ptc LIVEWORX

CAE TECH

USING ONSHAPE MODELS FOR ROBOTIC ASSEMBLY OF MASS-CUSTOMIZABLE PRODUCTS

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17th May 2023

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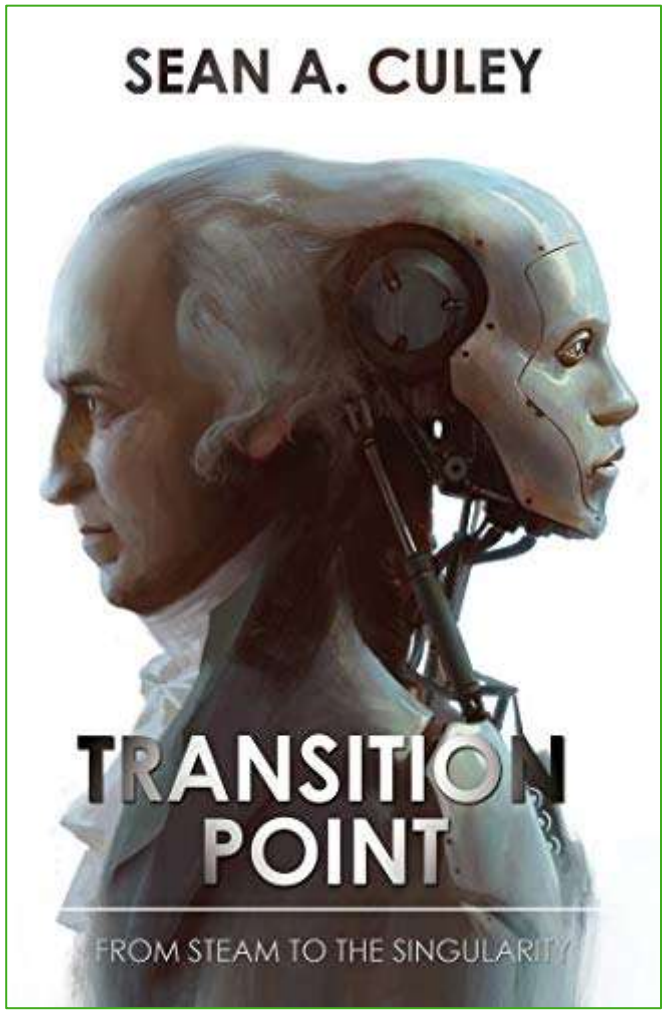
MASS-CUSTOMIZATION: MEGATRENDS

- Mass-customization and build-to-order manufacturing is at the **intersection** of **megatrends**

- **Net Zero**
  - Minimising resource and **material** usage
  - Reducing **transportation** of goods
- **De-Globalisation**
  - Conflict and other risks bring manufacturing closer to the consumer
- Crises of **Supply**
  - From Housing to Semiconductors
- Expectations of **Choice**
  - Many industries view personalization as a differentiator or a necessity

MASS-CUSTOMIZATION: MEGATRENDS



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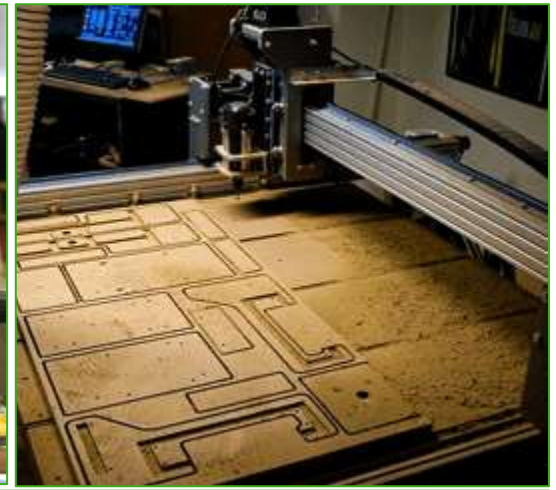
Future supply chains will be PAL: **Personalized**, **Automated** and **Local**

Sean Culey
"Transition Point: From Steam to the Singularity"

HOW ARE CUSTOM PRODUCTS MADE?

