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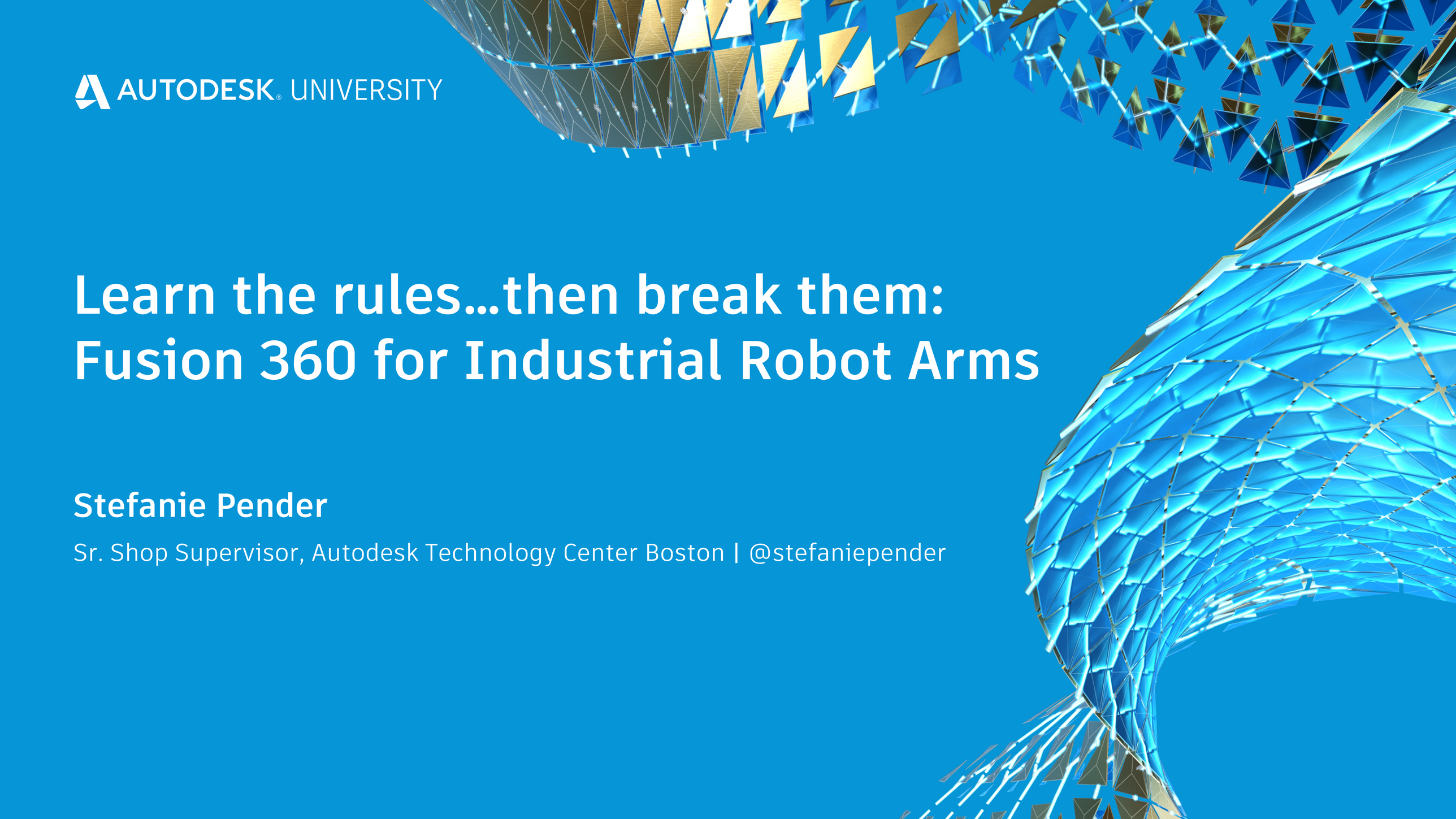
Learn the rules...then break them: Fusion 360 for Industrial Robot Arms

Stefanie Pender

Sr. Shop Supervisor, Autodesk Technology Center Boston | @stefaniepender



About the speaker

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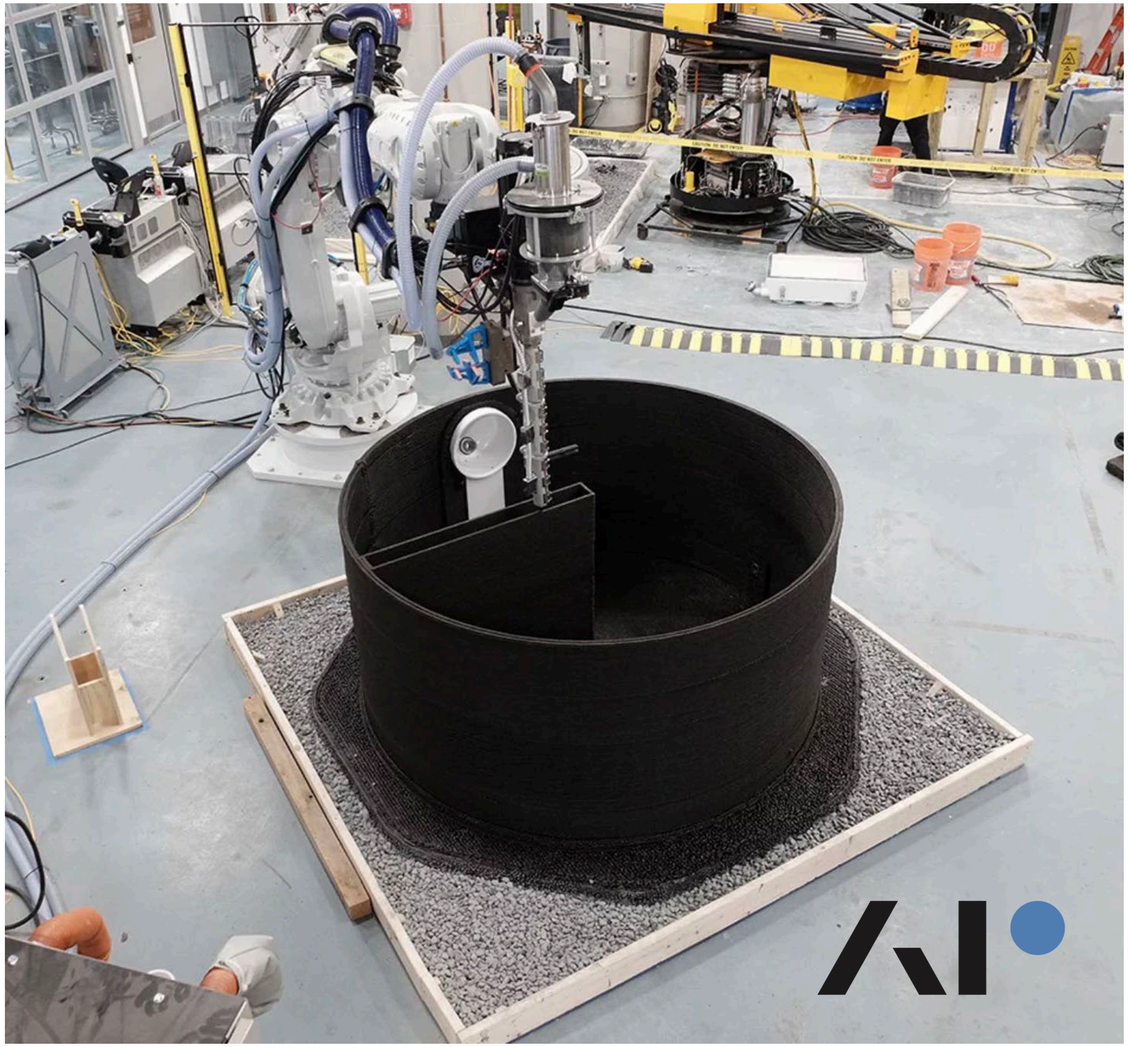

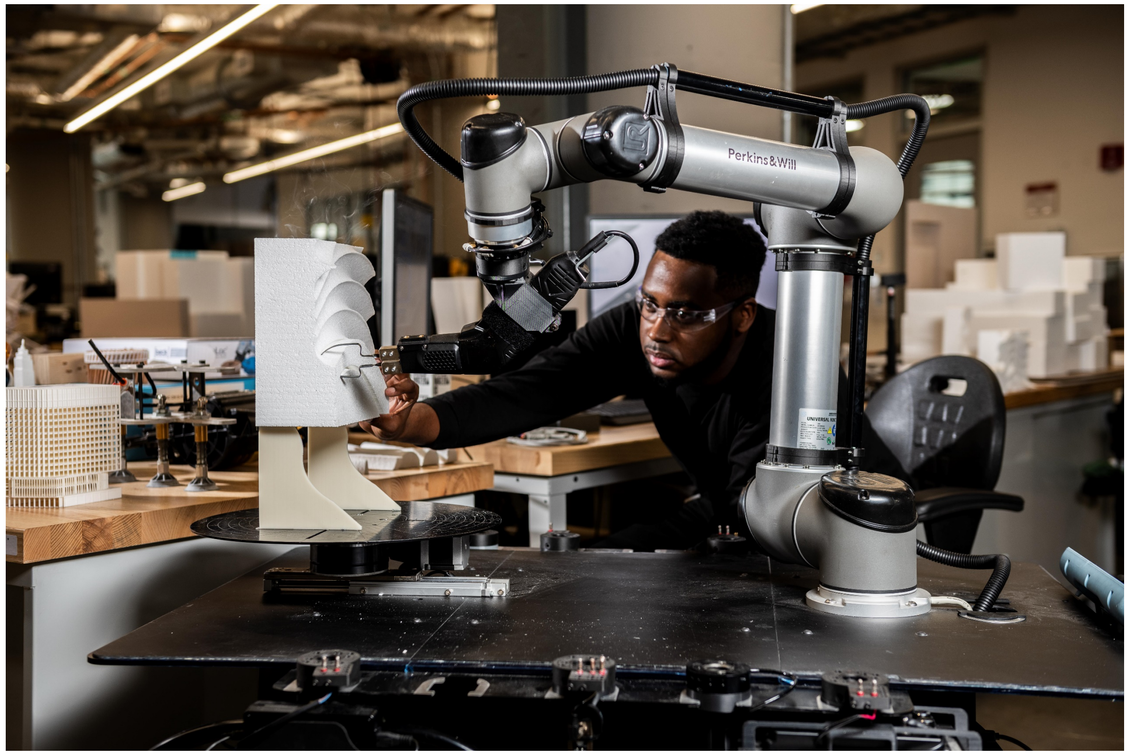

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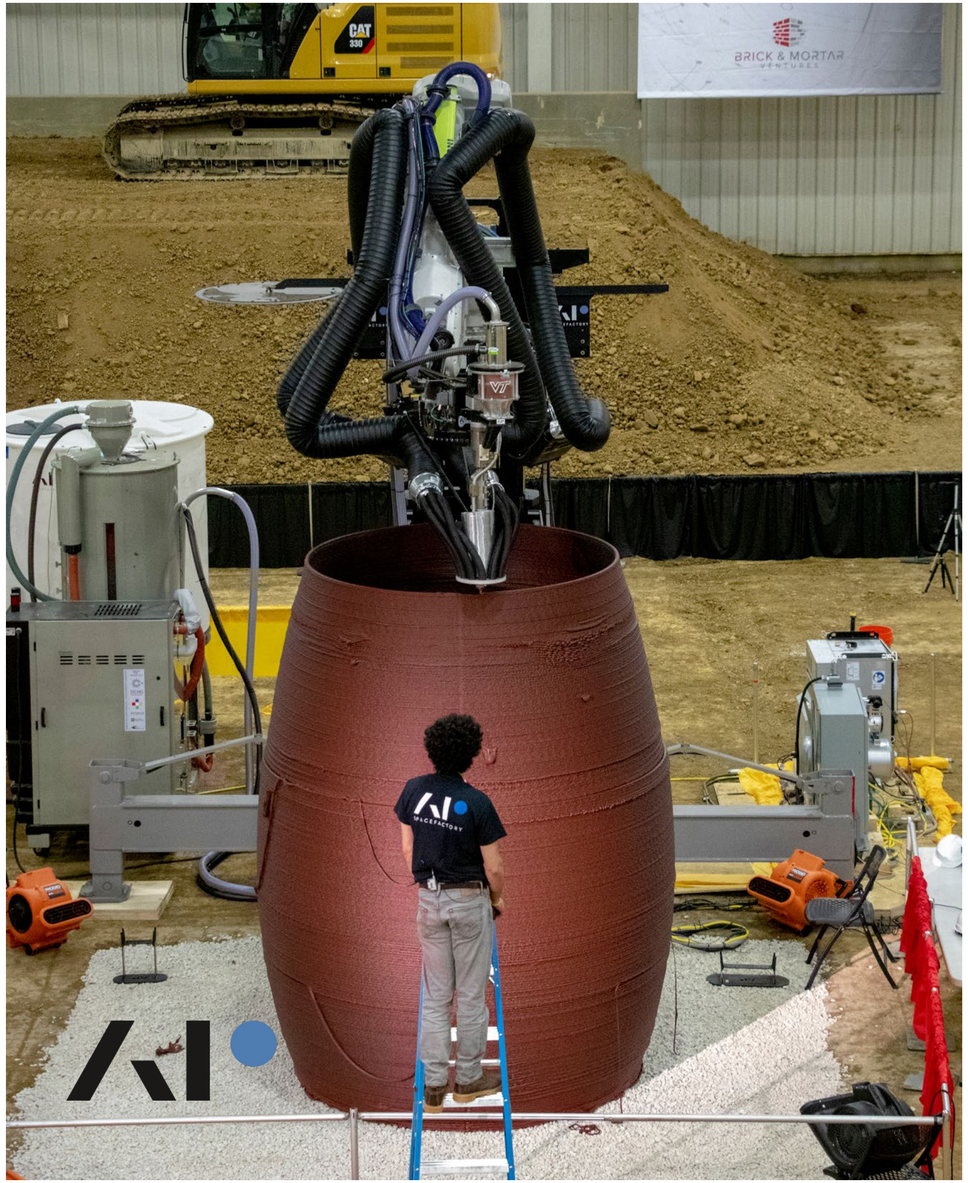
PERKINS+WILL


CAT
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BRICK & MORTAR
VENTURES


EXIT
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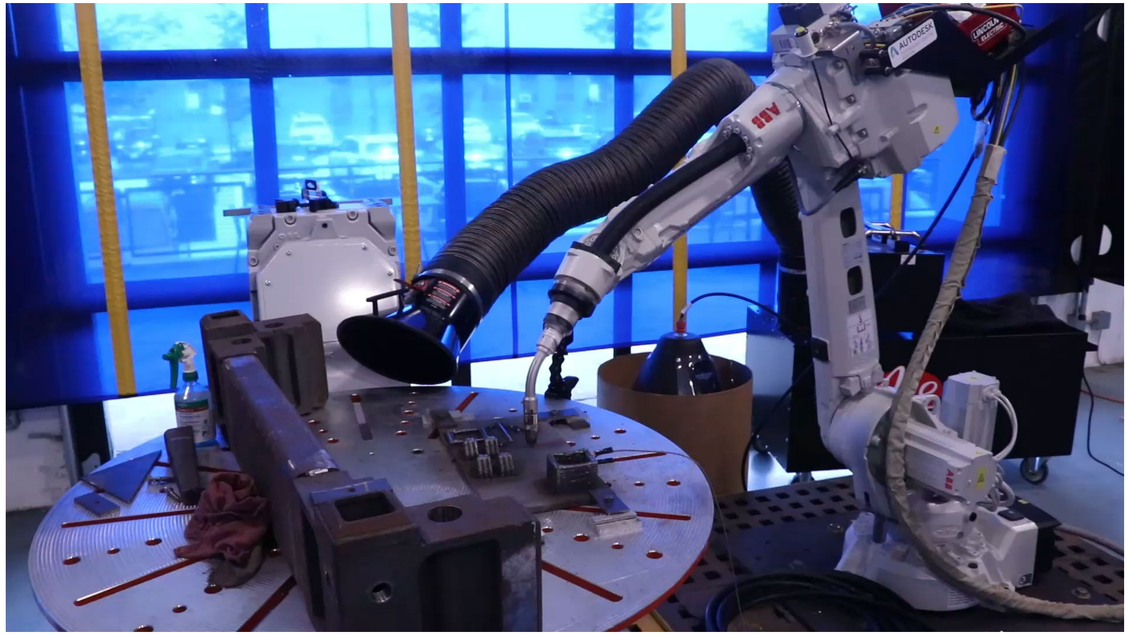
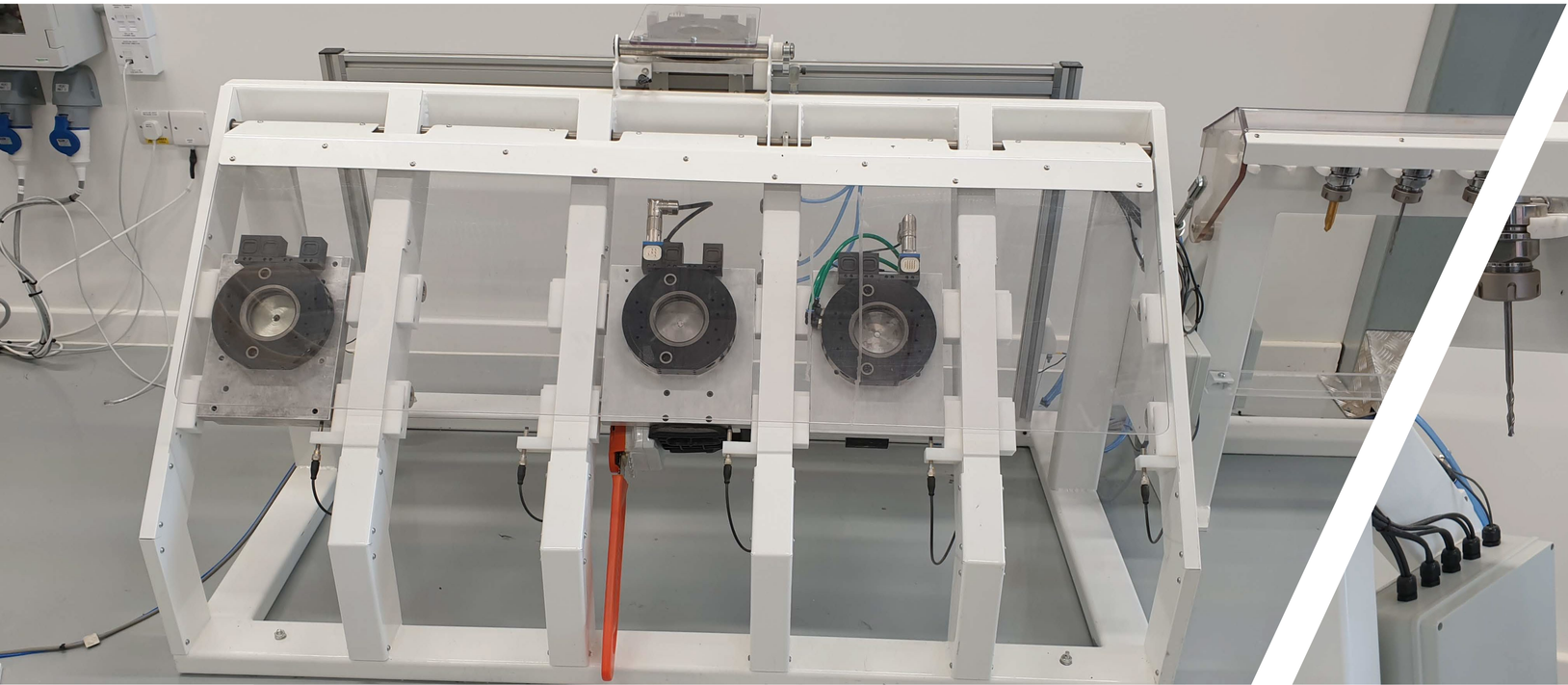

