Using SysML® and Systems Engineering for Manufacturing System Modeling

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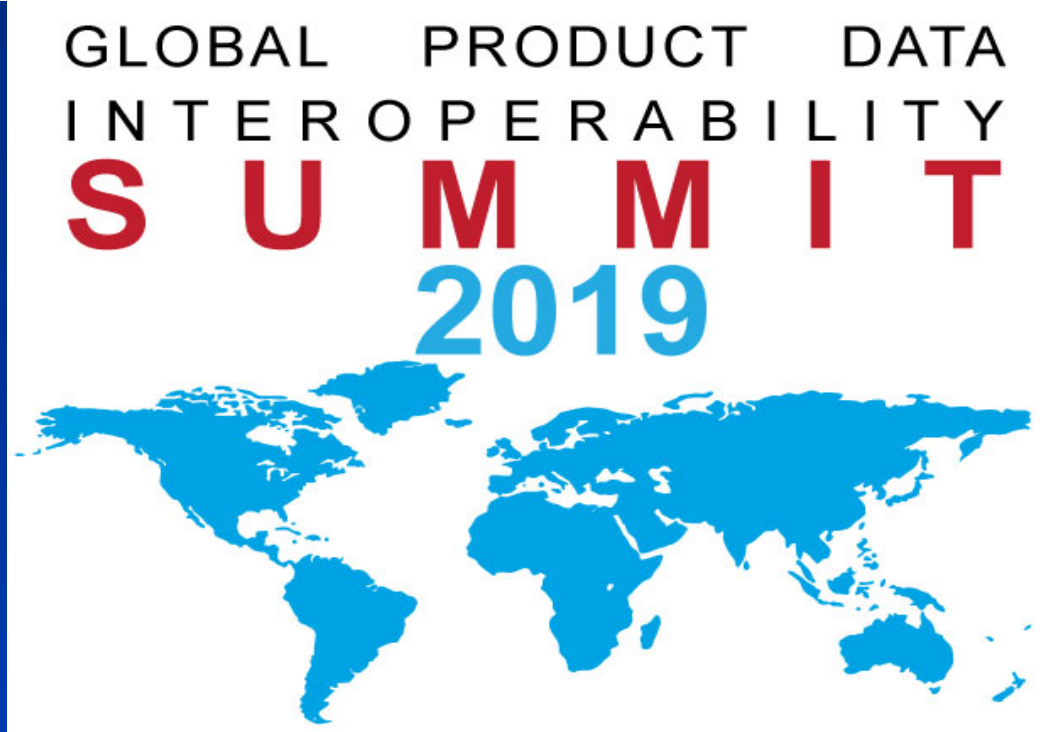
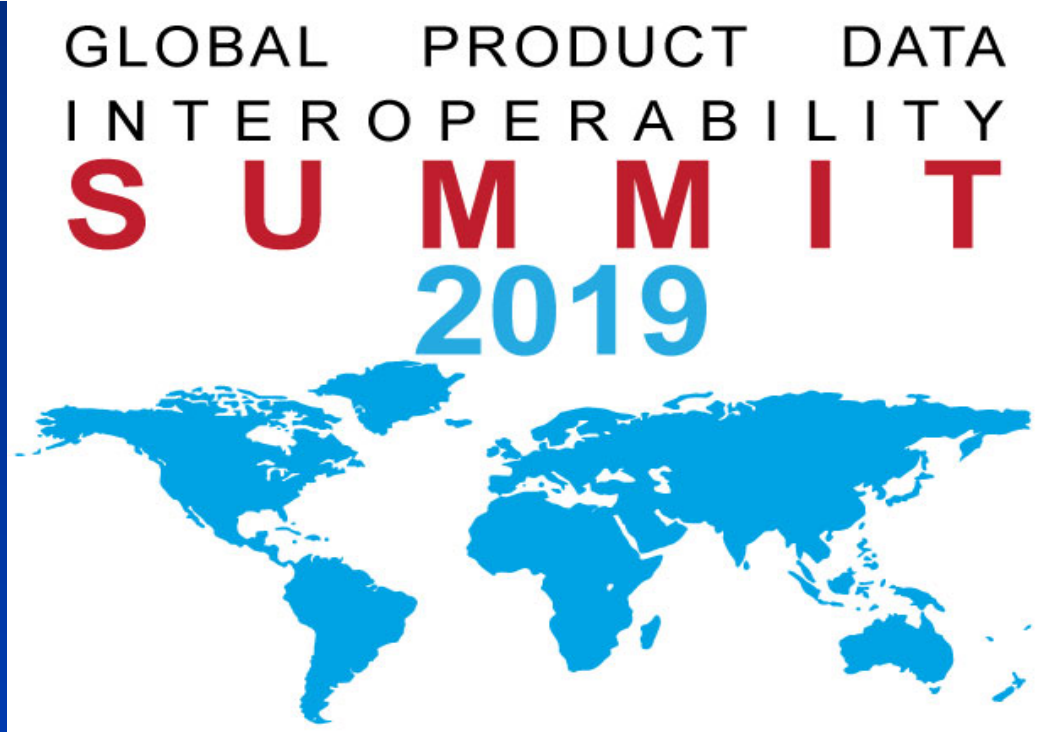