- Public Perception

- Reality. **Where are the robots?**



ROBOTIC ASSEMBLY OF A CUSTOMIZABLE PRODUCT

SETTING THE CHALLENGE: CURRENT PROCESS

What would the **current** process be to change a **robot program** for a new **configuration** of a product?

Define the Set of Robot Actions

Assembly **sequence** and **actions** are planned for the product as-designed

Determine Waypoints and Write Robot Code

An automation specialist writes robot code for the planned actions

Install and Execute on Robot

The code is installed on the controller and executed on demand

SETTING THE CHALLENGE: NEW PROCESS

What would the **automated** process be to change a **robot program** for a new **configuration** of a product?

Define the Set of Robot Actions

Actions are defined in the context of the **configurable** design

Quantity and **location** of parts and features are **parametric**

once

Convert to Waypoints and Generate Robot Code

For a given configuration, the waypoint locations and action repetition are determined

A post-processor generates robot code

Install and Execute on Robot

By connecting the robot controller to **cloud APIs**, the program can be updated as required

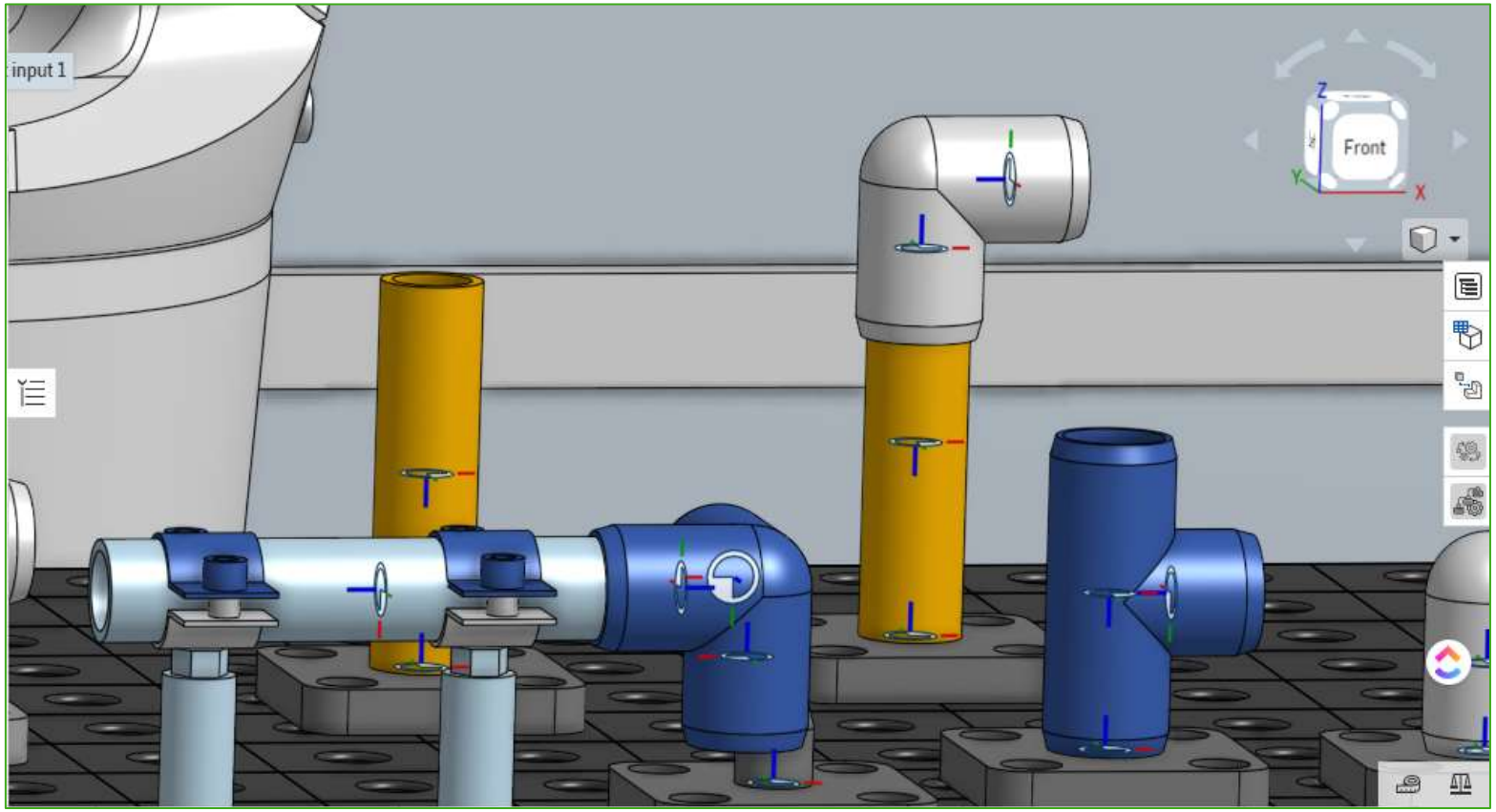
SETTING THE CHALLENGE: THE ROBOT CELL

BUILDING THE MODELS

- **Crusoe Technologies** built the Onshape models
- The robot model is based on STEP file from **ABB**
  - All **joints** defined with **limits**
  - Base and end-effector as **mate-connectors**