AUTODESK
ABB

https://youtu.be/awd3qwTV6uc?t=17


KUKA


KUKA
AUTODESK
CNC ROBOTICS LTD

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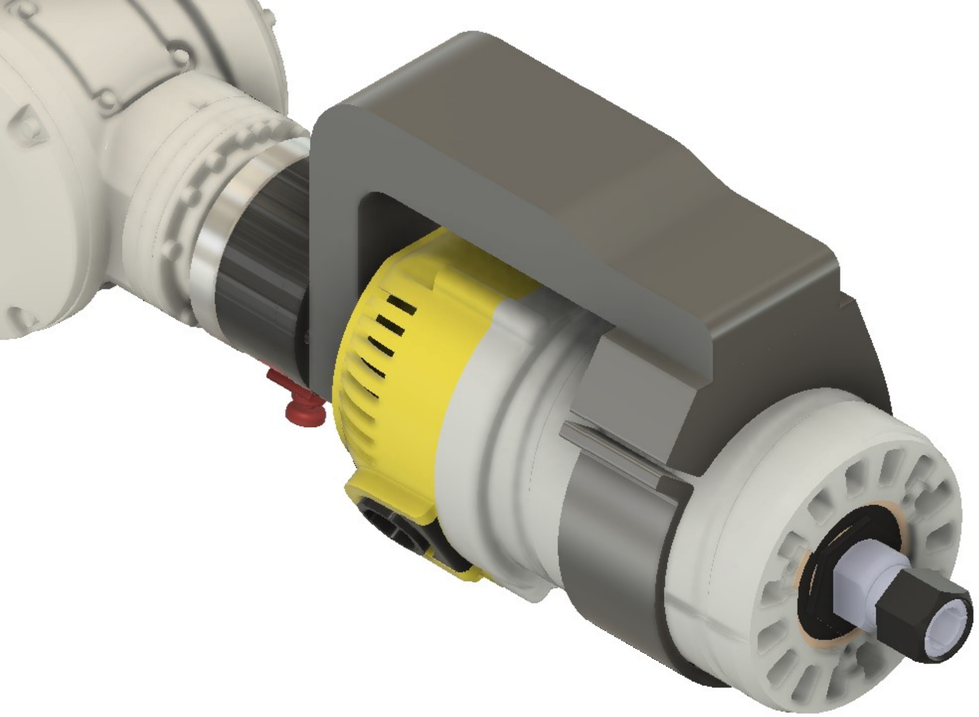
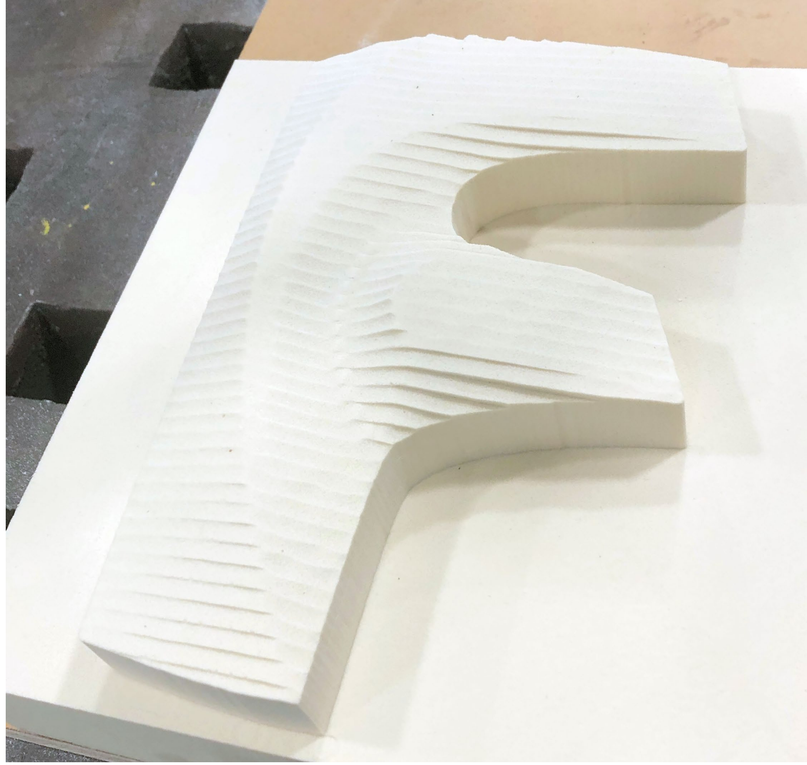
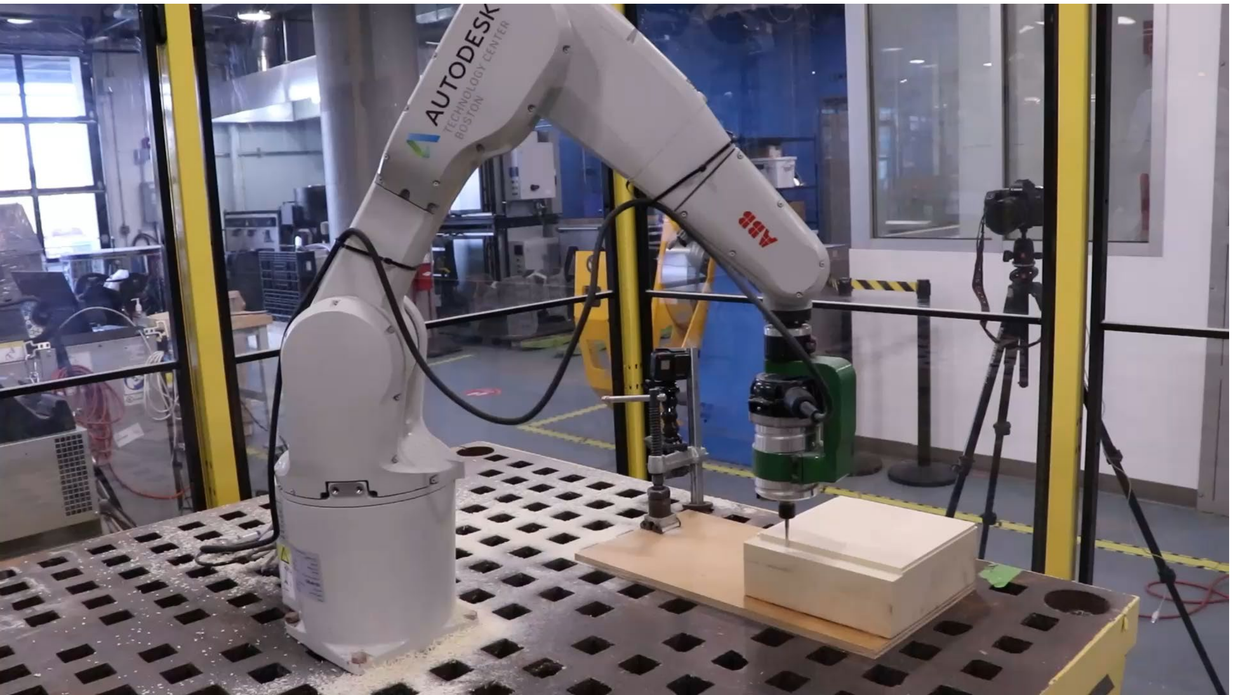
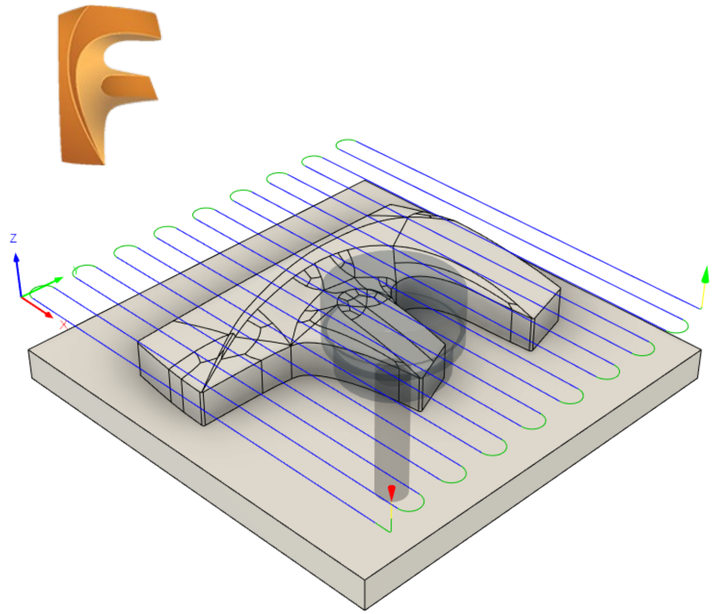


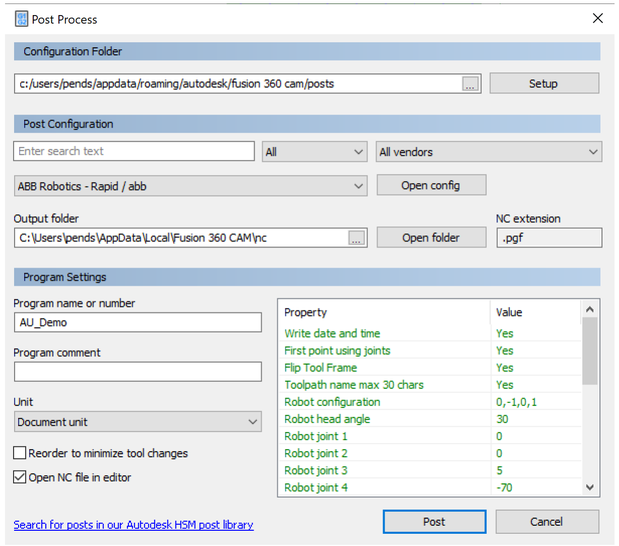


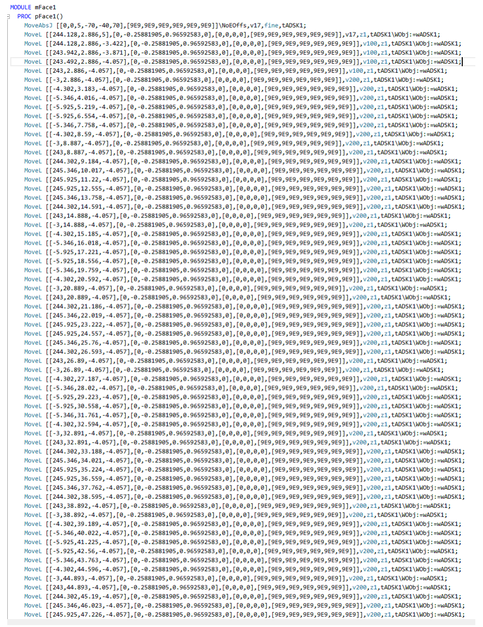


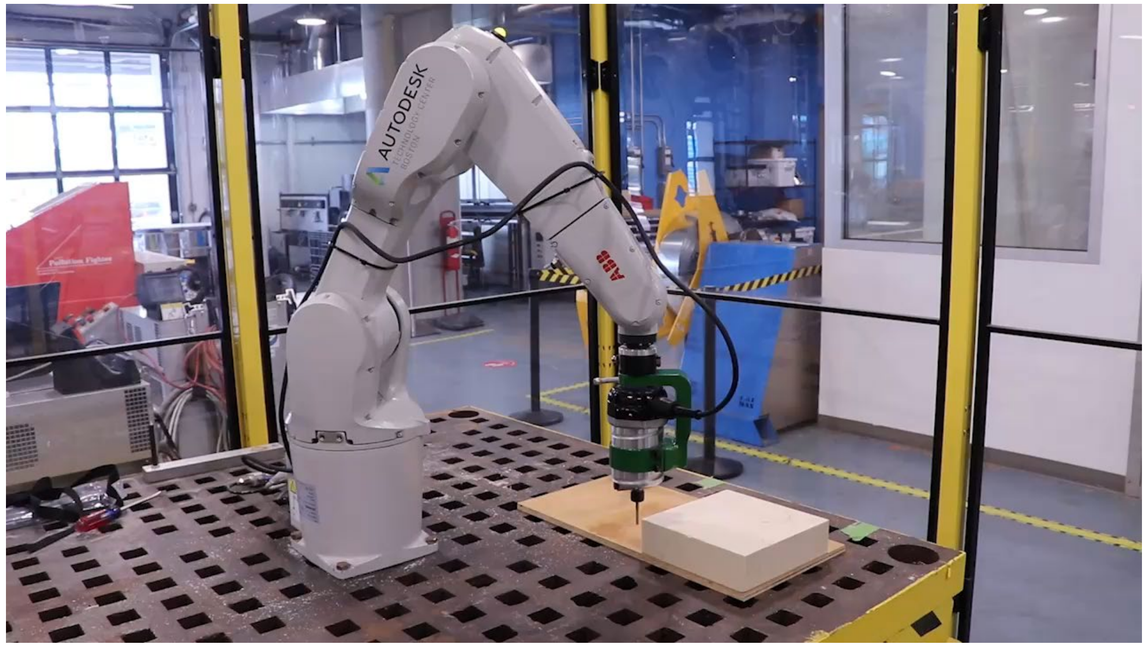
Equipment used:

- ABB IRB 1200 (5 kg/0.9 m reach) with IRC5 controller
- Dewalt hand router with custom mount
- End mill
- Polyurethane foam