Eugenio Rios
Staff Systems Engineer
Collins Aerospace, Avionics

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



Understanding System Architecting and Modeling

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

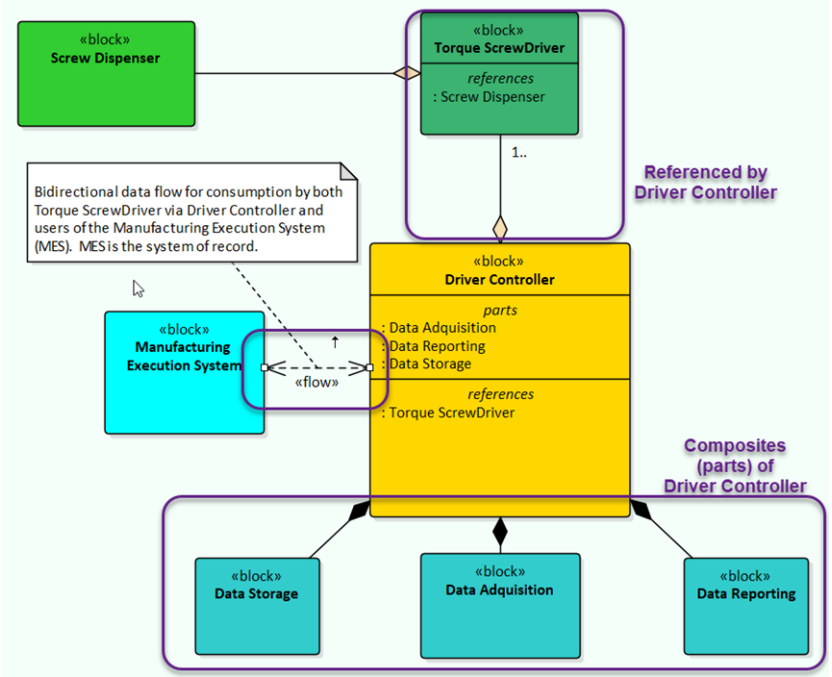
- View as isolated events with little or no impact beyond the point of use
- Focus is more on core functionality and less on interoperability
- Integration not easy due to incompatibility with existing systems (mechanical, electrical, digital)
- System or process modeling limited to static one-dimensional 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!