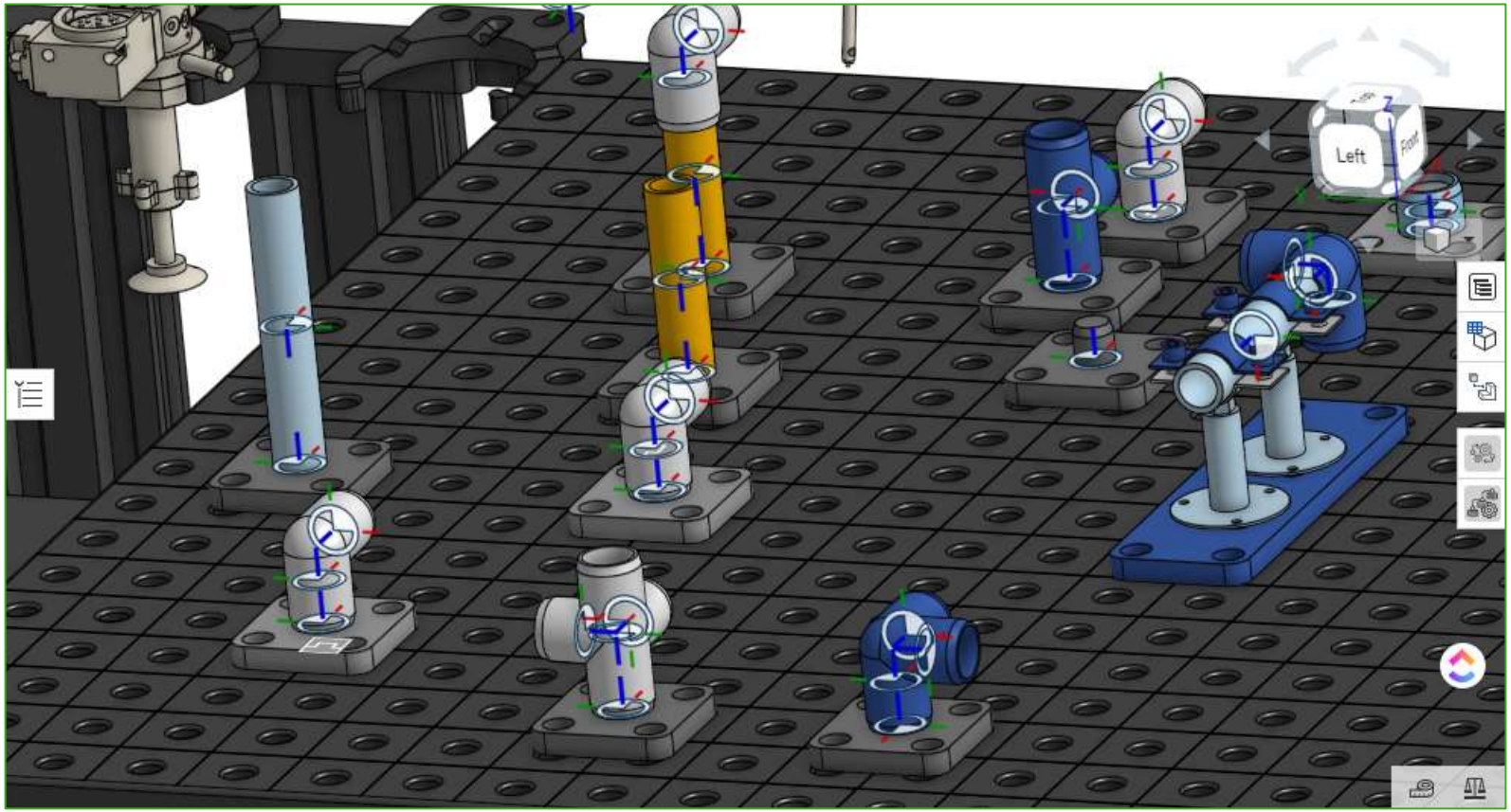
BUILDING THE MODELS: THE PRODUCT

- Each part is modelled in a Part Studio and can be placed into the Assembly
  - Part joining locations use **mate-connectors**