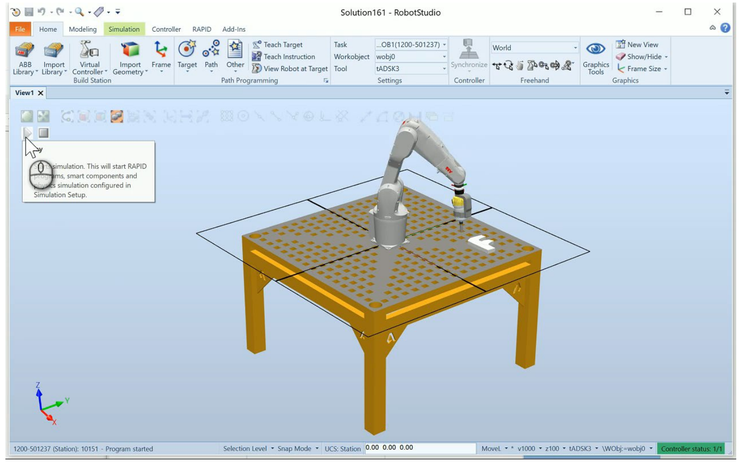








RobotStudio®

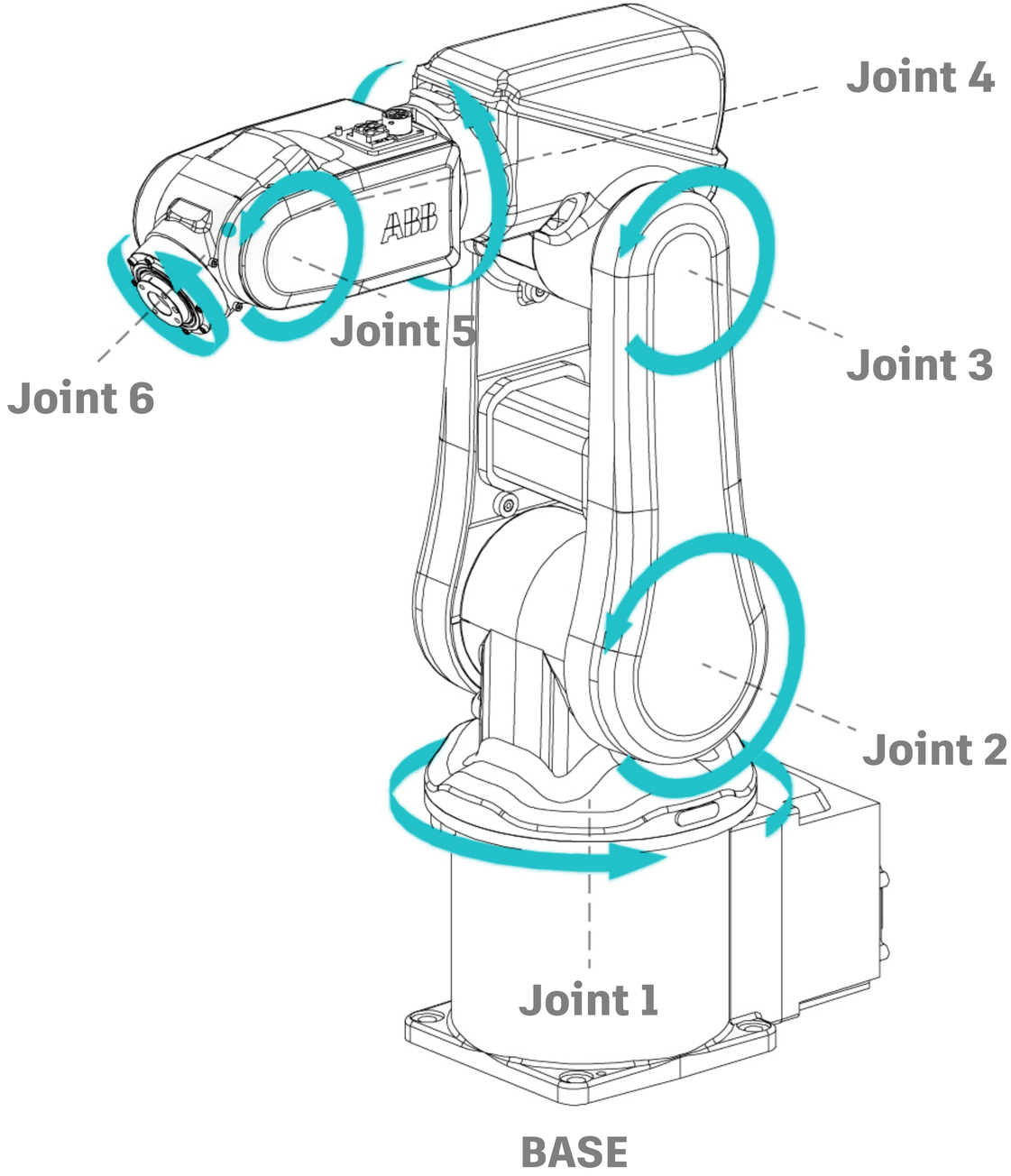


LEARNING OBJECTIVES

1. Quick introduction to Industrial Robots
2. Set-up manufacturing space in Fusion 360 to post-process native robot code for the application of milling
3. Test and validate posted robot code from Fusion 360 in a virtual robot simulator
4. Identify various coordinate systems of the industrial robot arm and calibrate tool data and work object data
5. Share customer case study – *Odico Construction Robotics*
6. Introduce the Autodesk Technology Centers and how anyone may access Industrial Robot Arms

INDUSTRIAL ROBOTS

For sake of this training, ‘robot’ refers to a 6-axis robotic arm. External devices, when used, create a 7th axis (such as linear rails, positioners, or rotaries). We will not be covering external devices in this presentation.

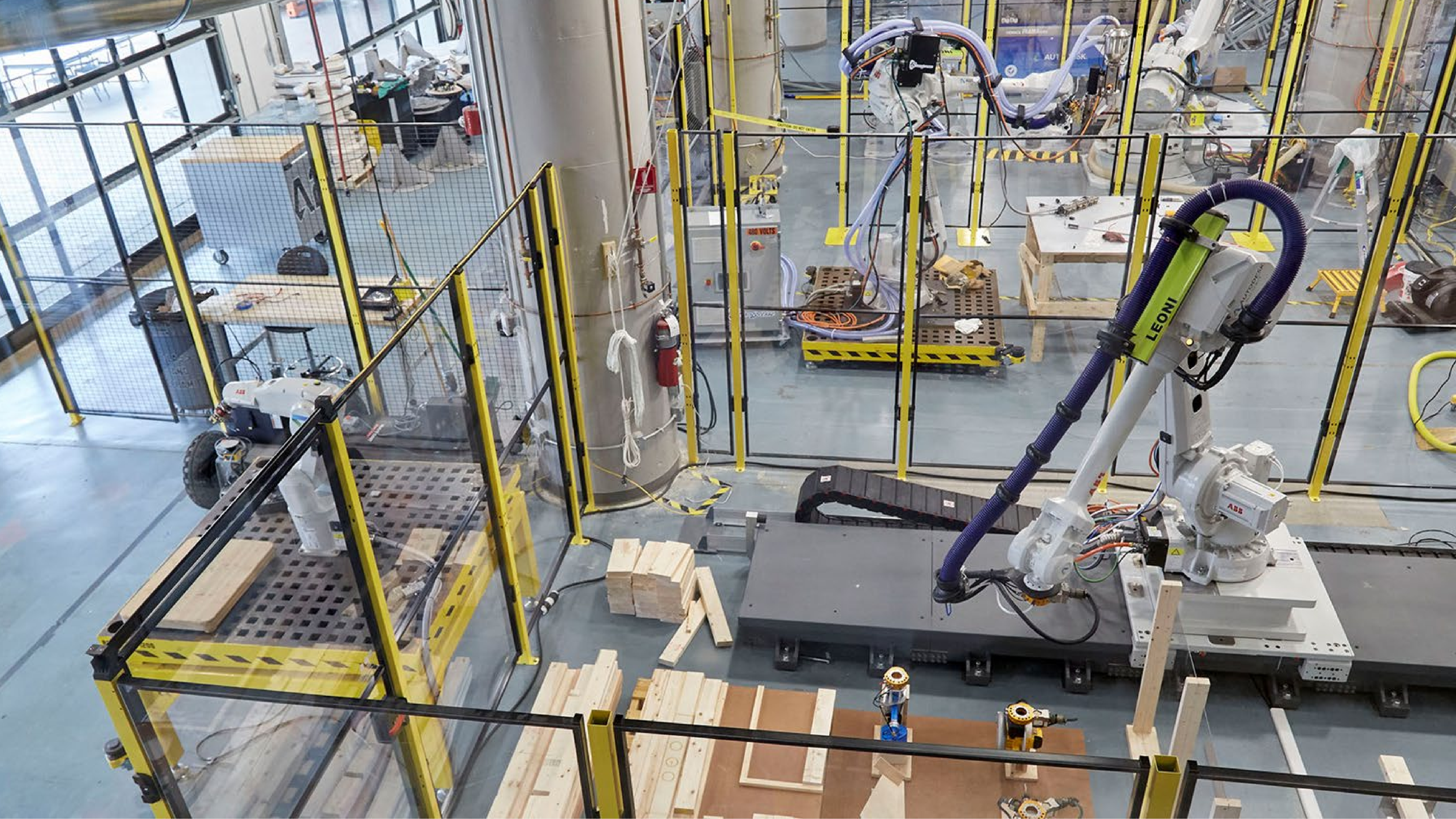


ROBOT SAFETY

Follow the standard! ANSI/RIA R15.06-2012 *American National Standards Institute* Safety Requirements for Industrial Robots and Robot Systems

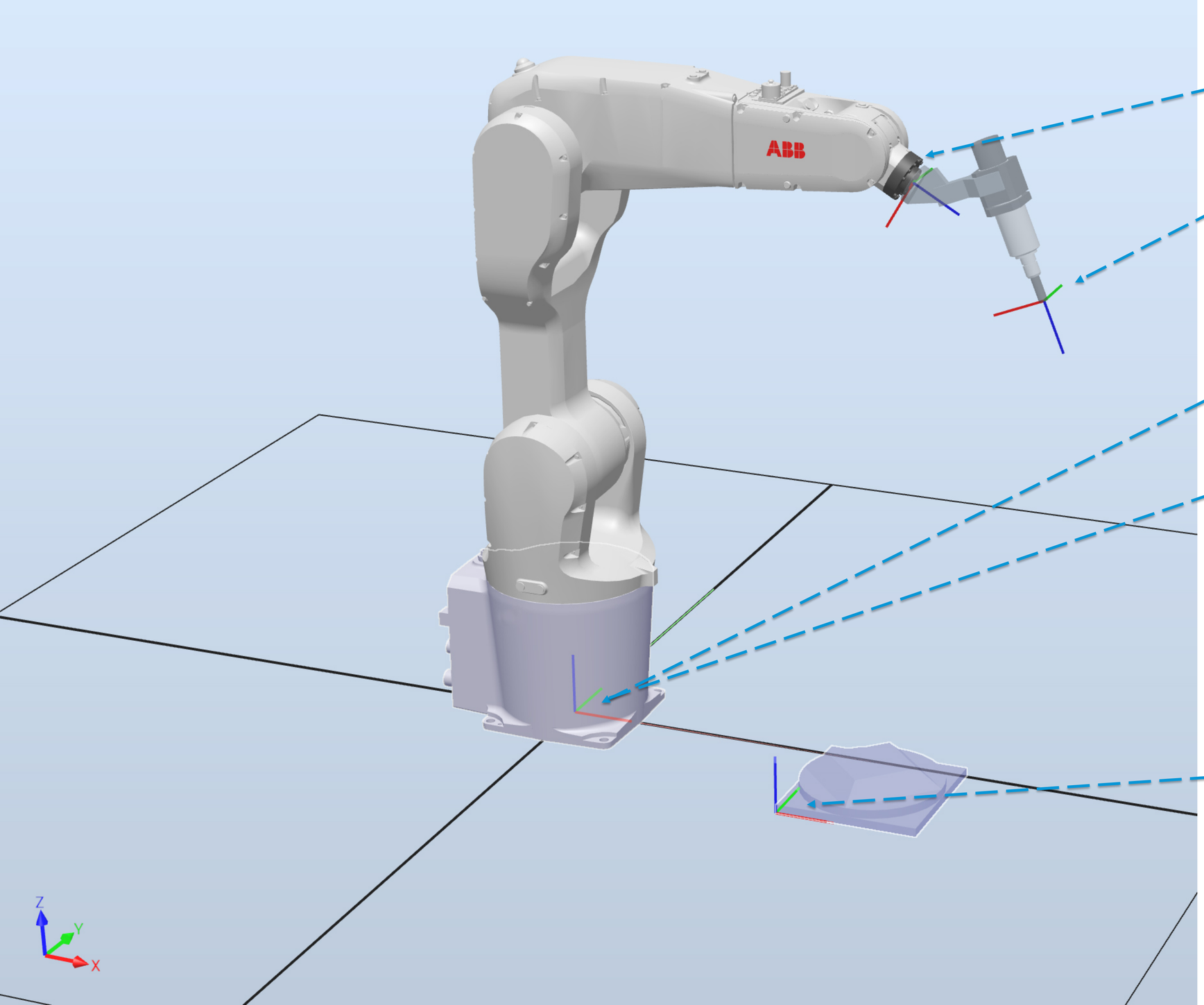
Get informed on general safety hazards surrounding the use of industrial robots and prevent injuries by controlling associated risks.

This hands-on lab does not substitute in-person equipment training.


LEONI
ABB

- Hard guarding
- Interlocked doors
- Spindle automatically turns off if anyone enters the cell

DO NOT mill without the appropriate safety systems in place.



Tool0

Tool Data
Tool Center Point (TCP)

World

Base

Work Object (WOBJ)

An industrial robot has no awareness of its position in space.

To establish spatial relationships, relative positioning must be established.

TOOL CENTER POINT (TCP)

Defines the relationship of the tool and the robot

WORK OBJECT (WOBJ)

Defines the relationship of the robot and the work piece

BASE

Origin of the individual robot - the center of Joint 1 at the bottom of the robot. WOBJ typically references this position. In multi-robot work environments more than one base coordinate may be present (that situation will not be covered in this presentation.)

WORLD

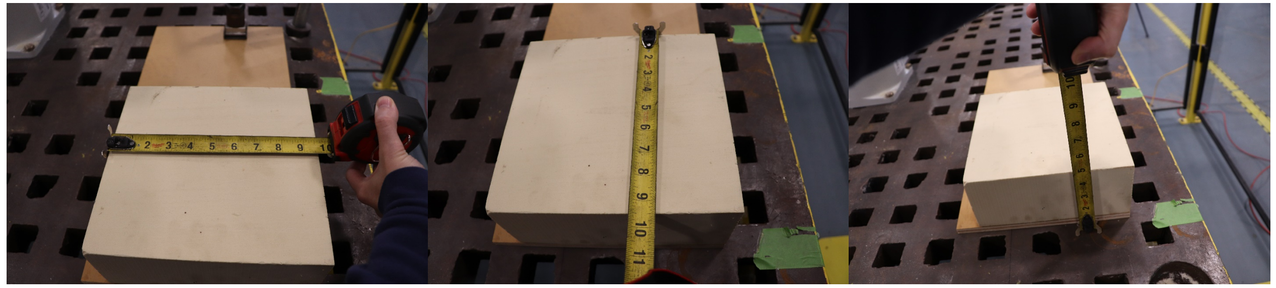
In situations where multiple robots are present, the word coordinate system is used to determine the relationship of multiple base systems.

Before we begin:

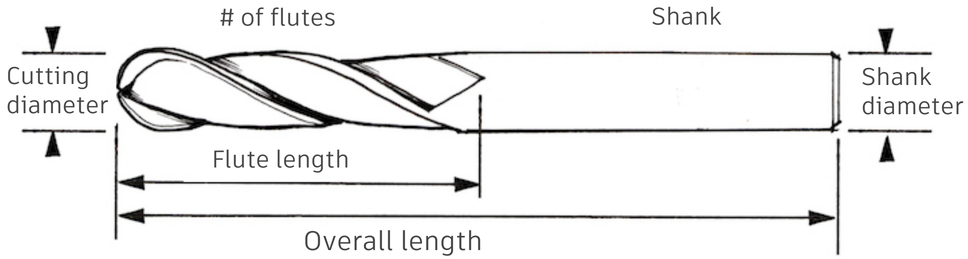
1. Download the *Data Set*

Name	Date modified	Type	Size
troubleshooting	10/12/2020 3:50 PM	File folder	
AU Demo.f3d	10/8/2020 12:57 PM	Autodesk Fusion 360...	698 KB
AU_Demo_bench.step	4/20/2020 12:30 PM	STEP 3D file	1,859 KB
AU_Demo_Fusion_Logo.iges	10/7/2020 1:19 PM	IGES 3D File	1,464 KB
AU_Demo_Spindle.iges	9/30/2020 10:09 AM	IGES 3D File	4,788 KB
AU_Demo_Stock.iges	10/7/2020 1:06 PM	IGES 3D File	14 KB
tADSK1.rslib	10/8/2020 2:23 PM	RobotStudio Library f...	2,005 KB

2. Measure your stock



3. Measure your tool



cam.autodesk.com/hsmposts

Post Customization | Support | Manual | API | Examples | RSS

Post Library for Autodesk Fusion 360

This is the place to find post processors for common CNC machines and controls.