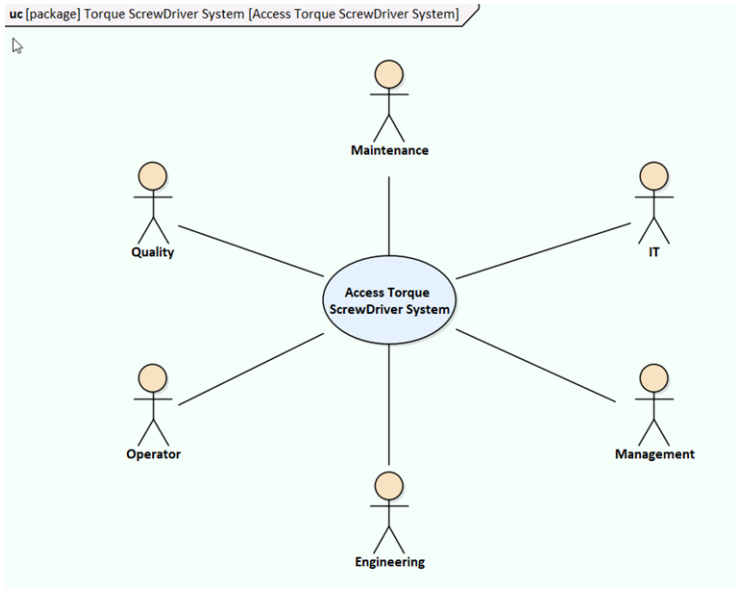
Searching for Building Blocks

- 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

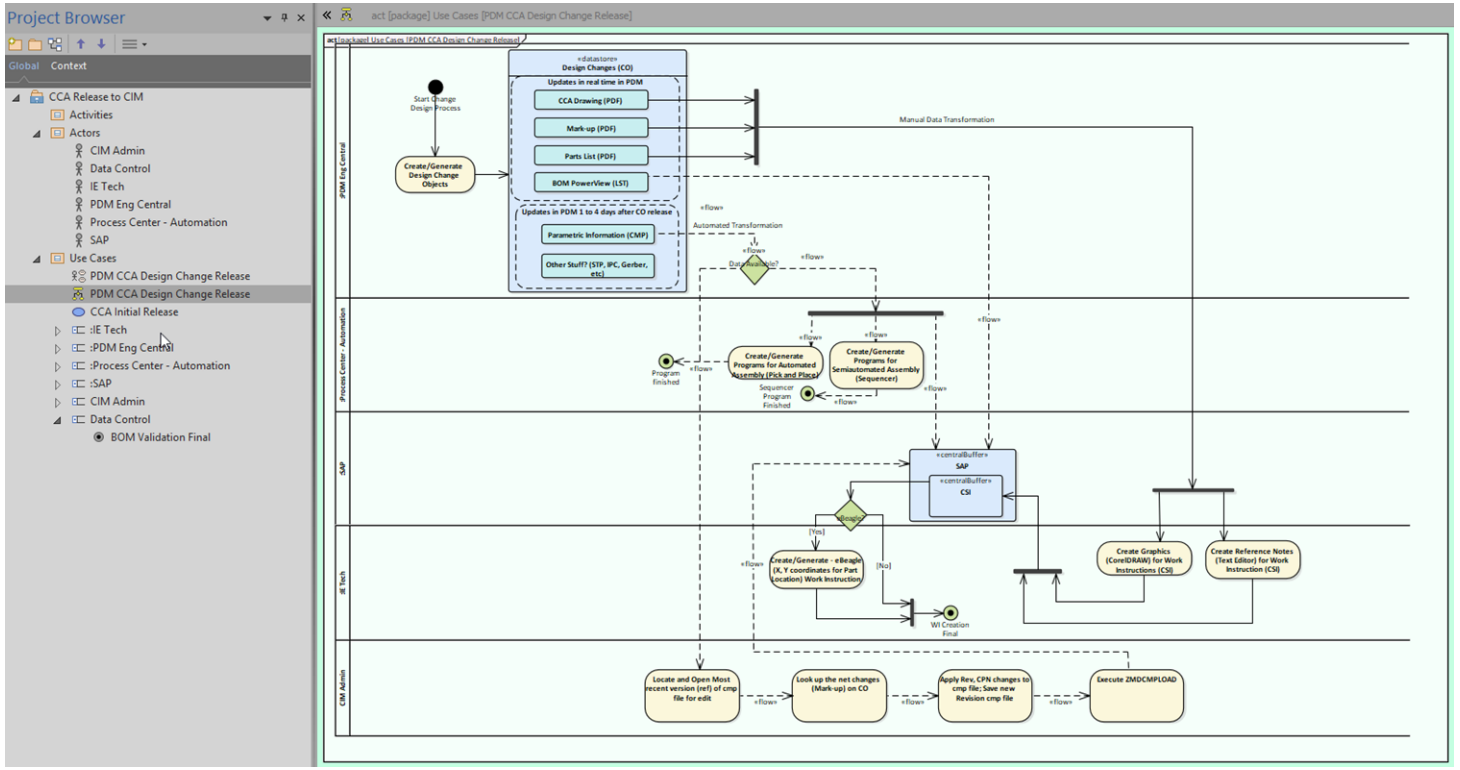
Applying New Knowledge