  - Part gripper locations use **mate-connectors**



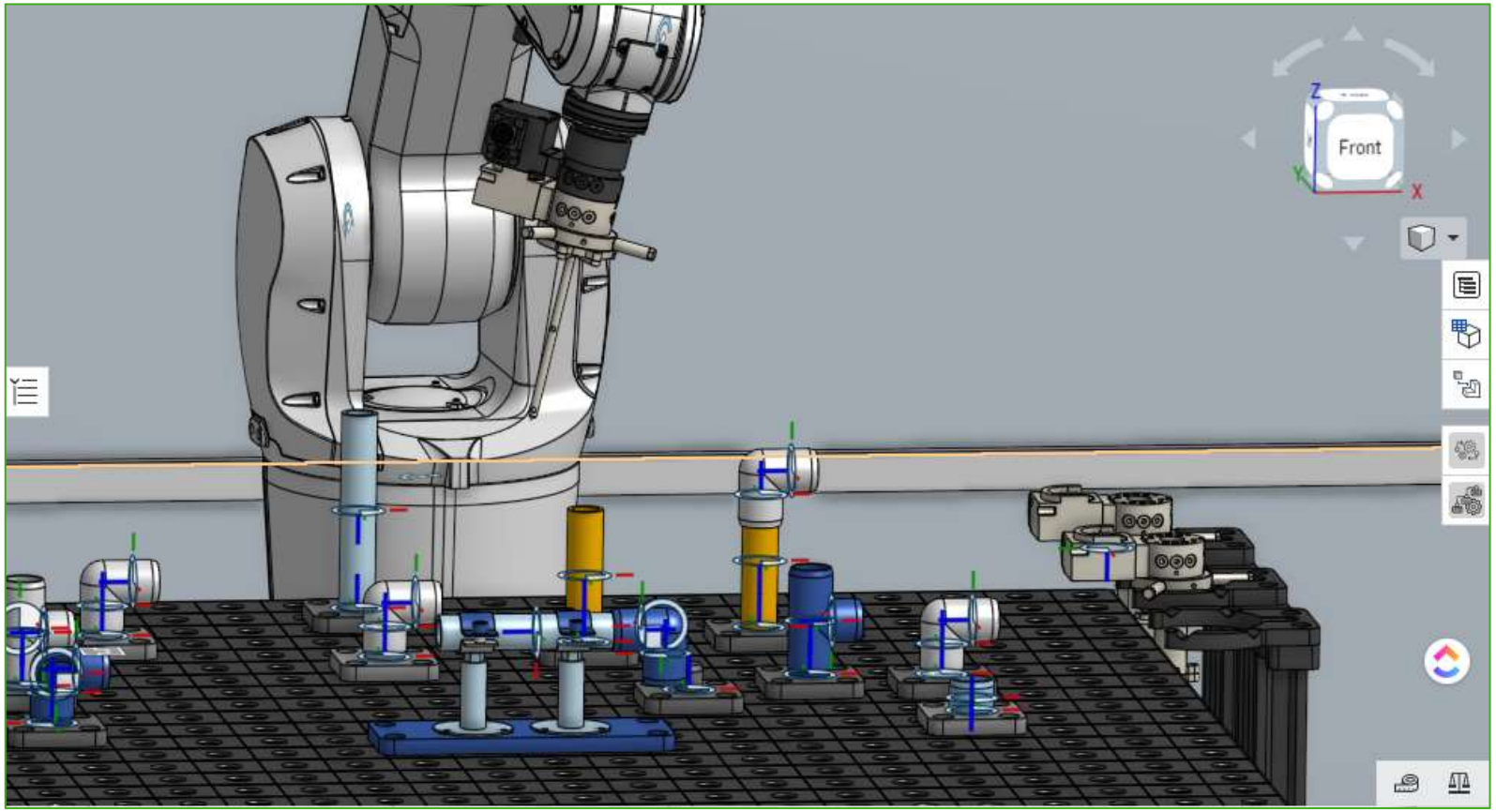
BUILDING THE MODELS: THE CELL

- Configurable table and mounts
  - Location of parts defined with **configuration-parameters**