Make sure to read this **important safety information** before using any posts.

abb

Any type | Any time | Any vendor

ABB Robotics - Rapid

Download / Share / RSS / Guide

ABB

Purpose: Milling

Version: 42890

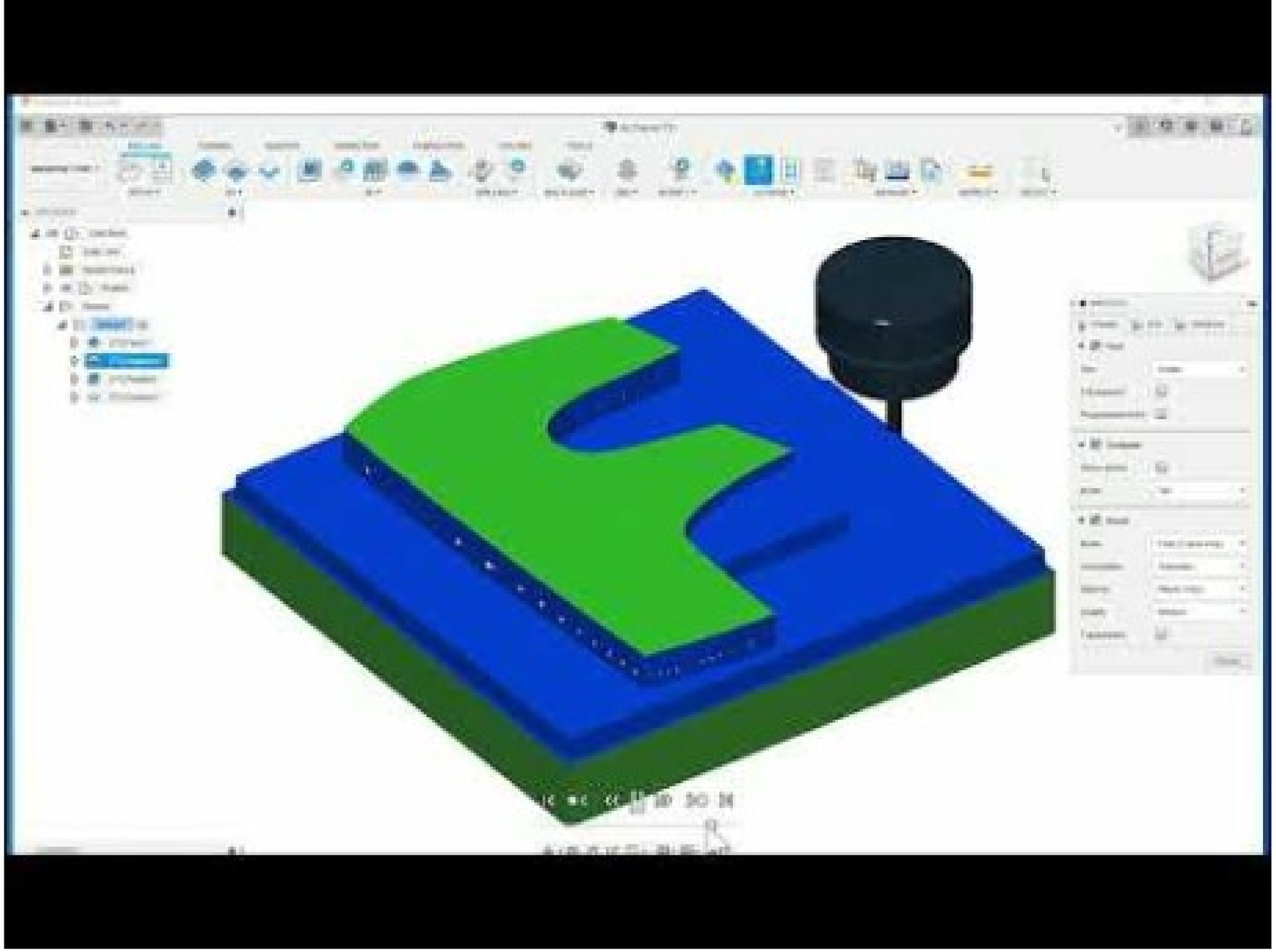
Changed: 61 days ago

Extension: pgf

Downloads: 408

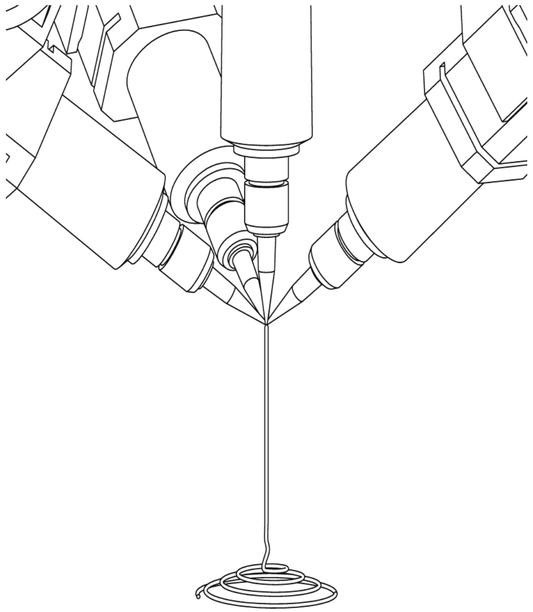
Generic ABB Rapid post. Please refer to the User Guide for programming specification and sample. Always simulate in Robot Studio before load any toolpath on your Robot.

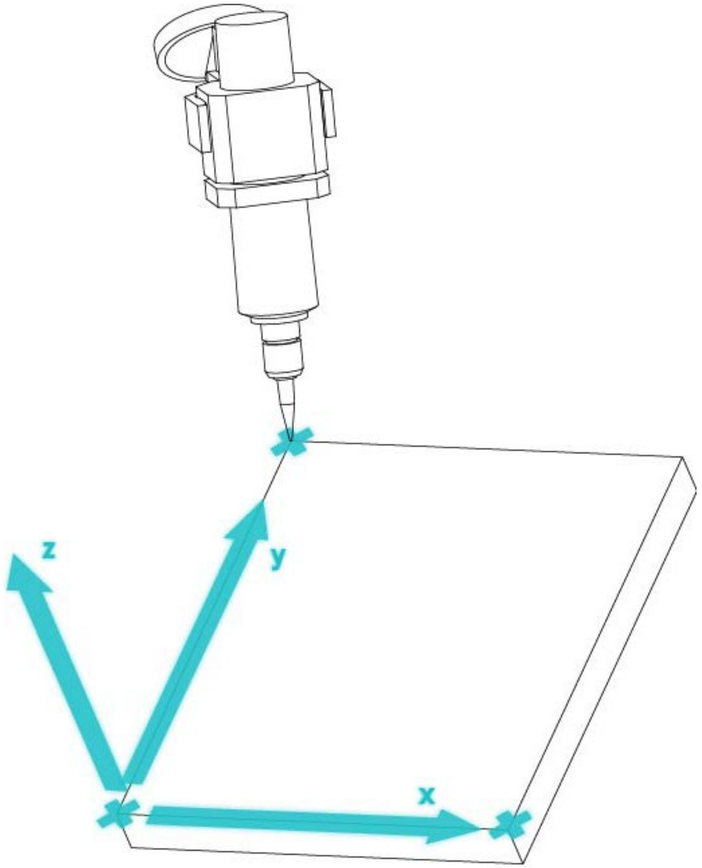
Recent changes

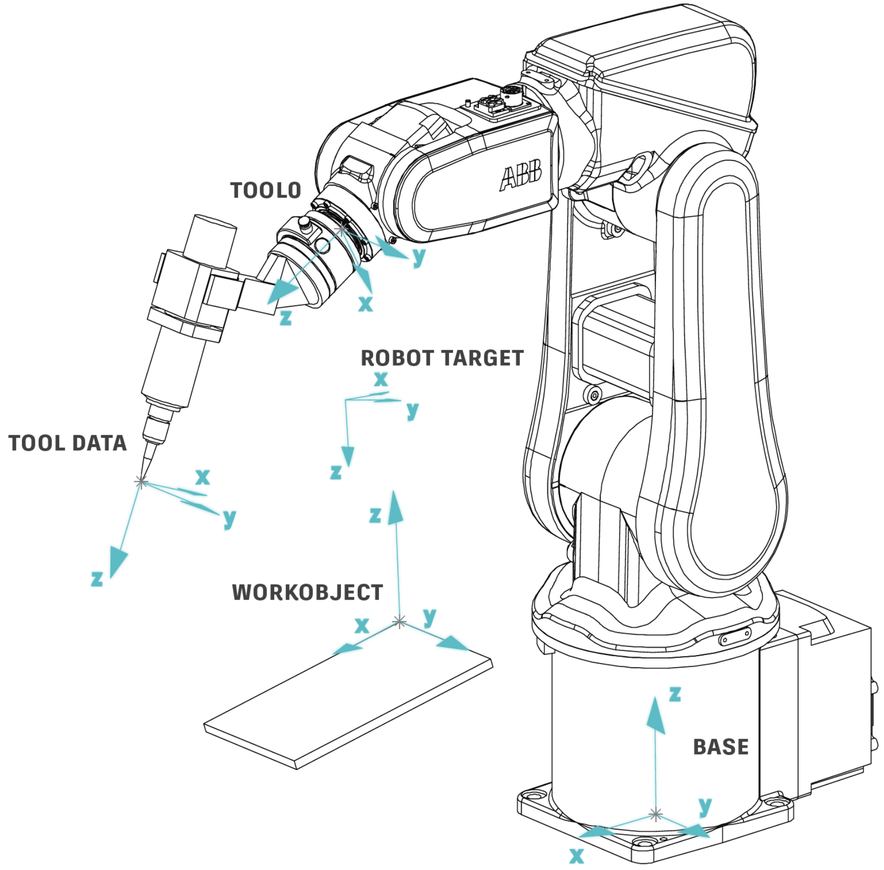


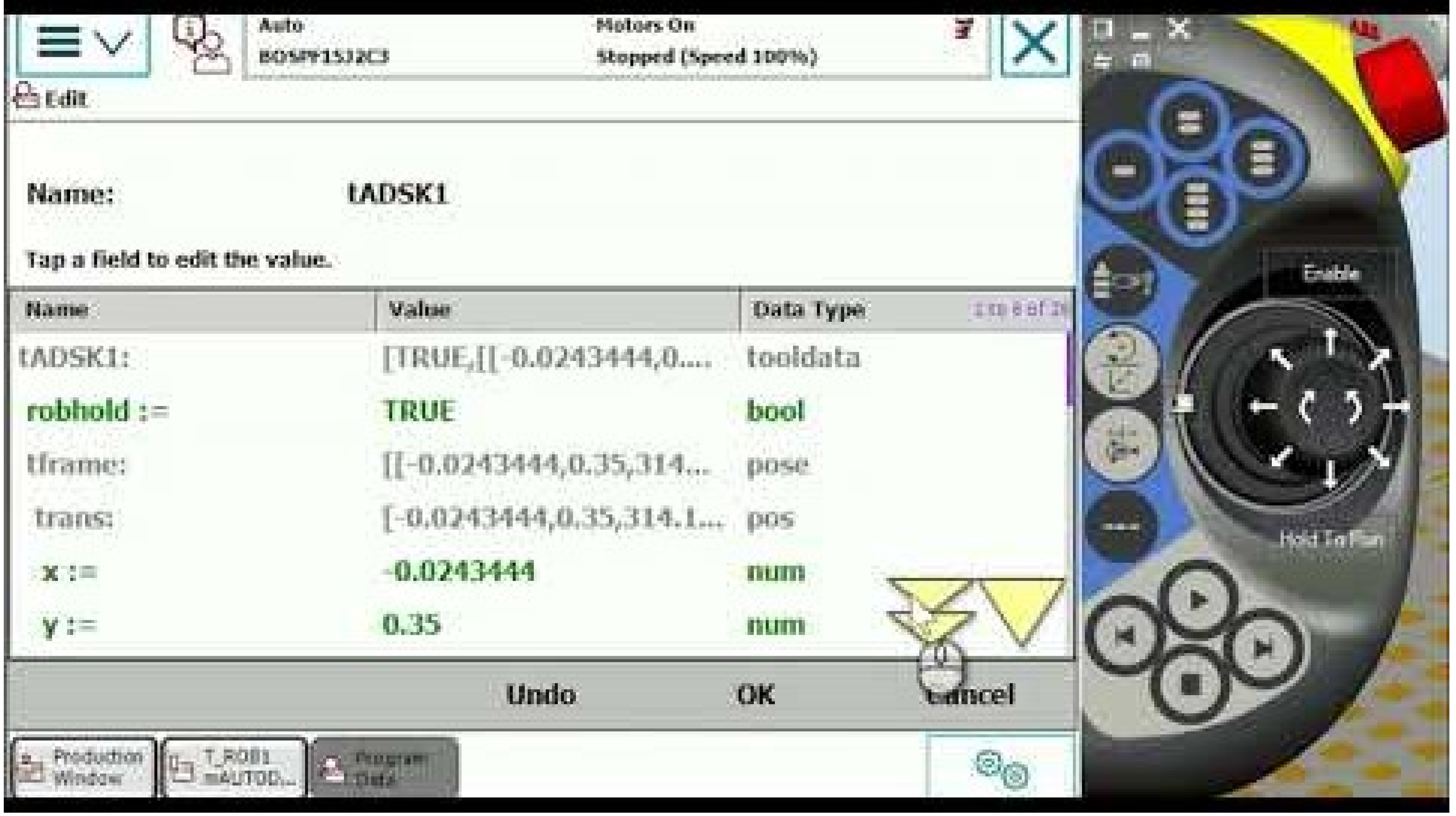
https://youtu.be/OxVt9XWRseo?t=16

Identify various coordinate systems of the industrial robot arm and calibrate tool data and work object data









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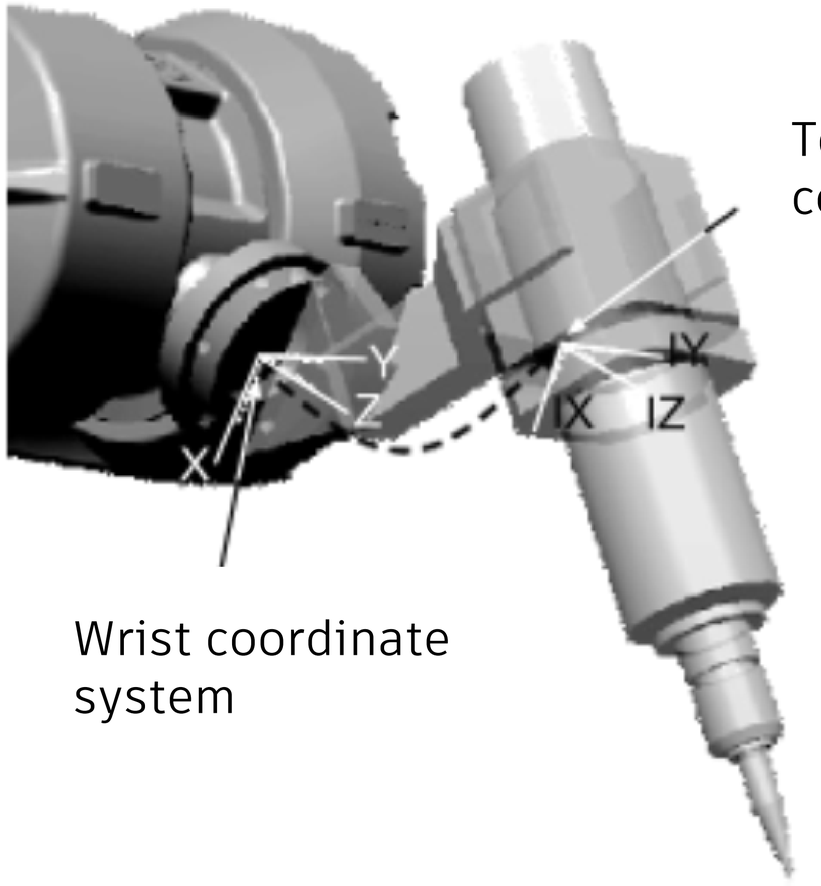


Tool load coordinate system, center of gravity (cog)

Wrist coordinate system

The load of the tool:

- The mass (weight) of the tool in kg
- The center of gravity of the tool load (x, y, and z) in mm, expressed in the wrist coordinate system

https://youtu.be/GFHGwSv57yQ

ODICO
CONSTRUCTION ROBOTICS

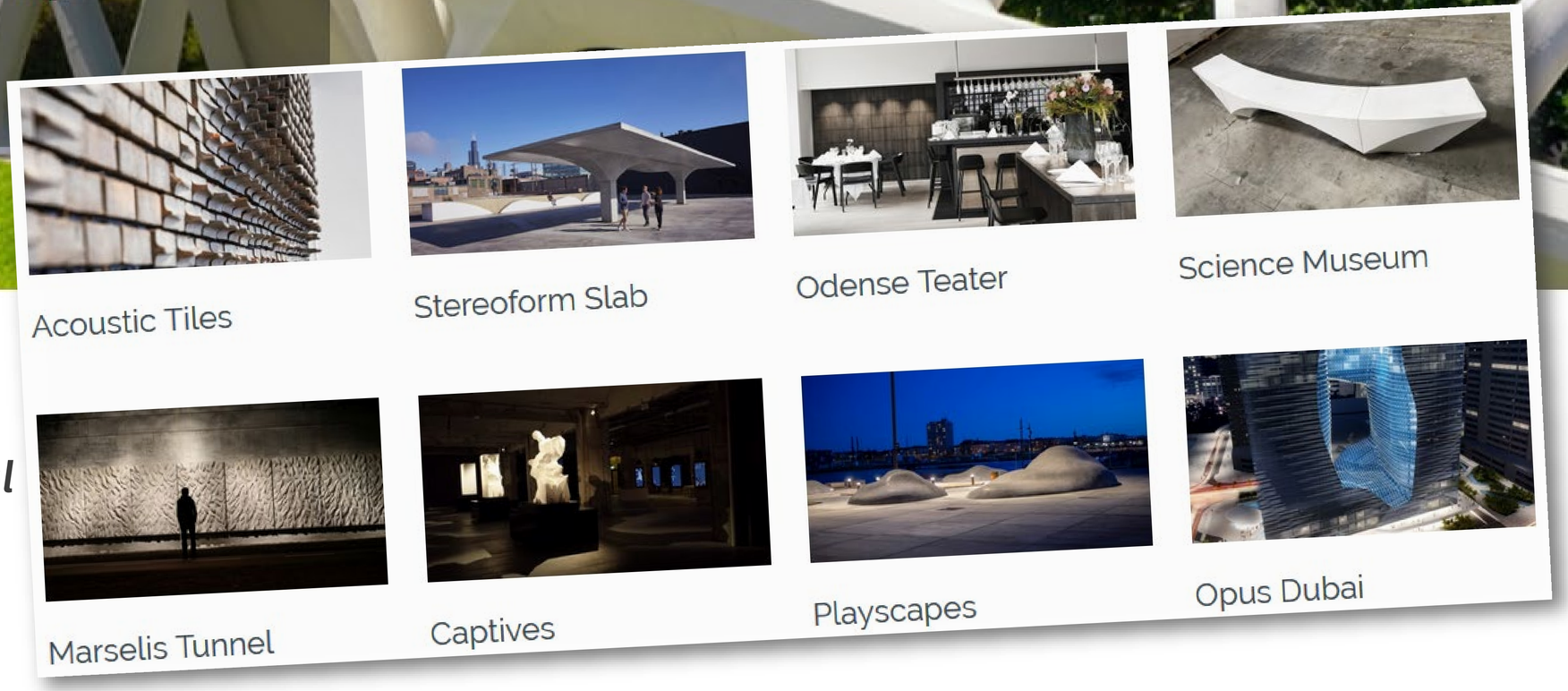
SERVICES TECHNOLOGIES CASES NEWS INVESTOR ABOUT US CONTACT DK EN

"Technology Provider"

Rethinking formwork

The goal of Odico is to revolutionize the construction industry with our ground-breaking robotic technologies.