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



Change Control Process - Deviation Tool

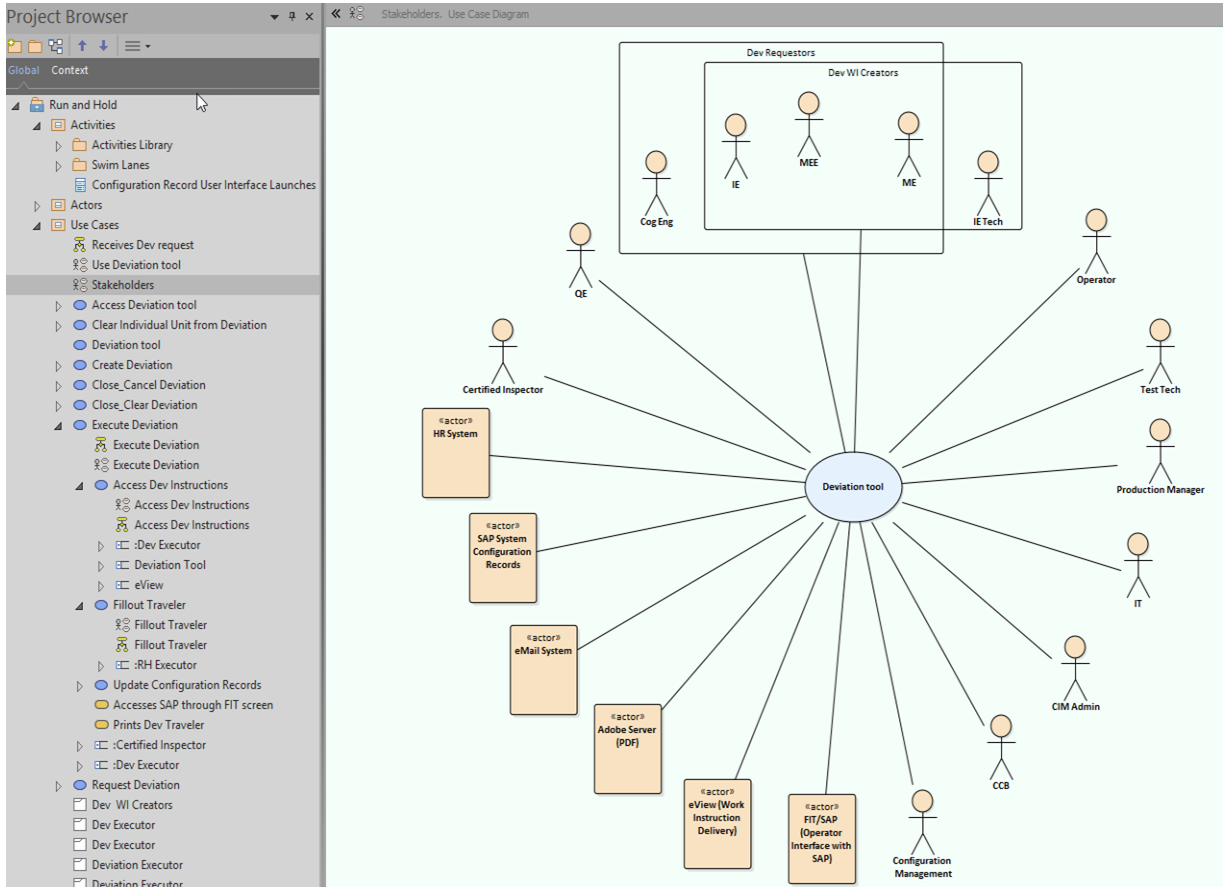
Journey to Modeling

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)