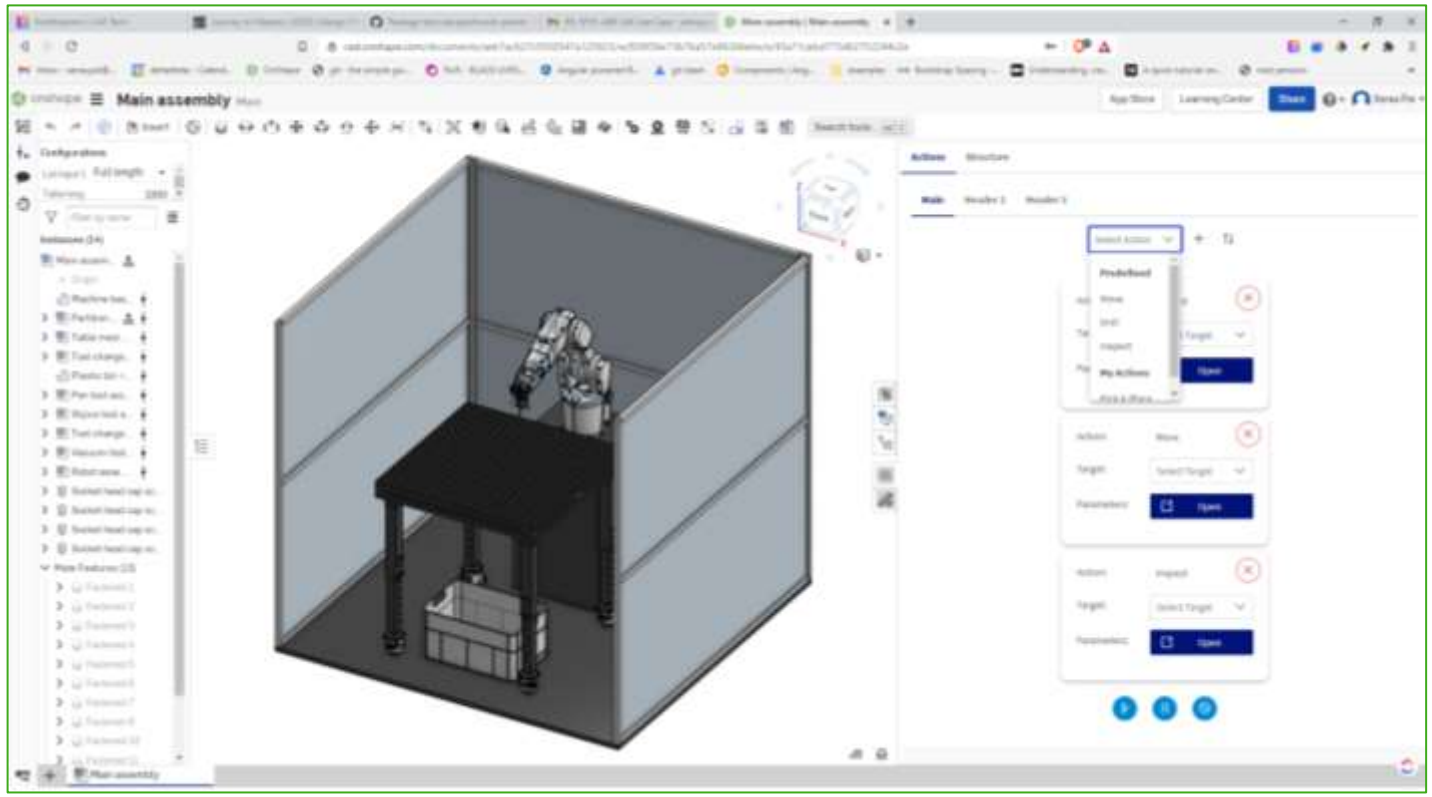


BUILDING THE MODELS: COMPLETE ASSEMBLY

- Product, Robot and Cell all combined
- Robot coordinate system defined with **mate-connector**