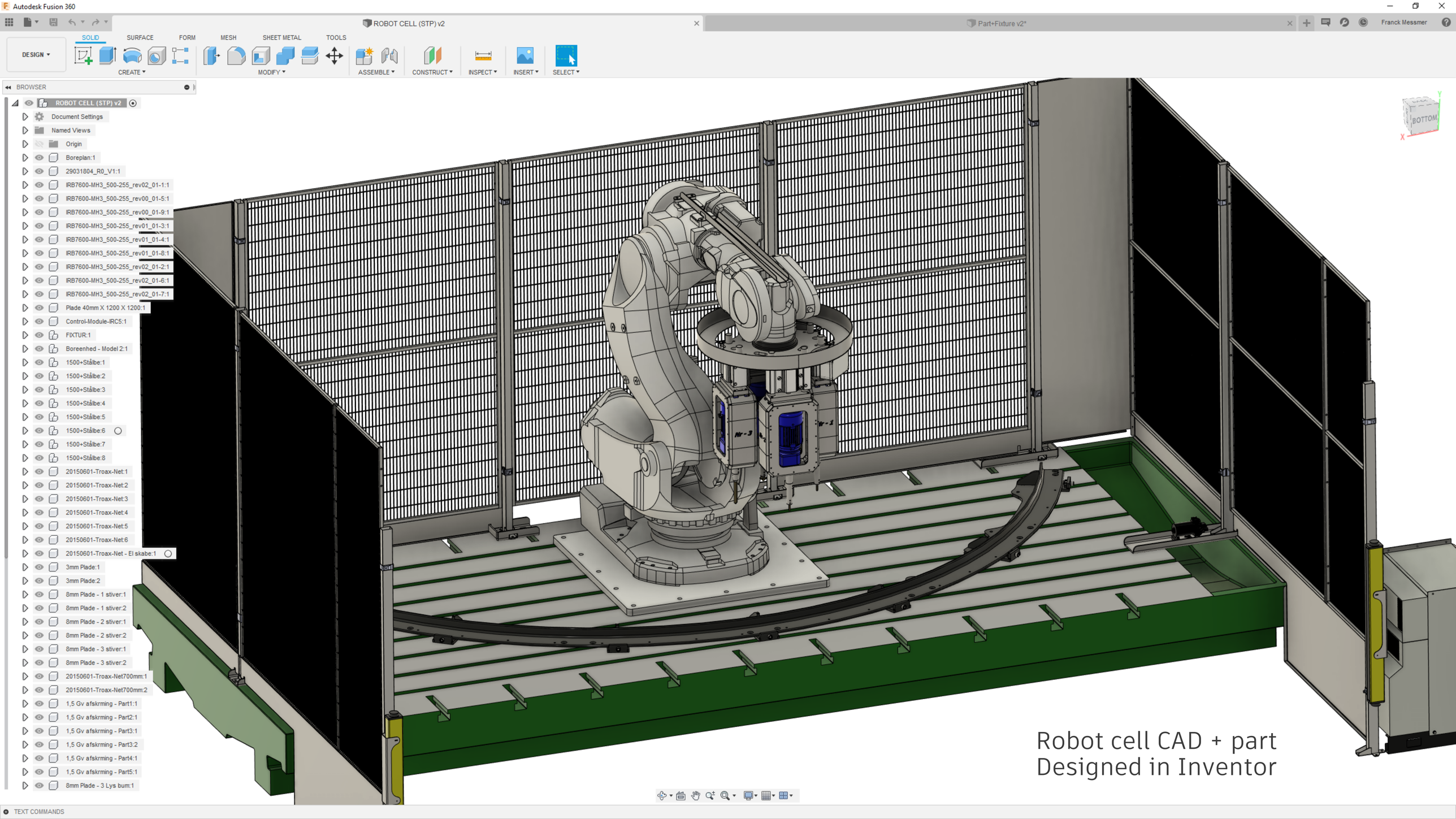
Read more



"Odico is a pioneer in robotics and digital manufacturing. Our mission is to transform the global construction industry. Using technology, we increase efficiency and unleash the industry's innovative potential."

https://odico.dk/en/

All images in this slide deck are courtesy of Odico.


Autodesk Fusion 360
ROBOT CELL (STP) v2
Part+Fixture v2*
Franck Messmer
DESIGN
SOLID
SURFACE
FORM
MESH
SHEET METAL
TOOLS
CREATE
MODIFY
ASSEMBLE
CONSTRUCT
INSPECT
INSERT
SELECT
BROWSER
ROBOT CELL (STP) v2
Document Settings
Named Views
Origin
Boreplan:1
29031804_R0_V1:1
IRB7600-MH3_500-255_rev02_01-1:1
IRB7600-MH3_500-255_rev00_01-5:1
IRB7600-MH3_500-255_rev00_01-9:1
IRB7600-MH3_500-255_rev01_01-3:1
IRB7600-MH3_500-255_rev01_01-4:1
IRB7600-MH3_500-255_rev01_01-8:1
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IRB7600-MH3_500-255_rev02_01-6:1
IRB7600-MH3_500-255_rev02_01-7:1
Plade 40mm X 1200 X 1200:1
Control-Module-IRC5:1
FIXTUR:1
Boreenhed - Model 2:1
1500+Stålbe:1
1500+Stålbe:2
1500+Stålbe:3
1500+Stålbe:4
1500+Stålbe:5
1500+Stålbe:6
1500+Stålbe:7
1500+Stålbe:8
20150601-Troax-Net:1
20150601-Troax-Net:2
20150601-Troax-Net:3
20150601-Troax-Net:4
20150601-Troax-Net:5
20150601-Troax-Net:6
20150601-Troax-Net - El skabe:1
3mm Plade:1
3mm Plade:2
8mm Plade - 1 stiver:1
8mm Plade - 1 stiver:2
8mm Plade - 2 stiver:1
8mm Plade - 2 stiver:2
8mm Plade - 3 stiver:1
8mm Plade - 3 stiver:2
20150601-Troax-Net700mm:1
20150601-Troax-Net700mm:2
1,5 Gv afskrming - Part1:1
1,5 Gv afskrming - Part2:1
1,5 Gv afskrming - Part3:1
1,5 Gv afskrming - Part3:2
1,5 Gv afskrming - Part4:1
1,5 Gv afskrming - Part5:1
8mm Plade - 3 Lys bum:1
BOTTOM
TEXT COMMANDS
Robot cell CAD + part
Designed in Inventor

Autodesk Fusion 360

ROBOT CELL (STP) v2

Part+Fixture v2*

Franck Messmer

DESIGN

SOLID | SURFACE | SHEET METAL | TOOLS

CREATE | MODIFY | ASSEMBLE | CONSTRUCT | INSPECT | INSERT | SELECT

BROWSER

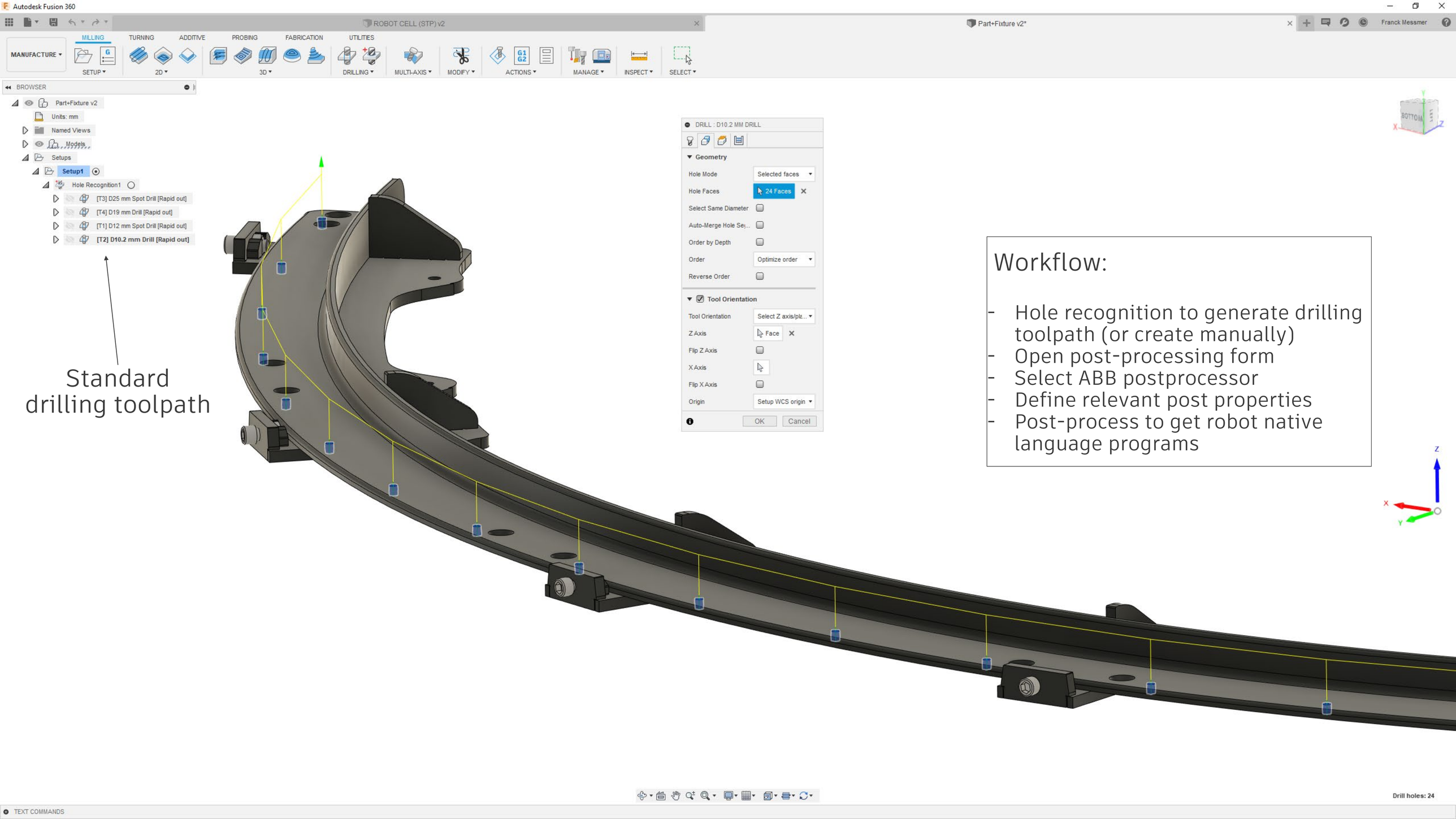
- Part+Fixture v2
  - Document Settings
  - Named Views
  - Origin
  - 29031804_R0_V1:1
  - FIXTUR:1

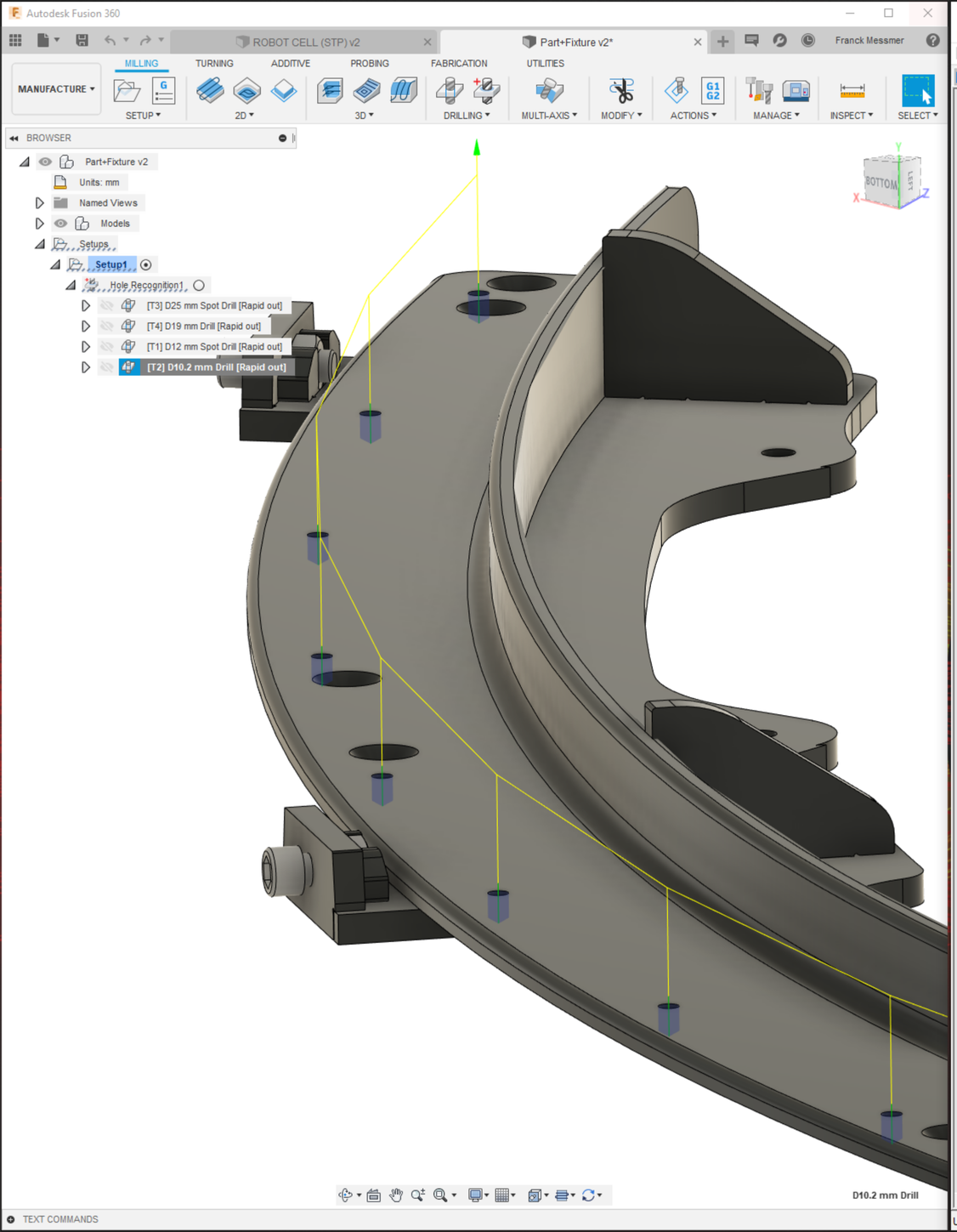
Part

Fixture

Holes to drill

TEXT COMMANDS


Autodesk Fusion 360
ROBOT CELL (STP) v2
Part+Fixture v2*
Franck Messmer
MANUFACTURE
MILLING
TURNING
ADDITIVE
PROBING
FABRICATION
UTILITIES
SETUP
2D
3D
DRILLING
MULTI-AXIS
MODIFY
ACTIONS
MANAGE
INSPECT
SELECT
BROWSER
Part+Fixture v2
Units: mm
Named Views
Models
Setups
Setup1
Hole Recognition1
[T3] D25 mm Spot Drill [Rapid out]
[T4] D19 mm Drill [Rapid out]
[T1] D12 mm Spot Drill [Rapid out]
[T2] D10.2 mm Drill [Rapid out]
DRILL : D10.2 MM DRILL
Geometry
Hole Mode
Selected faces
Hole Faces
24 Faces
Select Same Diameter
Auto-Merge Hole Se...
Order by Depth
Order
Optimize order
Reverse Order
Tool Orientation
Tool Orientation
Select Z axis/ple...
Z Axis
Face
Flip Z Axis
X Axis
Flip X Axis
Origin
Setup WCS origin
OK
Cancel
Standard drilling toolpath
Workflow:
- Hole recognition to generate drilling toolpath (or create manually)
- Open post-processing form
- Select ABB postprocessor
- Define relevant post properties
- Post-process to get robot native language programs
Drill holes: 24
TEXT COMMANDS



D:\OneDrive - autodesk\Projects\GO (DAM Design for Additive Manufacturing)\WP5 - T5.1.3 - ROBOTS IN FUSION 360\ODICO\nc\Odico\mD10_2_mm_Drill.mod - Notepad++

