Using SysML® and Systems Engineering for Manufacturing System Modeling

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25+ years of experience in Manufacturing which includes,
Production line design, Work Station design, Documentation,
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specifications, New Product Industrialization, Production Process
development, Inventory Analysis, Material Handling and Logistics
and Material Procurement.
The Journey Begins

- Understanding role systems architecture plays in the development of complex systems
- Strategies for architecting complex systems
- Perspectives a system model can offer
Typical Approach to System Changes in Manufacturing

Time of Reflection

- View as isolated events with little or no impact beyond the point of use
- Focus is more on core functionality and less on interoperability
- Integration not easy due to incompatibility with existing systems (mechanical, electrical, digital)
- System or process modeling limited to static one-dimensional representations
- Existing mathematical models do not easily convey information for the general audiences

Realization

Bring Systems Engineering methodologies and systems modeling to the production floor!
Learning Modeling Language and Tools

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Searching for Building Blocks

- Exploring systems modeling methods
  - IDEF0 and others
- Discovering what modeling language is and meaning behind the symbols
Searching for Building Blocks

- Why SysML?
  - Lends itself to model
    - Process flow
    - Data flow
    - Structure
    - Requirements
    - Use Cases
- Perspectives of a model
  - Structural
  - Behavior
- Views of a model
  - Diagrams
    - Activity
    - Sequence
    - Block Definition
    - Use Case
    - Others
Transferring Engineering Data to Manufacturing

Applying New Knowledge

Problem:
Manufacturing (automated assembly lines) getting intermittent Design data for machine place parts

Path to solution:
- Created model of our Computer Integrated Manufacturing system to view data flow from Design Engineering to Manufacturing
- Identified gap (manufacturing data no longer produced for changes to existing products)
- Brought awareness of gap to Design Engineering through graphical view of model
- Solution put in place
Journey to Modeling

Problem:
Deviation process not being followed by manufacturing

Path to solution:
- Created model of Deviation process through manufacturing system
- Identified process users and user interactions (who, why, when, what, how, etc.) through use case diagram
- Identified weak links (non-value added tasks)
Journey to Modeling

Problem:
Deviation process not being followed by manufacturing

Path to solution:
- Communicated findings to Manufacturing via activity model
- Identified weak links (non-value added tasks)
- Proposed solution (automate to remove non-value added tasks)
Change Control Process - Deviation Tool

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Journey to Modeling

Problem:
Deviation process not being followed by manufacturing

Path to solution:
- Created model of proposed solution
- Generated activity diagram of user interaction with the tool
- Extracted system requirements from model for codification
Programmable Torque Screwdriver System

Journey to Modeling

Objective: Introduce programmable torque screwdriver system to manufacturing

Path to solution:
- Created model and generated structural view of system through block definition diagram
- Extracted additional system requirements from structural view
Programmable Torque Screwdriver System

Journey to Modeling

Objective:
Introduce programmable torque screwdriver system to manufacturing

Path to solution:
- Generated use case diagram to show possible system interactions beyond the operator
Programmable Torque Screwdriver System

Journey to Modeling

Objective:
Introduce programmable torque screwdriver system to manufacturing

Path to solution:
- Generated activity diagram to show system behavior upon interaction with an operator
- Extracted system requirements from model for system and vendor selection
Lessons Learned

- Look at equipment/tool/process as a part of a larger manufacturing system
- From the larger system perspective, identify all possible (current and future) interactions (user and other systems) with system of interest
- Model structural relationships with system to gain perspective and identify initial requirements
- Identify and model expected behavior of system based on identified interactions
- Redefine system architecture based on identified interactions
- Use model perspectives and views to convey system requirements, intent and functionality to different audiences
- From the larger system perspective, identify all possible (current and future) interactions (user and other systems) with system of interest
Thank You! Questions?