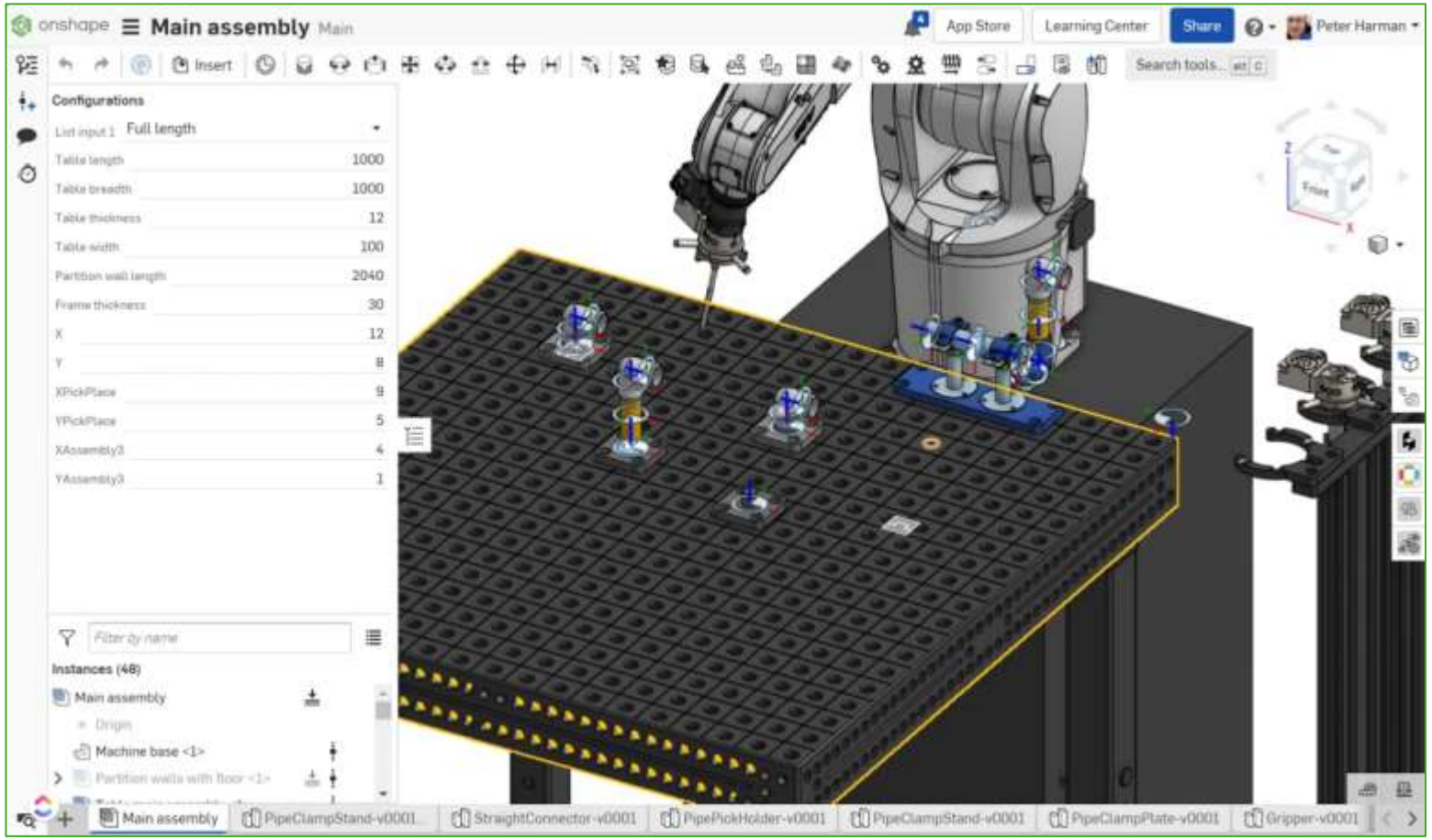
BUILDING THE SOFTWARE



- Prototype software embedded in **Onshape** platform
- **Actions** defined as a series of robot movements
- Waypoints based on **mate-connectors**