File Edit Search View Encoding Language Settings Tools Macro Run Plugins Window ?

mAutodesk.mod | mD10_2_mm_Drill.mod | mD12_mm_Spot_Drill.mod | mD19_mm_Drill.mod | mD25_mm_Spot_Drill.mod | Odico.pgf | Odico.log

```
%%%
  VERSION:1
  LANGUAGE:ENGLISH
%%%

MODULE mD10_2_mm_Drill
  PROC pD10_2_mm_Drill()
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    MoveL [[-778.876,2333.951,16],[0,0,1,0],[0,0,0,0],[9E9,9E9,9E9,9E9,9E9,9E9]],v17,z1,tADSK2\W
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    MoveL [[-101.495,1942.865,6],[0,0,1,0],[0,0,0,0],[9E9,9E9,9E9,9E9,9E9,9E9]],v17,z1,tADSK2\WC
    MoveL [[-101.495,1942.865,-48],[0,0,1,0],[0,0,0,0],[9E9,9E9,9E9,9E9,9E9,9E9]],v17,z1,tADSK2\
    MoveL [[-101.495,1942.865,-68.064],[0,0,1,0],[0,0,0,0],[9E9,9E9,9E9,9E9,9E9,9E9]],v12,z1,tAD
    MoveL [[-101.495,1942.865,6],[0,0,1,0],[0,0,0,0],[9E9,9E9,9E9,9E9,9E9,9E9]],v17,z1,tADSK2\WC
    MoveL [[92.971,1767.767,6],[0,0,1,0],[0,0,0,0],[9E9,9E9,9E9,9E9,9E9,9E9]],v17,z1,tADSK2\WObj
    MoveL [[92.971,1767.767,6],[0,0,1,0],[0,0,0,0],[9E9,9E9,9E9,9E9,9E9,9E9]],v17,z1,tADSK2\WObj
    MoveL [[92.971,1767.767,-48],[0,0,1,0],[0,0,0,0],[9E9,9E9,9E9,9E9,9E9,9E9]],v17,z1,tADSK2\WC
    MoveL [[92.971,1767.767,-68.064],[0,0,1,0],[0,0,0,0],[9E9,9E9,9E9,9E9,9E9,9E9]],v12,z1,tADSK
    MoveL [[92.971,1767.767,6],[0,0,1,0],[0,0,0,0],[9E9,9E9,9E9,9E9,9E9,9E9]],v17,z1,tADSK2\WObj
    MoveL [[268.069,1573.301,6],[0,0,1,0],[0,0,0,0],[9E9,9E9,9E9,9E9,9E9,9E9]],v17,z1,tADSK2\WOb
    MoveL [[268.069,1573.301,6],[0,0,1,0],[0,0,0,0],[9E9,9E9,9E9,9E9,9E9,9E9]],v17,z1,tADSK2\WOb
    MoveL [[268.069,1573.301,-48],[0,0,1,0],[0,0,0,0],[9E9,9E9,9E9,9E9,9E9,9E9]],v17,z1,tADSK2\W
    MoveL [[268.069,1573.301,-68.064],[0,0,1,0],[0,0,0,0],[9E9,9E9,9E9,9E9,9E9,9E9]],v12,z1,tADS
    MoveL [[268.069,1573.301,6],[0,0,1,0],[0,0,0,0],[9E9,9E9,9E9,9E9,9E9,9E9]],v17,z1,tADSK2\WOb
    MoveL [[421.881,1361.598,6],[0,0,1,0],[0,0,0,0],[9E9,9E9,9E9,9E9,9E9,9E9]],v17,z1,tADSK2\WOb
    MoveL [[421.881,1361.598,6],[0,0,1,0],[0,0,0,0],[9E9,9E9,9E9,9E9,9E9,9E9]],v17,z1,tADSK2\WOb
    MoveL [[421.881,1361.598,-48],[0,0,1,0],[0,0,0,0],[9E9,9E9,9E9,9E9,9E9,9E9]],v17,z1,tADSK2\W
    MoveL [[421.881,1361.598,-68.064],[0,0,1,0],[0,0,0,0],[9E9,9E9,9E9,9E9,9E9,9E9]],v12,z1,tADS
    MoveL [[421.881,1361.598,6],[0,0,1,0],[0,0,0,0],[9E9,9E9,9E9,9E9,9E9,9E9]],v17,z1,tADSK2\WOb
    MoveL [[552.72,1134.976,6],[0,0,1,0],[0,0,0,0],[9E9,9E9,9E9,9E9,9E9,9E9]],v17,z1,tADSK2\WObj
    MoveL [[552.72,1134.976,6],[0,0,1,0],[0,0,0,0],[9E9,9E9,9E9,9E9,9E9,9E9]],v17,z1,tADSK2\WObj
    MoveL [[552.72,1134.976,-48],[0,0,1,0],[0,0,0,0],[9E9,9E9,9E9,9E9,9E9,9E9]],v17,z1,tADSK2\WC
    MoveL [[552.72,1134.976,-68.064],[0,0,1,0],[0,0,0,0],[9E9,9E9,9E9,9E9,9E9,9E9]],v12,z1,tADSK
    MoveL [[552.72,1134.976,6],[0,0,1,0],[0,0,0,0],[9E9,9E9,9E9,9E9,9E9,9E9]],v17,z1,tADSK2\WObj
```
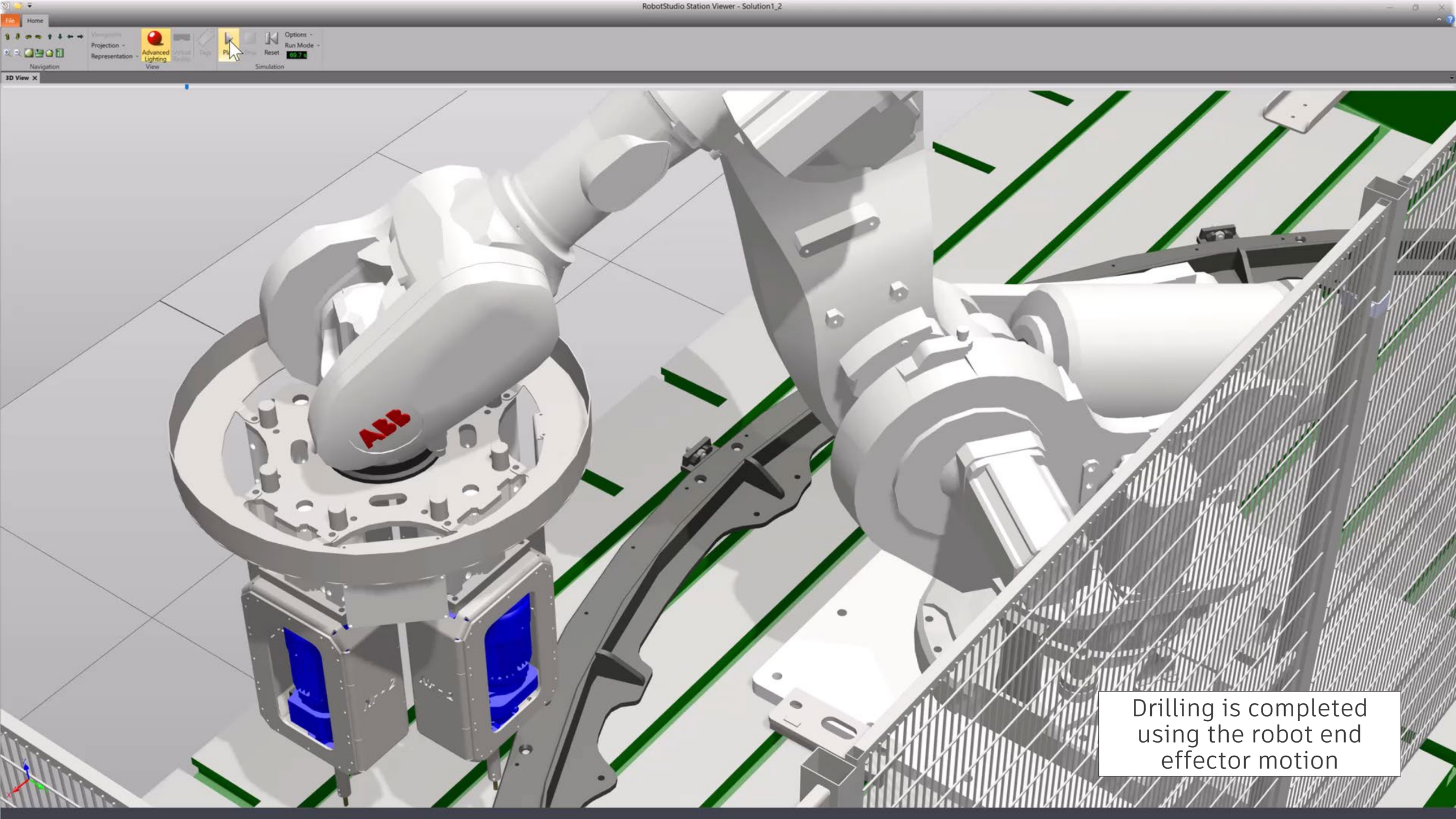
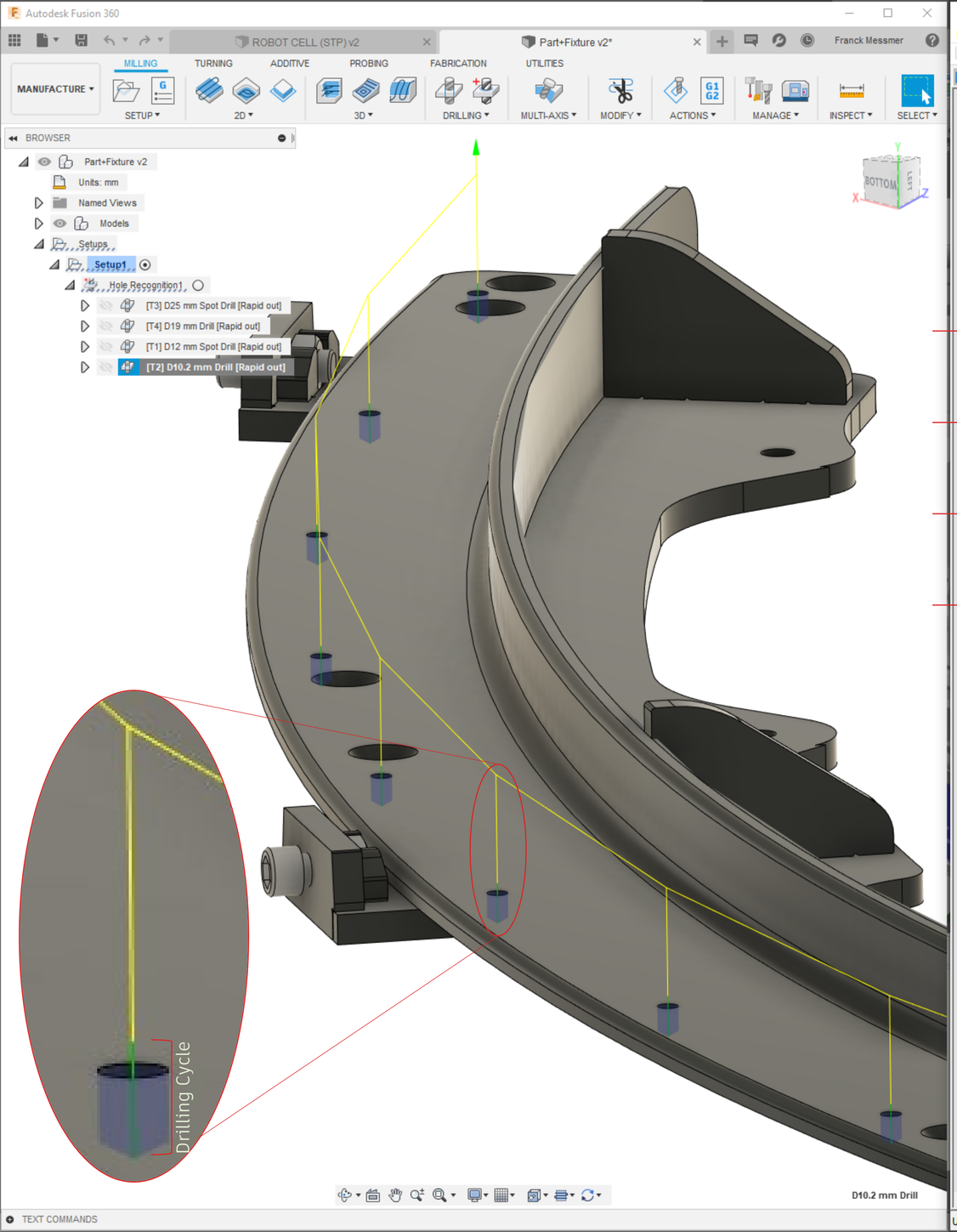

ABB robot native language output
(including option to define the rotation angle of the robot head around tool axis)

User Defined language file - ABB_RAPID | length : 13,473 lines : 132 | Ln : 1 Col : 1 Sel : 0 | 0 | Windows (CR LF) | UTF-8 | INS


RobotStudio Station Viewer - Solution1_2
File
Home
Navigation
Projection
Representation
Advanced Lighting
View
Reset
Options
Run Mode
Simulation
3D View
ABB
Drilling is completed using the robot end effector motion



D:\OneDrive - autodesk\Projects\GO (DAM Design for Additive Manufacturing)\WP5 - T5.1.3 - ROBOTS IN FUSION 360\ODICO\nc\Odico\mD10_2_mm_Drill.mod - Notepad++

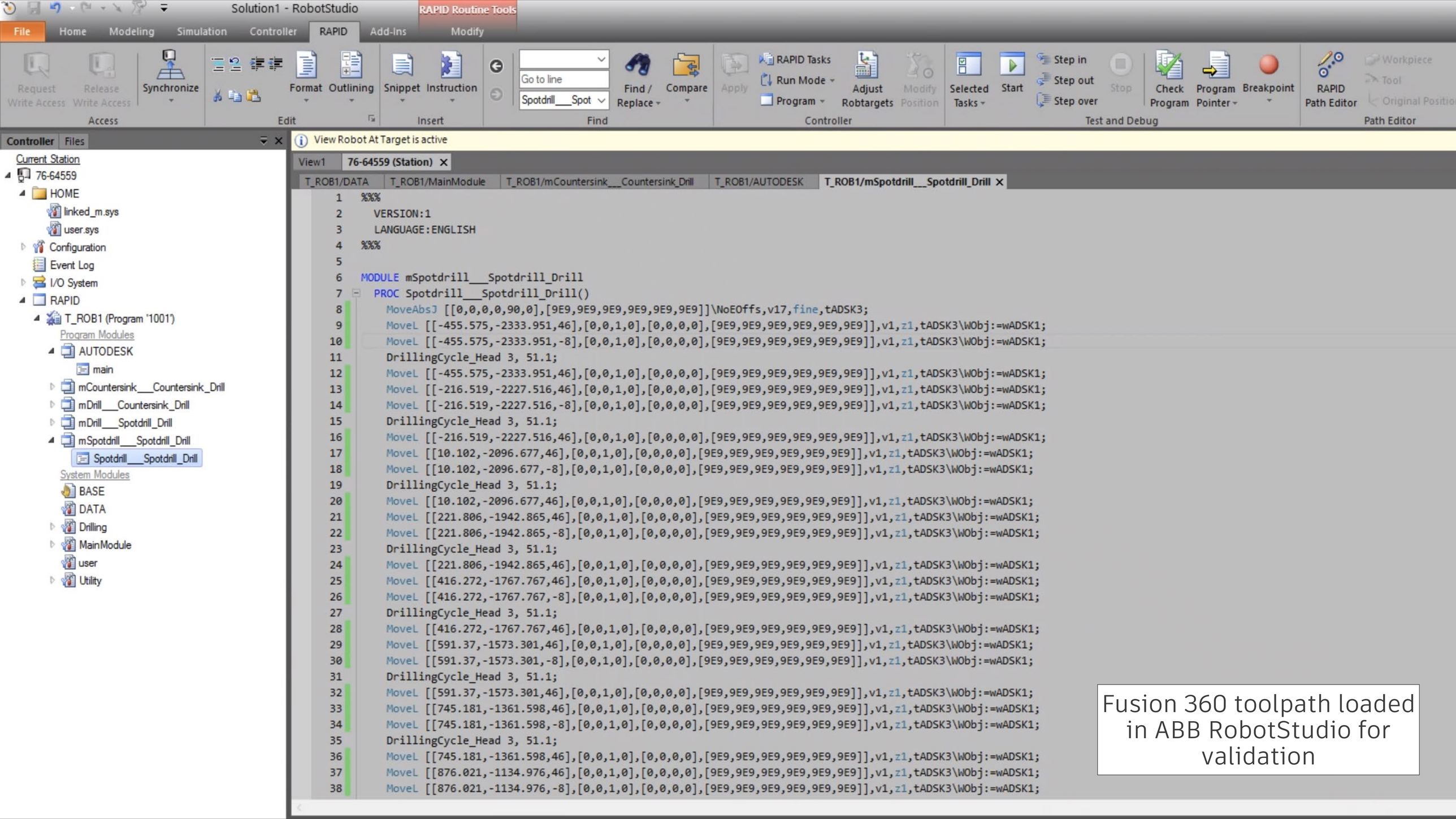
File Edit Search View Encoding Language Settings Tools Macro Run Plugins Window ?