Change Control Process - Deviation Tool

Journey to Modeling

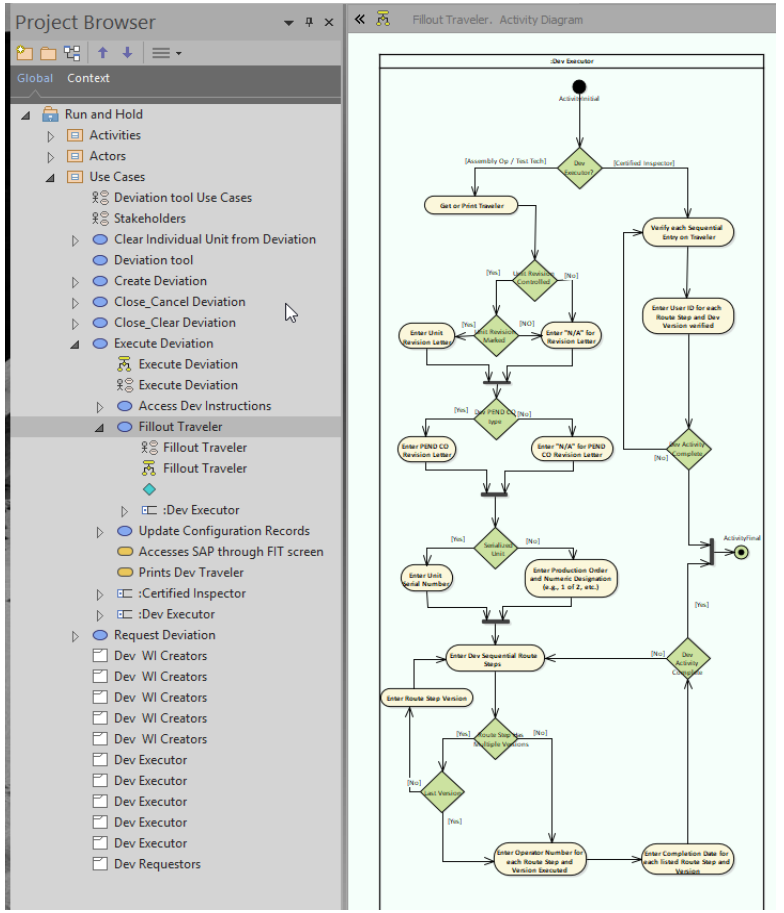
Problem:

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

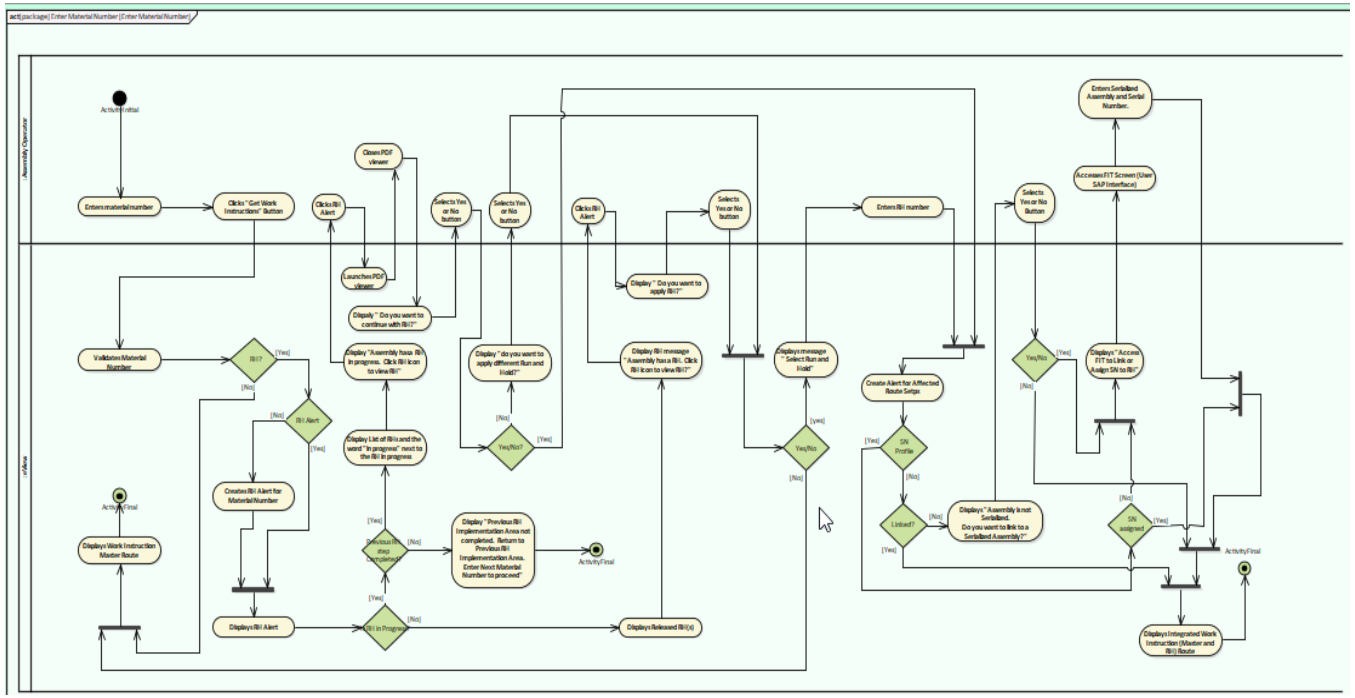
Journey to Modeling

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

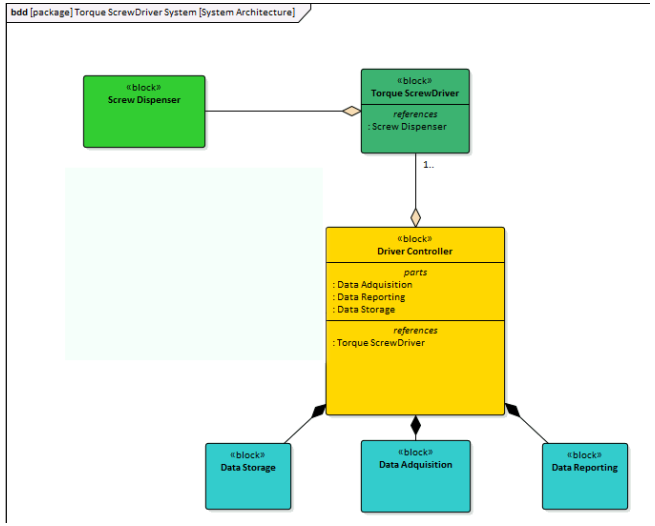
Objective:

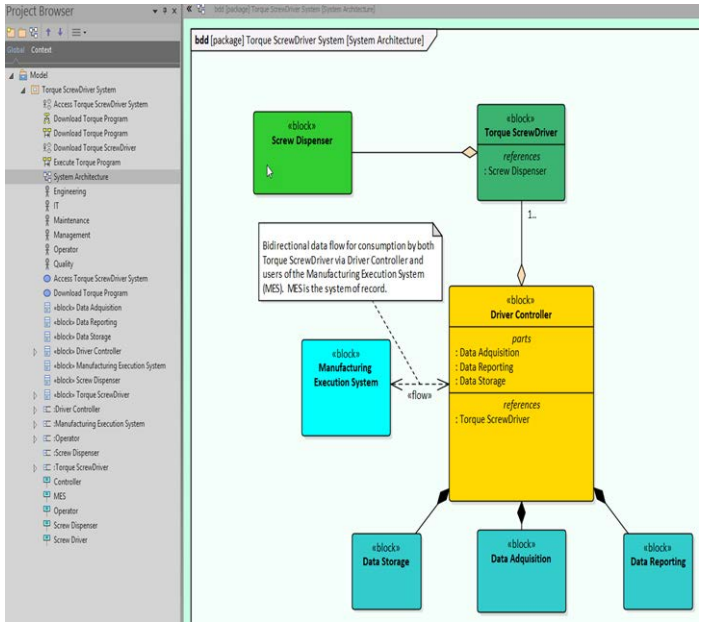
Introduce programmable torque screwdriver system to manufacturing