IN ACTION: CONFIGURING THE SYSTEM

- Changing **configuration parameters** in the assembly changes the locations of parts



IN ACTION: INSTALLING THE ROBOT PROGRAM

- Custom software by MTC uploads the program
- Reduced risk by use of ABB controller

IN ACTION: EXECUTING THE ROBOT PROGRAM

- The assembly actions are performed as required

CONCLUSIONS: VIEWS FROM MTC

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In collaboration with the MTC, CAE Tech were able to **remove risk** by developing and testing the robot configurator on the MTC’s automation testbed.

This enabled a low-risk, **industrially relevant** sandbox environment for innovative design of the solution.

Dr Mahesh Dissanayake
Team Lead, Intelligent Robotics

mtc
Manufacturing
Technology Centre

CONCLUSIONS: ADVANTAGES OF CLOUD-CAD

What features of using and managing **Onshape** made the concept work?

Collaboration

The CAD models were created in **India**

CAE Tech shared models with MTC without needing to install software

Integration and APIs

APIs for fetching data enables the translation to a robot program

A **custom UI** can be embedded directly in the CAD tool

Configuration Parameters

Every aspect of the model is **configurable**

The API can fetch the **assembly** as **configured** with no change to the model

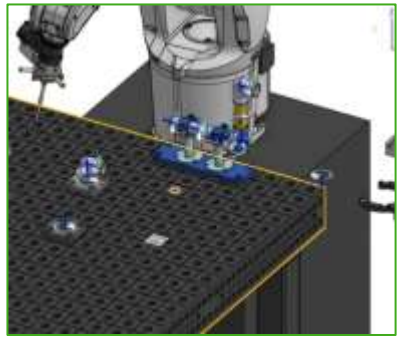
CONCLUSIONS: ADVANTAGES OF ONSHAPE

What CAD modelling features in **Onshape** made this concept work?

Mechanism Joints

Correct kinematics of robot models ensures **reachability** analysis and **path-planning**

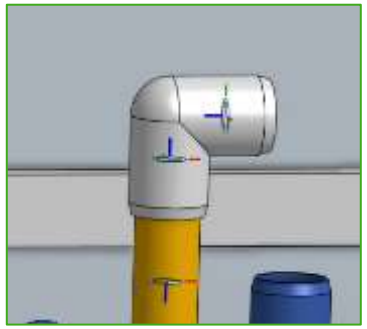
Mate Connectors



The robot coordinate system is defined by one **mate-connector**

This is a huge benefit in mapping from CAD to robotics

Mate Connectors (Again)