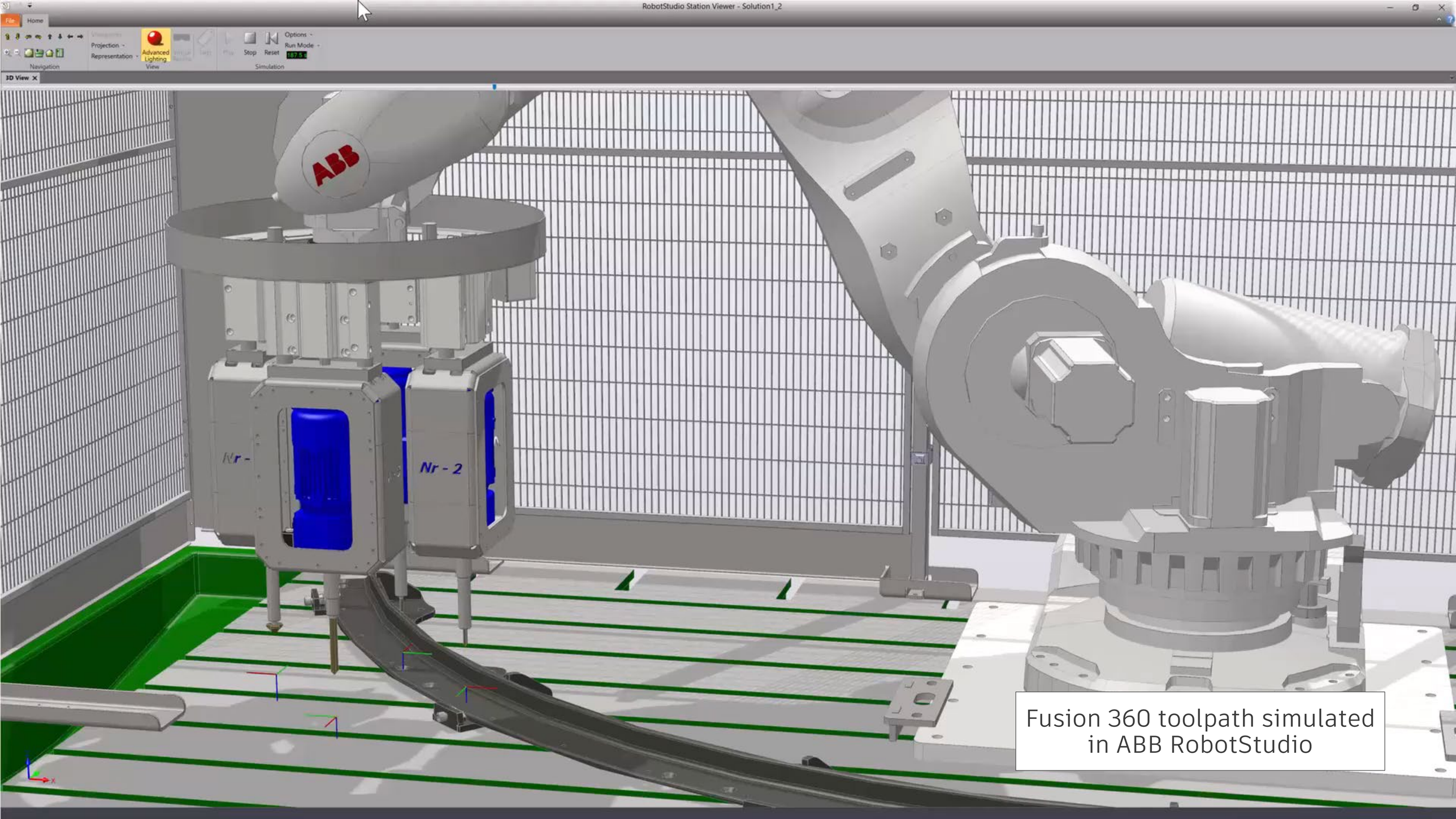
mAutodesk.mod | mD10_2_mm_Drill.mod | mD12_mm_Spot_Drill.mod | mD19_mm_Drill.mod | mD25_mm_Spot_Drill.mod | Odico.pgf | Odico.log

```
1  %%%
2    VERSION:1
3    LANGUAGE:ENGLISH
4  %%%
5
6  MODULE mD10_2_mm_Drill
7    PROC pD10_2_mm_Drill()
8      MoveAbsJ [[0,0,0,0,90,0],[9E9,9E9,9E9,9E9,9E9,9E9]]\NoEOffs,v17,fine,tADSK2;
9      MoveL [[-778.876,2333.951,6],[0,0,1,0],[0,0,0,0],[9E9,9E9,9E9,9E9,9E9,9E9]],v12,z1,tADSK2\WC
10     MoveL [[-778.876,2333.951,-48],[0,0,1,0],[0,0,0,0],[9E9,9E9,9E9,9E9,9E9,9E9]],v12,z1,tADSK2\
11     DrillingCycle_Head 2, 21.064;
12     MoveL [[-778.876,2333.951,6],[0,0,1,0],[0,0,0,0],[9E9,9E9,9E9,9E9,9E9,9E9]],v12,z1,tADSK2\WC
13     MoveL [[-539.82,2227.516,6],[0,0,1,0],[0,0,0,0],[9E9,9E9,9E9,9E9,9E9,9E9]],v12,z1,tADSK2\WOb
14     MoveL [[-539.82,2227.516,-48],[0,0,1,0],[0,0,0,0],[9E9,9E9,9E9,9E9,9E9,9E9]],v12,z1,tADSK2\W
15     DrillingCycle_Head 2, 21.064;
16     MoveL [[-539.82,2227.516,6],[0,0,1,0],[0,0,0,0],[9E9,9E9,9E9,9E9,9E9,9E9]],v12,z1,tADSK2\WOb
17     MoveL [[-313.198,2096.677,6],[0,0,1,0],[0,0,0,0],[9E9,9E9,9E9,9E9,9E9,9E9]],v12,z1,tADSK2\WC
18     MoveL [[-313.198,2096.677,-48],[0,0,1,0],[0,0,0,0],[9E9,9E9,9E9,9E9,9E9,9E9]],v12,z1,tADSK2\
19     DrillingCycle_Head 2, 21.064;
20     MoveL [[-313.198,2096.677,6],[0,0,1,0],[0,0,0,0],[9E9,9E9,9E9,9E9,9E9,9E9]],v12,z1,tADSK2\WC
21     MoveL [[-101.495,1942.865,6],[0,0,1,0],[0,0,0,0],[9E9,9E9,9E9,9E9,9E9,9E9]],v12,z1,tADSK2\WC
22     MoveL [[-101.495,1942.865,-48],[0,0,1,0],[0,0,0,0],[9E9,9E9,9E9,9E9,9E9,9E9]],v12,z1,tADSK2\
23     DrillingCycle_Head 2, 21.064;
24     MoveL [[-101.495,1942.865,6],[0,0,1,0],[0,0,0,0],[9E9,9E9,9E9,9E9,9E9,9E9]],v12,z1,tADSK2\WC
25     MoveL [[92.971,1767.767,6],[0,0,1,0],[0,0,0,0],[9E9,9E9,9E9,9E9,9E9,9E9]],v12,z1,tADSK2\WObj
26     MoveL [[92.971,1767.767,-48],[0,0,1,0],[0,0,0,0],[9E9,9E9,9E9,9E9,9E9,9E9]],v12,z1,tADSK2\WC
27     DrillingCycle_Head 2, 21.064;
28     MoveL [[92.971,1767.767,
29     MoveL [[268.069,1573.30
30     MoveL [[268.069,1573.30
31     DrillingCycle_Head 2, 21
32     MoveL [[268.069,1573.30
33     MoveL [[421.881,1361.598
34     MoveL [[421.881,1361.598
35     DrillingCycle_Head 2, 21
36     MoveL [[421.881,1361.598
37     MoveL [[552.72,1134.976,
38     MoveL [[552.72,1134.976,
39     DrillingCycle_Head 2, 21
40     MoveL [[552.72,1134.976,
41     MoveL [[659.155,895.92,6
42     MoveL [[659.155,895.92,-
43     DrillingCycle_Head 2, 21
44     MoveL [[659.155,895.92,6
45     MoveL [[740.019,647.048,
46     MoveL [[740.019,647.048,
47     DrillingCycle_Head 2, 21
48     MoveL [[740.019,647.048,6],[0,0,1,0],[0,0,0,0],[9E9,9E9,9E9,9E9,9E9,9E9]],v12,z1,tADSK2\WObj
```

```
358
359  function onCycle() {
360  }
361
362  function onCyclePoint(_x, _y, _z) {
363    var workPlane = currentSection.workPlane.forward;
364    writeRobotMove(_x, _y, cycle.clearance, workPlane.x, workPlane.y, workPlane.z, cycle.feedrate);
365    writeRobotMove(_x, _y, cycle.retract, workPlane.x, workPlane.y, workPlane.z, cycle.feedrate);
366    var drillDepth = zOutput.format(cycle.clearance + cycle.depth);
367    if (tool.number == 1) {
368      writeBlock("    DrillingCycle_Head " + tool.number + ", " + drillDepth + ";");
369    } else if (tool.number == 2) {
370      writeBlock("    DrillingCycle_Head " + tool.number + ", " + drillDepth + ";");
371    } else if (tool.number == 3) {
372      writeBlock("    DrillingCycle_Head " + tool.number + ", " + drillDepth + ";");
373    } else if (tool.number == 4) {
374      writeBlock("    DrillingCycle_Head " + tool.number + ", " + drillDepth + ";");
375    } else {
376      error(localize("Tool not supported"));
377    }
378    writeRobotMove(_x, _y, cycle.clearance, workPlane.x, workPlane.y, workPlane.z, cycle.feedrate);
379  }
380
381  function onCycleEnd() {
382  }
383
```

User Defined language file - ABB_RAPID | length : 8,980 lines : 108 | Ln : 1 Col : 1 Sel : 0 | 0 | Windows (CR LF) | UTF-8 | INS


Solution1 - RobotStudio
RAPID Routine Tools
File
Home
Modeling
Simulation
Controller
RAPID
Add-Ins
Modify
Request Write Access
Release Write Access
Synchronize
Format
Outlining
Snippet
Instruction
Go to line
Spotdrill___Spot
Find / Replace
Compare
Apply
RAPID Tasks
Run Mode
Program
Adjust Robtargets
Modify Position
Selected Tasks
Start
Step in
Step out
Step over
Stop
Check Program
Program Pointer
Breakpoint
RAPID Path Editor
Workpiece
Tool
Original Position
Access
Edit
Insert
Find
Controller
Test and Debug
Path Editor
Controller
Files
Current Station
76-64559
HOME
linked_m.sys
user.sys
Configuration
Event Log
I/O System
RAPID
T_ROB1 (Program '1001')
Program Modules
AUTODESK
main
mCountersink___Countersink_Drill
mDrill___Countersink_Drill
mDrill___Spotdrill_Drill
mSpotdrill___Spotdrill_Drill
Spotdrill___Spotdrill_Drill
System Modules
BASE
DATA
Drilling
MainModule
user
Utility
View Robot At Target is active
View1
76-64559 (Station)
T_ROB1/DATA
T_ROB1/MainModule
T_ROB1/mCountersink___Countersink_Drill
T_ROB1/AUTODESK
T_ROB1/mSpotdrill___Spotdrill_Drill
%%%
VERSION:1
LANGUAGE:ENGLISH
%%%
MODULE mSpotdrill___Spotdrill_Drill
PROC Spotdrill___Spotdrill_Drill()
MoveAbsJ [[0,0,0,0,90,0],[9E9,9E9,9E9,9E9,9E9,9E9]]\NoEOffs,v17,fine,tADSK3;
MoveL [[-455.575,-2333.951,46],[0,0,1,0],[0,0,0,0],[9E9,9E9,9E9,9E9,9E9,9E9]],v1,z1,tADSK3\WObj:=wADSK1;
MoveL [[-455.575,-2333.951,-8],[0,0,1,0],[0,0,0,0],[9E9,9E9,9E9,9E9,9E9,9E9]],v1,z1,tADSK3\WObj:=wADSK1;
DrillingCycle_Head 3, 51.1;
MoveL [[-455.575,-2333.951,46],[0,0,1,0],[0,0,0,0],[9E9,9E9,9E9,9E9,9E9,9E9]],v1,z1,tADSK3\WObj:=wADSK1;
MoveL [[-216.519,-2227.516,46],[0,0,1,0],[0,0,0,0],[9E9,9E9,9E9,9E9,9E9,9E9]],v1,z1,tADSK3\WObj:=wADSK1;
MoveL [[-216.519,-2227.516,-8],[0,0,1,0],[0,0,0,0],[9E9,9E9,9E9,9E9,9E9,9E9]],v1,z1,tADSK3\WObj:=wADSK1;
DrillingCycle_Head 3, 51.1;
MoveL [[-216.519,-2227.516,46],[0,0,1,0],[0,0,0,0],[9E9,9E9,9E9,9E9,9E9,9E9]],v1,z1,tADSK3\WObj:=wADSK1;
MoveL [[10.102,-2096.677,46],[0,0,1,0],[0,0,0,0],[9E9,9E9,9E9,9E9,9E9,9E9]],v1,z1,tADSK3\WObj:=wADSK1;
MoveL [[10.102,-2096.677,-8],[0,0,1,0],[0,0,0,0],[9E9,9E9,9E9,9E9,9E9,9E9]],v1,z1,tADSK3\WObj:=wADSK1;
DrillingCycle_Head 3, 51.1;
MoveL [[10.102,-2096.677,46],[0,0,1,0],[0,0,0,0],[9E9,9E9,9E9,9E9,9E9,9E9]],v1,z1,tADSK3\WObj:=wADSK1;
MoveL [[221.806,-1942.865,46],[0,0,1,0],[0,0,0,0],[9E9,9E9,9E9,9E9,9E9,9E9]],v1,z1,tADSK3\WObj:=wADSK1;
MoveL [[221.806,-1942.865,-8],[0,0,1,0],[0,0,0,0],[9E9,9E9,9E9,9E9,9E9,9E9]],v1,z1,tADSK3\WObj:=wADSK1;
DrillingCycle_Head 3, 51.1;
MoveL [[221.806,-1942.865,46],[0,0,1,0],[0,0,0,0],[9E9,9E9,9E9,9E9,9E9,9E9]],v1,z1,tADSK3\WObj:=wADSK1;
MoveL [[416.272,-1767.767,46],[0,0,1,0],[0,0,0,0],[9E9,9E9,9E9,9E9,9E9,9E9]],v1,z1,tADSK3\WObj:=wADSK1;
MoveL [[416.272,-1767.767,-8],[0,0,1,0],[0,0,0,0],[9E9,9E9,9E9,9E9,9E9,9E9]],v1,z1,tADSK3\WObj:=wADSK1;
DrillingCycle_Head 3, 51.1;
MoveL [[416.272,-1767.767,46],[0,0,1,0],[0,0,0,0],[9E9,9E9,9E9,9E9,9E9,9E9]],v1,z1,tADSK3\WObj:=wADSK1;
MoveL [[591.37,-1573.301,46],[0,0,1,0],[0,0,0,0],[9E9,9E9,9E9,9E9,9E9,9E9]],v1,z1,tADSK3\WObj:=wADSK1;
MoveL [[591.37,-1573.301,-8],[0,0,1,0],[0,0,0,0],[9E9,9E9,9E9,9E9,9E9,9E9]],v1,z1,tADSK3\WObj:=wADSK1;
DrillingCycle_Head 3, 51.1;
MoveL [[591.37,-1573.301,46],[0,0,1,0],[0,0,0,0],[9E9,9E9,9E9,9E9,9E9,9E9]],v1,z1,tADSK3\WObj:=wADSK1;
MoveL [[745.181,-1361.598,46],[0,0,1,0],[0,0,0,0],[9E9,9E9,9E9,9E9,9E9,9E9]],v1,z1,tADSK3\WObj:=wADSK1;
MoveL [[745.181,-1361.598,-8],[0,0,1,0],[0,0,0,0],[9E9,9E9,9E9,9E9,9E9,9E9]],v1,z1,tADSK3\WObj:=wADSK1;
DrillingCycle_Head 3, 51.1;
MoveL [[745.181,-1361.598,46],[0,0,1,0],[0,0,0,0],[9E9,9E9,9E9,9E9,9E9,9E9]],v1,z1,tADSK3\WObj:=wADSK1;
MoveL [[876.021,-1134.976,46],[0,0,1,0],[0,0,0,0],[9E9,9E9,9E9,9E9,9E9,9E9]],v1,z1,tADSK3\WObj:=wADSK1;
MoveL [[876.021,-1134.976,-8],[0,0,1,0],[0,0,0,0],[9E9,9E9,9E9,9E9,9E9,9E9]],v1,z1,tADSK3\WObj:=wADSK1;
Fusion 360 toolpath loaded in ABB RobotStudio for validation


RobotStudio Station Viewer - Solution1_2
File
Home
Navigation
Projection
Representation
Advanced Lighting
View
Stop
Reset
Options
Run Mode
Simulation
3D View
ABB
Nr -
Nr - 2
Fusion 360 toolpath simulated in ABB RobotStudio