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

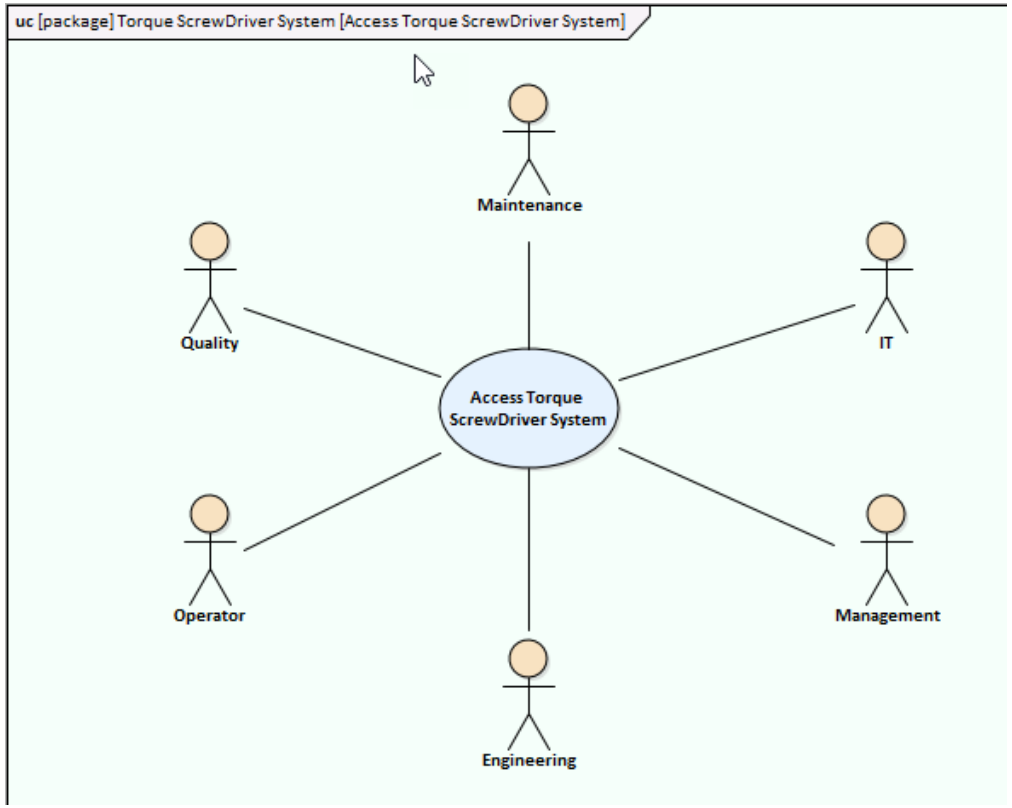
Journey to Modeling

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

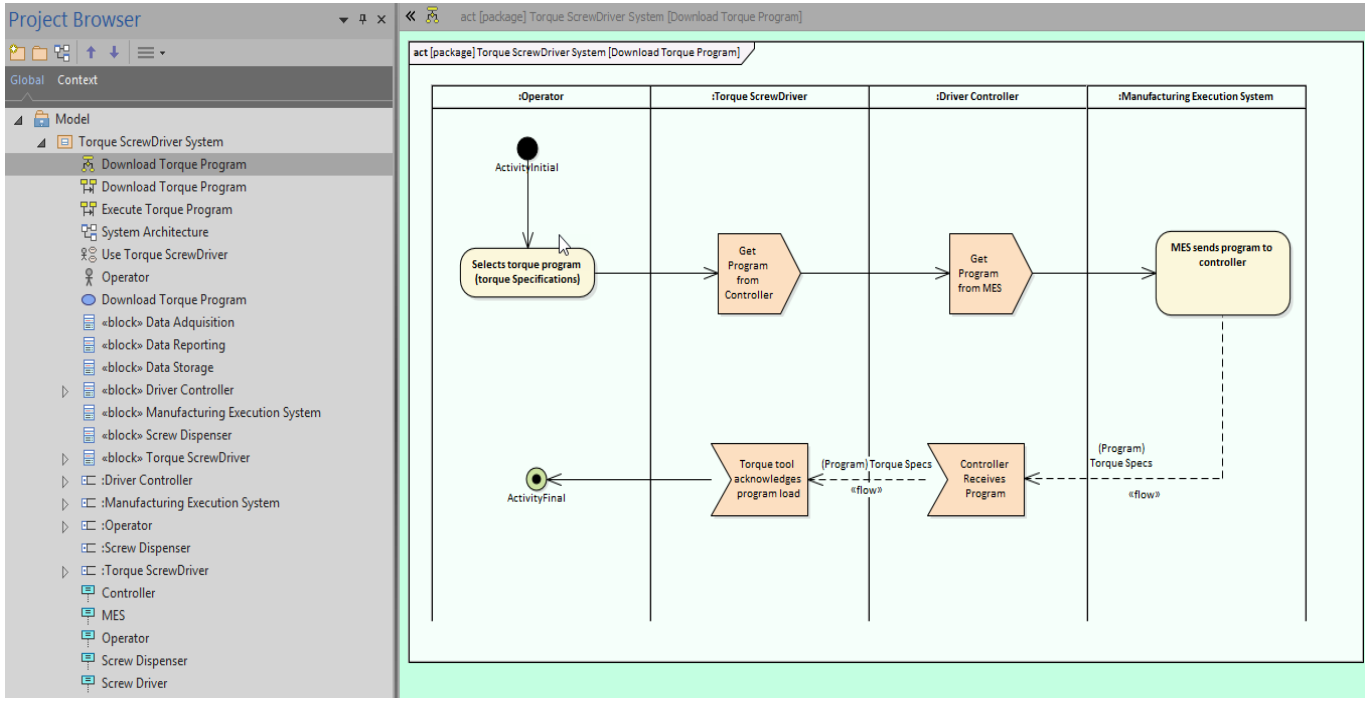
Journey to Modeling

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



Takeaways

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?