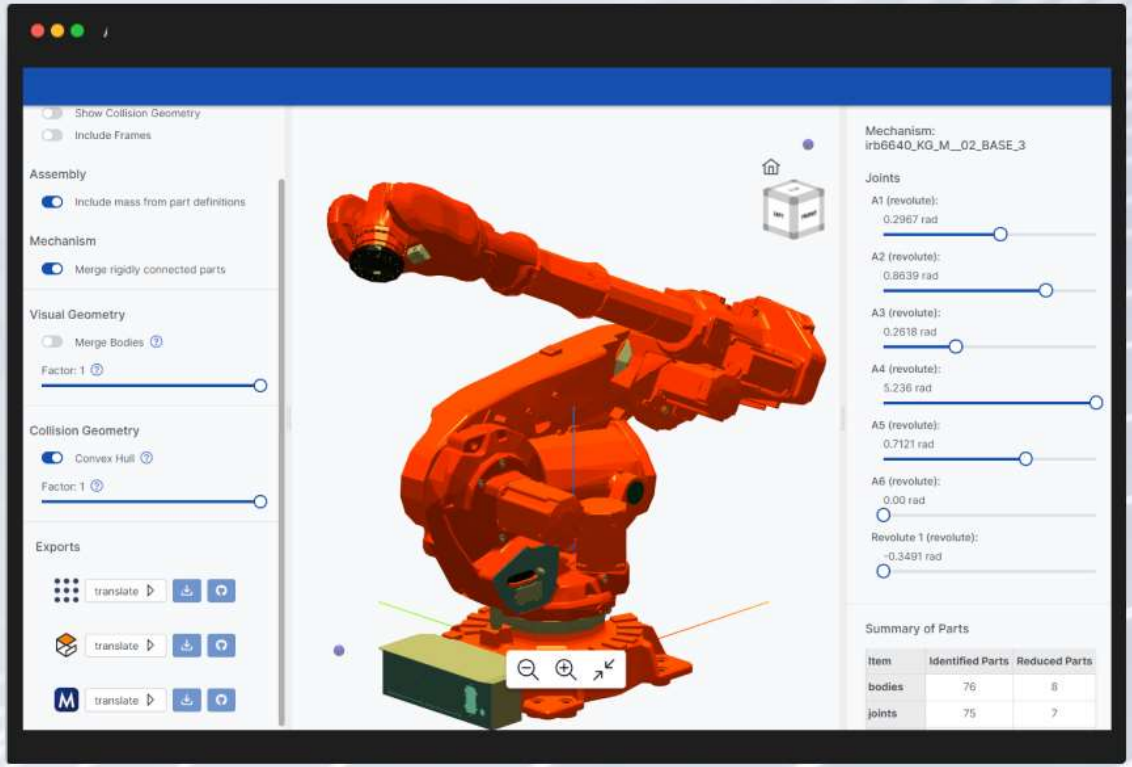


Each of the following can be defined by **mate-connectors**:

- Part connection locations
- Part gripper locations
- End-effector location

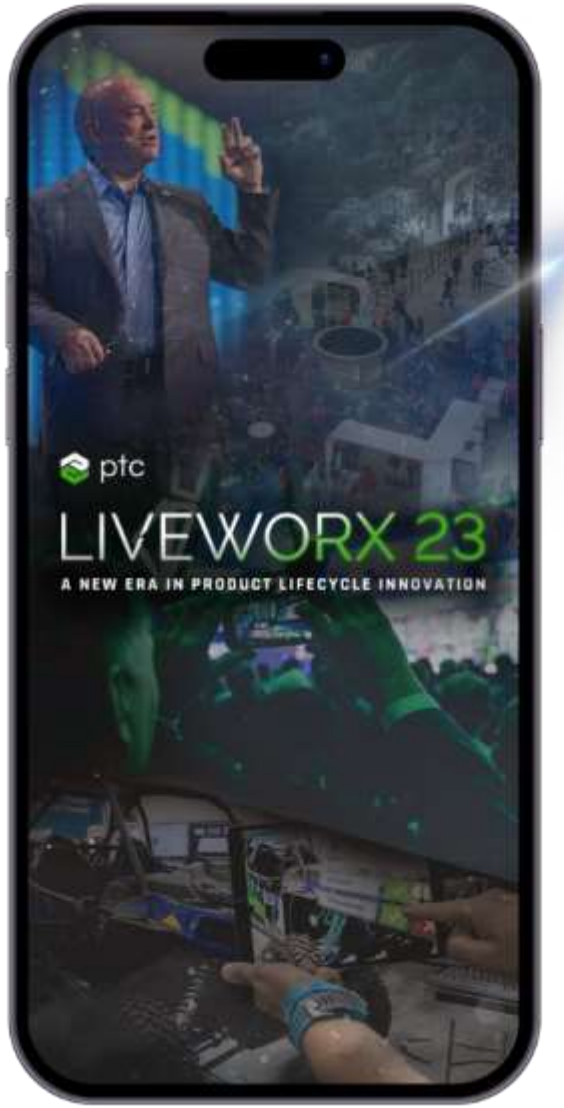
CONCLUSIONS: ROBOTICS IN ONSHAPE

RoboForge



CONCLUSIONS: CONFIGURATORS TO PRODUCTION

- This forms part of a future toolset for bringing customizable products to market
- Design a product in **Onshape**
- Deploy a configurator using **Infinitive**
- Plan robotic assembly using **RoboForge** and connected simulation and control software



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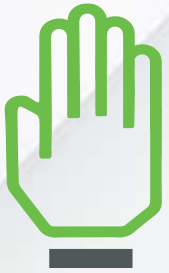

QUESTIONS?

Thank you! You can find me at:

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