NASA Quality Leadership Forum 2021

The need for Digital Twins for Manufacturing and Supplier Assurance

Jan de Nijs

Fellow

Enterprise Digital Production

22 April 2021

PIRA# CET202104001

LOCKHEED MARTIN

LOCKHEED MARTIN: BUSINESS STRUCTURE

Jan's main domains of expertise.

Aeronautics





Missiles and Fire Control





Rotary and Mission Systems

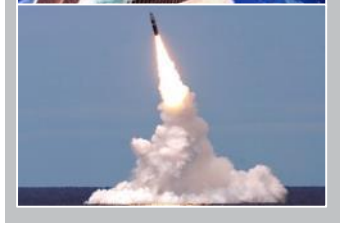




Space







Digital Twins (DT's): Two main "maturity" stages

1. **"Driven" Digital Twins**
   Purpose-built digital descriptions of observable elements: the DT's mirror the real, physical world.

   ISO 23247, ISO 10303-AP242, ISO 10303-AP238, QIF, MTConnect

2. **"Driving" Digital Twins**
   Purpose-built digital descriptions of what the real world ought to look like: the real, physical world is made to mirror the DT.

   DAU definition: "An integrated multiphysics, multiscale, probabilistic simulation of an as-built system, enabled by Digital Thread, that uses the best available models, sensor information, and input data to mirror and **predict** activities/performance over the life of its corresponding physical twin.

Done for years on our products. However, hard to translate to the Factory.

Challenges in developing Factory Digital Twins

Issues developing “Driven” DT’s

1. **Missing digital thread**

   Part Numbers, Serial Numbers, Model Based Product Characteristics (MBPC’s)

2. **Confusing Record of Authority**

   Native CAD models? JT? ISO10303-AP242? What is driving downstream consumption?

3. **No culture of delivering digital artifacts with manufactured parts**

   “If the part meets the specs, SHIP IT!!!!”
   Test/Inspection data typically gets “lost”.

4. **No industry wide model to describe factory capability and capacity**

If you can’t create a realistic “Driven” DT, then it will be hard to create a successful “Driving” DT.

Needed to create a realistic “Driven” Factory DT

1. **Clear “Record of Authority” for downstream consumption.**
   ISO 10303-AP242 Edition 2 is a good candidate (Persistent ID’s on geometry and Product Manufacturing Information (PMI))
2. **Clear digital thread.**
   “Deliberate” serialization, Persistent ID’s
3. **Ontologies and semantic definitions of factory data.**
   IO Foundry , MTConnect
4. **Digital artifacts will become a required deliverable.**
   Standards, such as QIF results (“as-built”), MTConnect process information (“as-processed”)
5. **Supply-chain-wide capability and capacity modelling.**
   “SysML” “OWL (Web Ontology Language)”

Accurate “Driven” DT’s are the foundation for successful “Driving” DT’s

Thoughts on the future of Factory Digital Twins

1. **Model Based to Requirements Based.**

   Engineering requirements, DfX, Supply chain information
   "SysML"

2. **Flexible manufacturing.**

   Part processing based on requirements and supply chain information, not on fixed make/buy decisions.

3. **No more "design for a specific process".**

   Can we stop this "design-for-additive" yet? We need a SysML description of the additive process.

4. **Standards will become key enablers.**

   ISO 10303 family, QIF, MTConnect, IPC family (surface mount), Project Haystack etc.


LOCKHEED MARTIN