Autodesk Fusion 360

Part+Fixture_Demo v6*

DESIGN

SOLID SURFACE SHEET METAL TOOLS

CREATE MODIFY ASSEMBLE CONSTRUCT INSPECT INSERT SELECT

BROWSER

- Part+Fixture_Demo v6
  - Document Settings
  - Named Views
  - Origin
  - Sketches
  - 29031804_R0_V1:1
  - FIXTUR:1

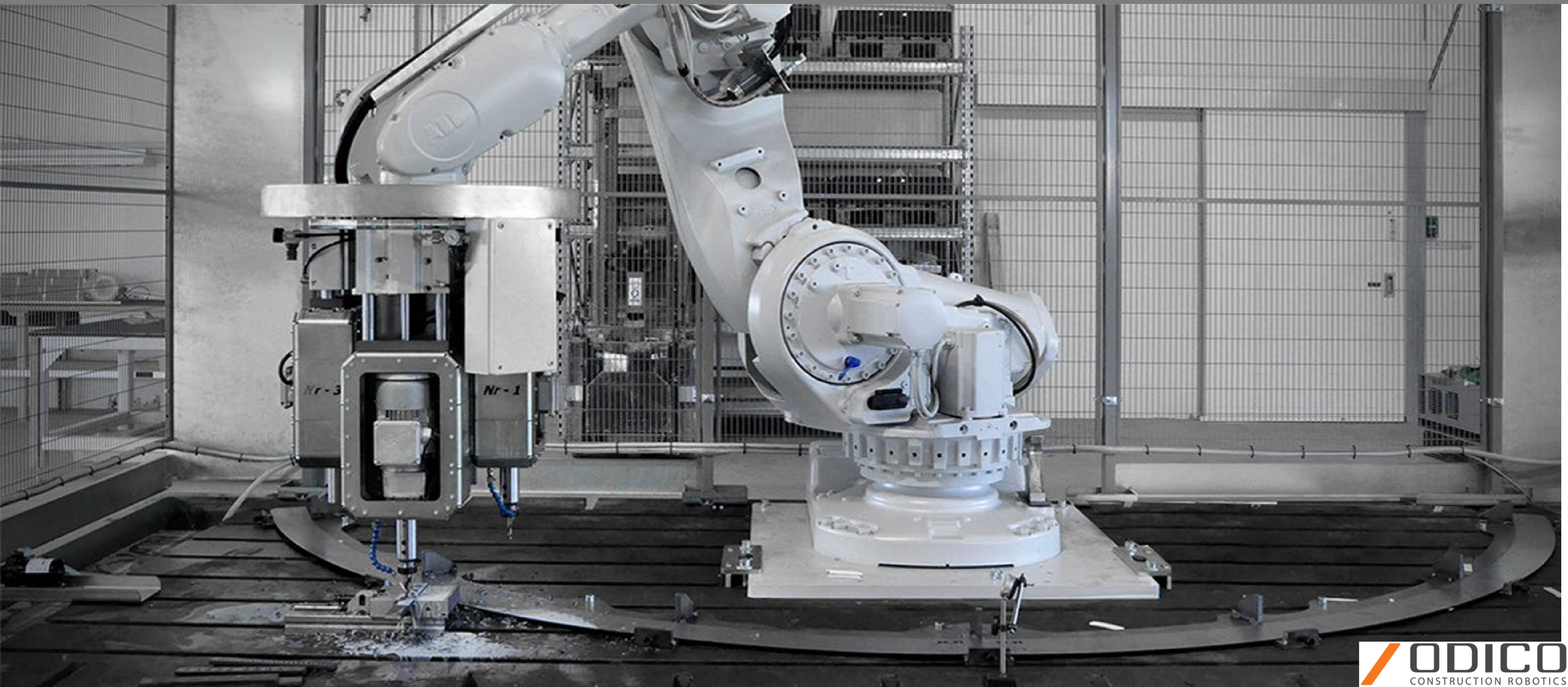
TEXT COMMANDS

Robot cell being assembled...

Fusion 360 toolpath being run on actual robot cell

Drill Mate

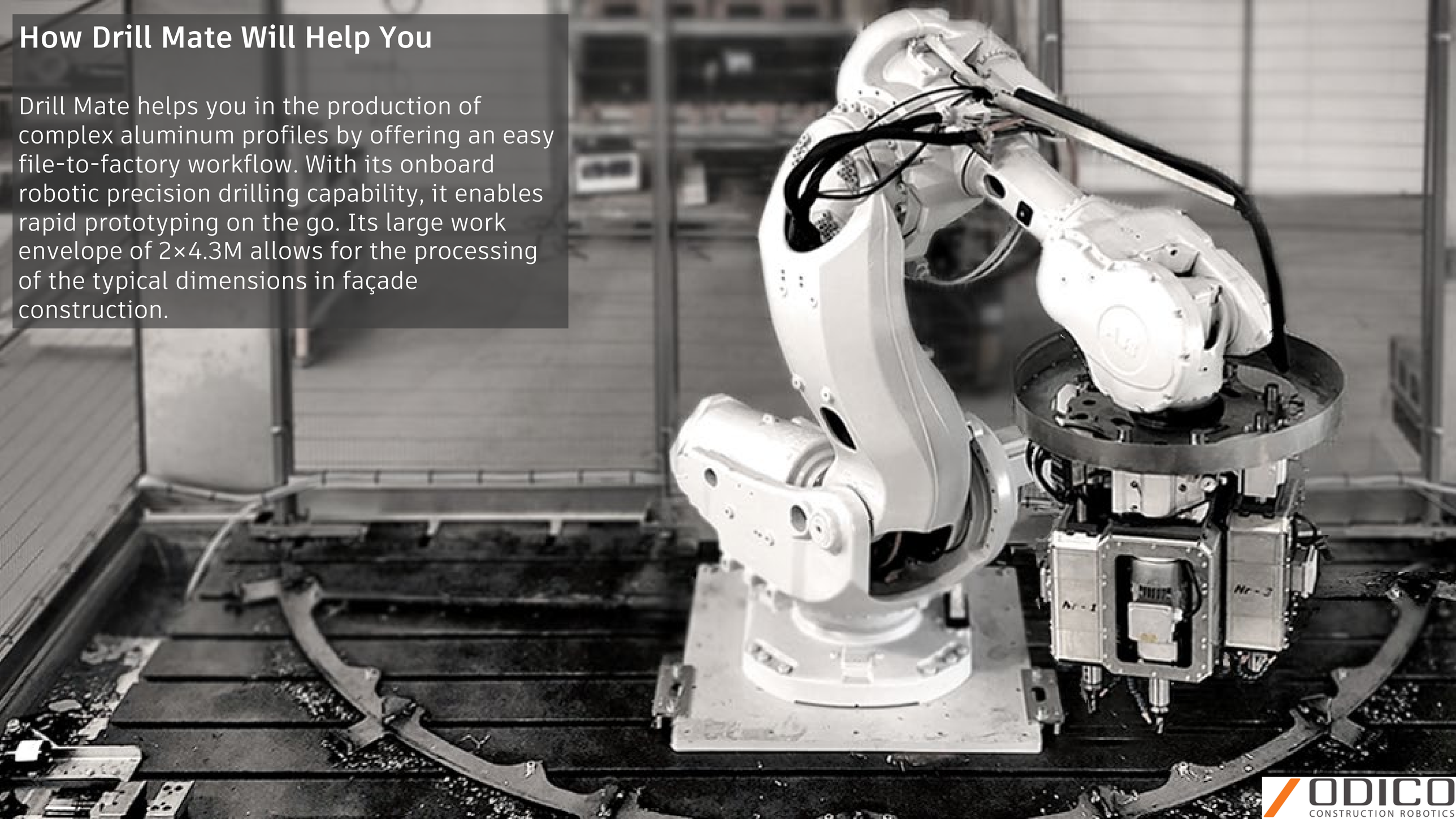
Drilling the same patterns over and over again in huge objects calls for extreme precision and stamina. It is something better left for machines than for humans. Based on this, we've created a beast of a robot that does this one thing masterfully.



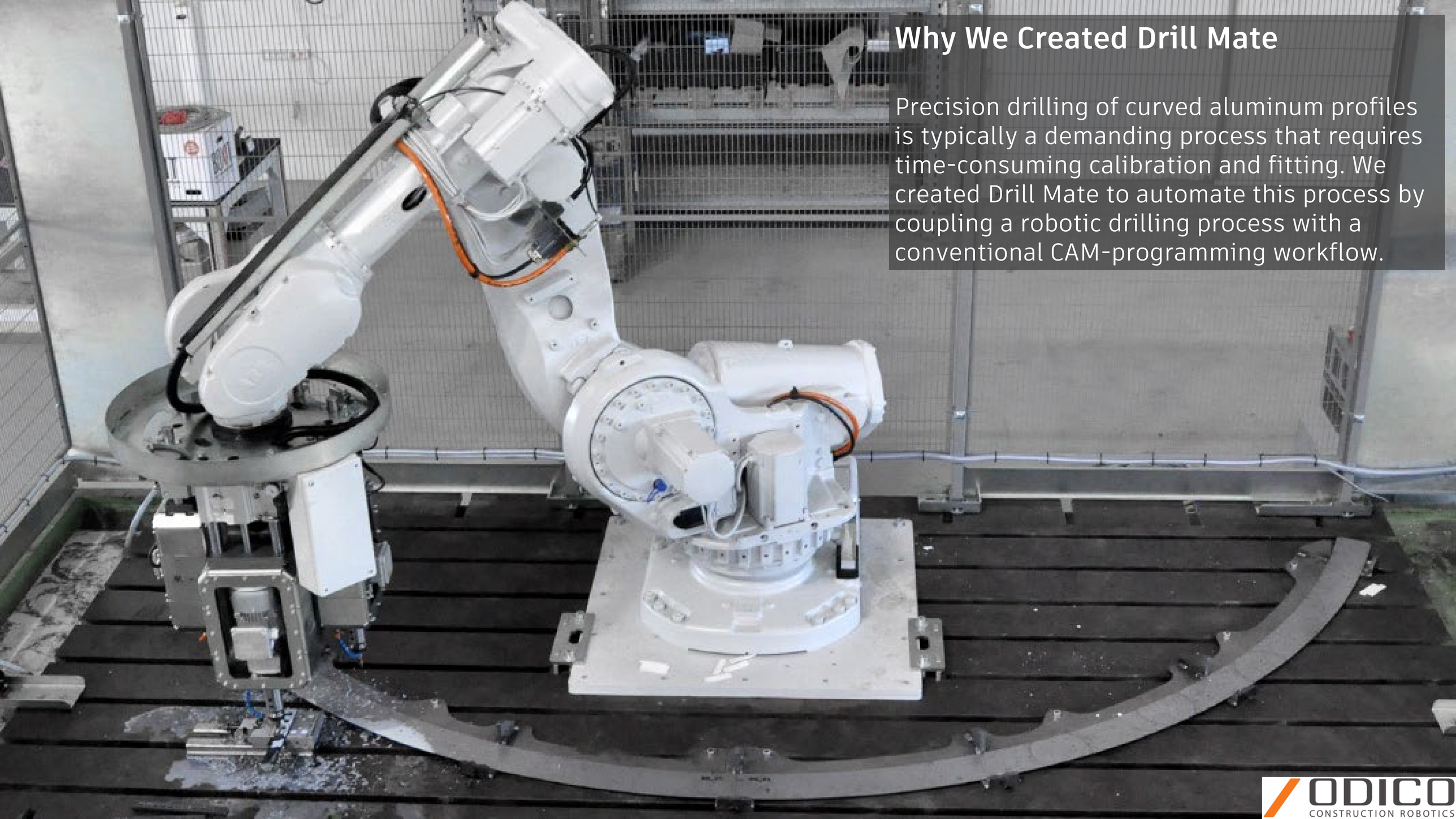
ODICO
CONSTRUCTION ROBOTICS

How Drill Mate Will Help You

Drill Mate helps you in the production of complex aluminum profiles by offering an easy file-to-factory workflow. With its onboard robotic precision drilling capability, it enables rapid prototyping on the go. Its large work envelope of 2×4.3M allows for the processing of the typical dimensions in façade construction.



ODICO
CONSTRUCTION ROBOTICS



Why We Created Drill Mate

Precision drilling of curved aluminum profiles is typically a demanding process that requires time-consuming calibration and fitting. We created Drill Mate to automate this process by coupling a robotic drilling process with a conventional CAM-programming workflow.

ODICO
CONSTRUCTION ROBOTICS

What Is Drill Mate

Drill Mate is a mobile robotic platform for precision drilling of advanced aluminum façade profiles. Its sturdy steel base and modular architecture allows for quick, in-factory installation. The system comes with a heavy-duty 6-axis robot manipulator equipped with a multi-phase drilling head that has 4 variable bit-sizes and an inbuilt cooling system. **Drill Mate is compatible with Autodesk Fusion 360 for an easy CAM-programming work**.

ODICO
CONSTRUCTION ROBOTICS

The Future of Making

Autodesk Technology Centers Outsight Network

www.autodesk.com/technology-centers

technology.centers@autodesk.com

AUTODESK.

The Future of Making

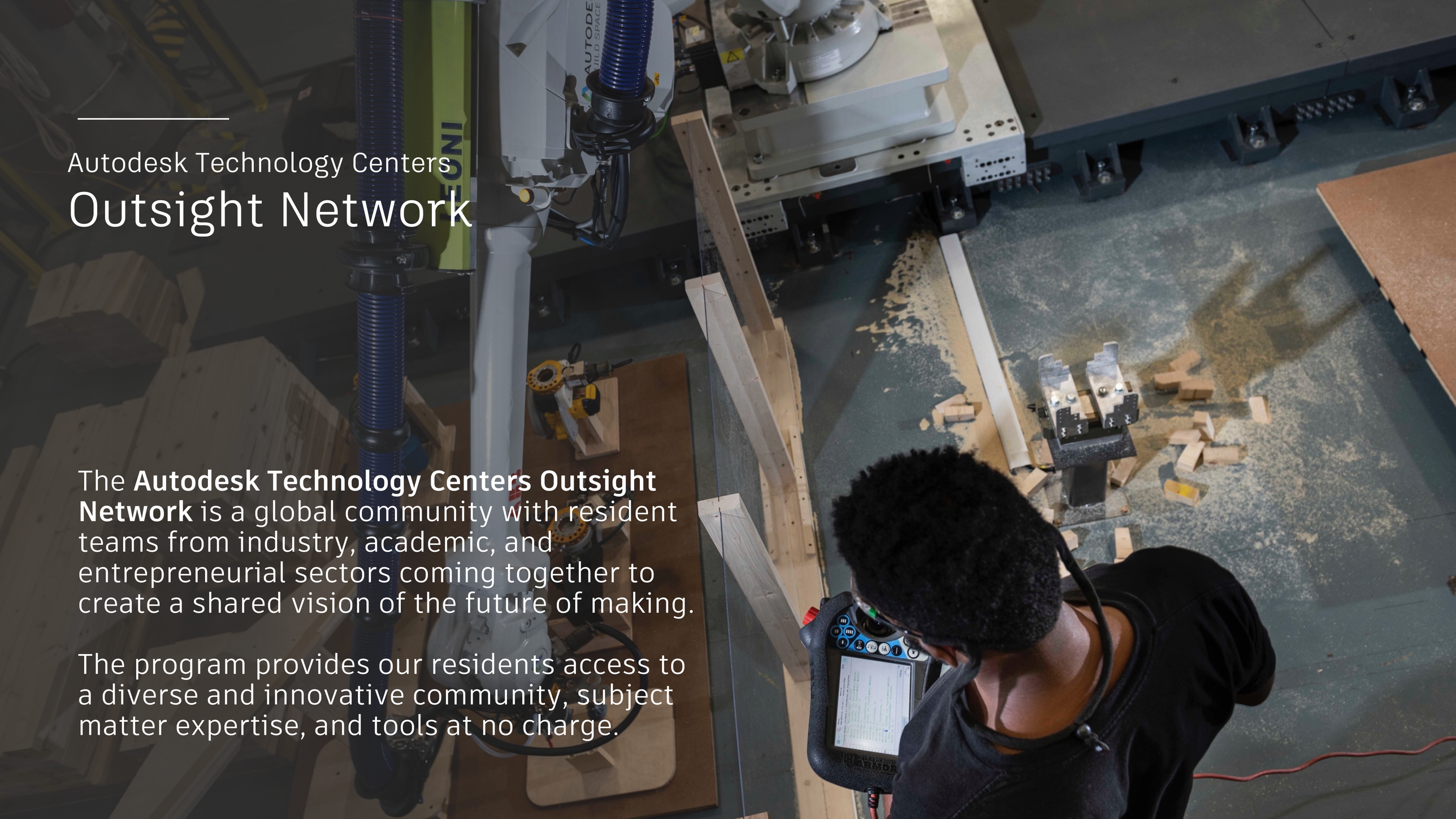
Starts Here

The **Autodesk Technology Centers Outsight Network** brings together pioneers innovating in design, architecture, engineering, construction, manufacturing, and emerging technologies.

Through this network, Autodesk helps bring solutions to life that enable people to do more and make better things with less negative impact on the world.

Autodesk Technology Centers

Outsight Network



The **Autodesk Technology Centers Outsight Network** is a global community with resident teams from industry, academic, and entrepreneurial sectors coming together to create a shared vision of the future of making.

The program provides our residents access to a diverse and innovative community, subject matter expertise, and tools at no charge.

https://youtu.be/-SgnK-u8puM