEE 1364-2005 – The official standard for Verilog 2005
- HW architectures, such as ARM and x86



Technical challenges

- How far can we go with the standards for industrial information we have already for capturing the different aspects of key equipment?
  - Are extensions or new standards needed?
  - Manual/automatic assembly instructions?
  - How to categorize equipment according to interdisciplinary design complexity?
- Consider cascading effects to introducing a DSEquipment into the process if it is not 100% functionally equivalent (how the process needs to be re-configured)
- What can we consider as a given (standard components, computational platforms, software languages) when we think of long lifetime periods?
- How is the small scale manufacturing model different to the large scale manufacturing version, equivalent solutions?
- How can we secure the data storage and the communication between stakeholders?
  - International Data Spaces Association (IDSA) – reference model application?

Business-related challenges

- **What would be the impact of this new concept to the way Owners/Operators and equipment vendors interact and do business?**
  - Consider that many times a vendor is chosen because of better promise for supplying spare parts and support, what if this can be taken out of the equation?
  - **The equipment vendor can choose to produce a spare part using the DSEquipment data** in case it is not financially viable to stockpile spares or keep a production line running
- **What will be the impact when eventually many DSEquipment do go to public domain (companies go bankrupt and the IP is released to the public), how can this data be exploited for generating better designs?**

Past research – new research proposal

- The **Digital Spare Part** Business Finland projects (VTT and Aalto)
  - Past project on single piece parts (not assemblies) – *Digital Spare Part*[1]
  - Current project including research on adding “smart” features to these parts – *New business from Digital Spare Parts*
- Depending on the interest from industrial partners, it is possible to plan a **Co-innovation Business Finland** proposal, potential partners include:
  - Owner-Operators
  - Engineering offices
  - Equipment vendors
  - Small scale manufacturing companies

[1] https://www.vtt.fi/inf/julkaisut/muut/2018/DIVA_final_report.pdf

beyond
the obvious

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