Introduction to PowerMill Robot in Subtractive Manufacturing

Tatenda Mushonga

Technical Consultant

MFG226311

AUTODESK. UNIVERSITY

About me

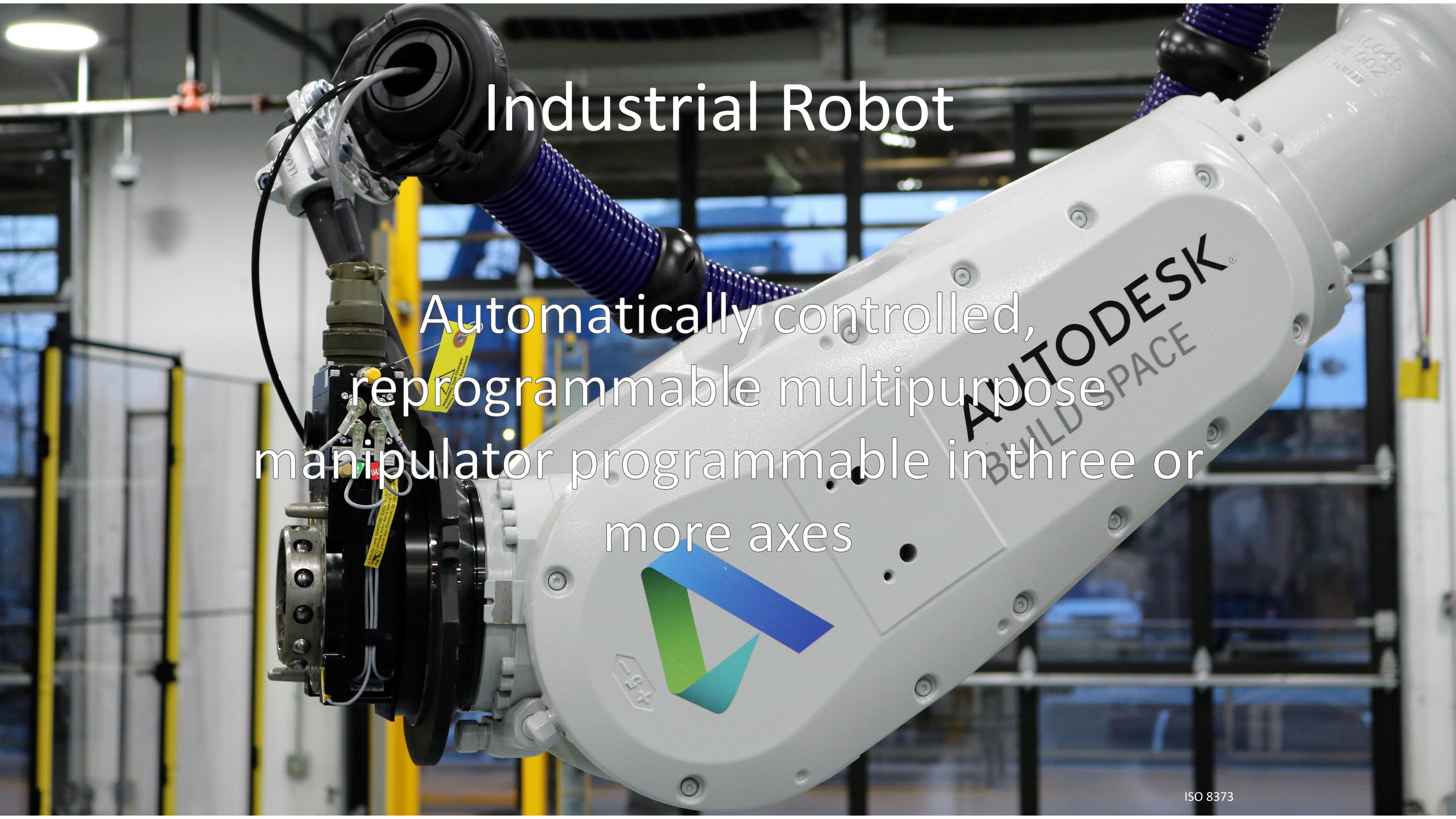
Tatenda Mushonga

Technical Consultant

Autodesk Inc.

Class Objectives

- Setting up a robot cell and positioning a part
- Creating basic toolpaths
- Simulating the toolpaths and checking for collisions
- Optimizing for safety and efficiency by applying constraints
- Posting Code

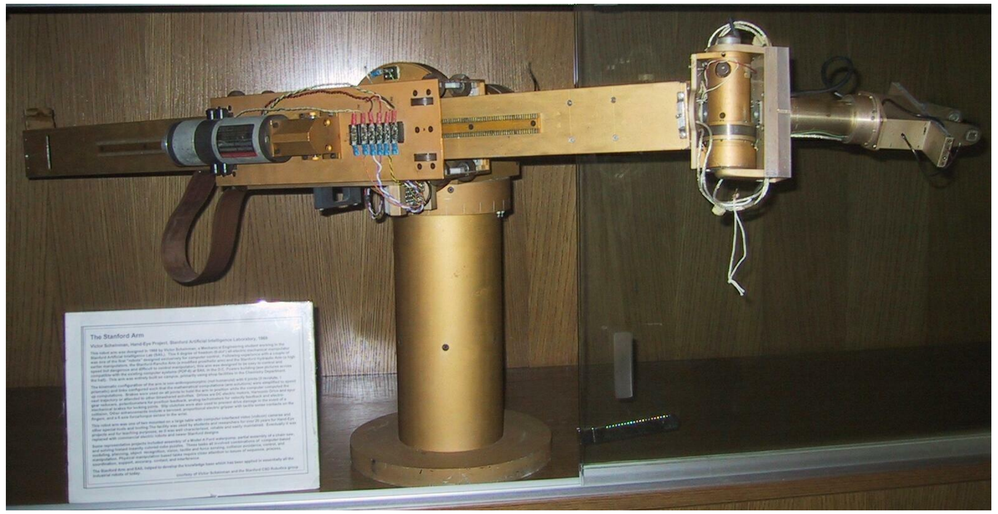


Industrial Robot

Automatically controlled, reprogrammable multipurpose manipulator programmable in three or more axes

ISO 8373

Industrial Robots Through The Years: 70s



Stanford Arm, 1974

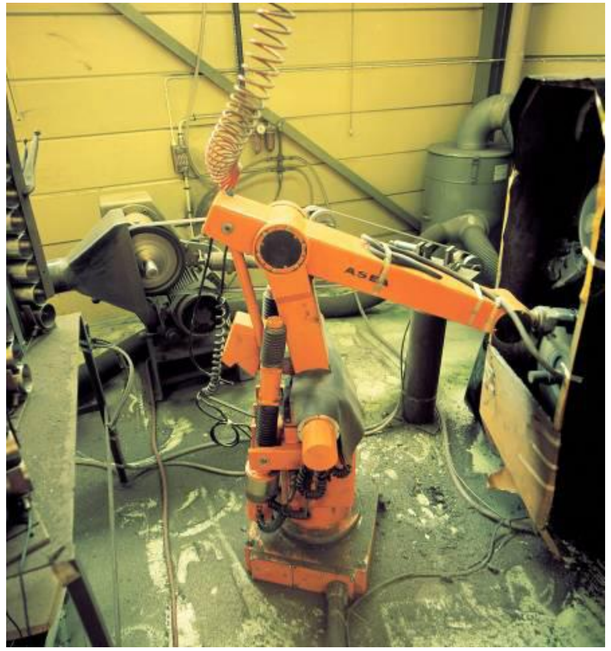


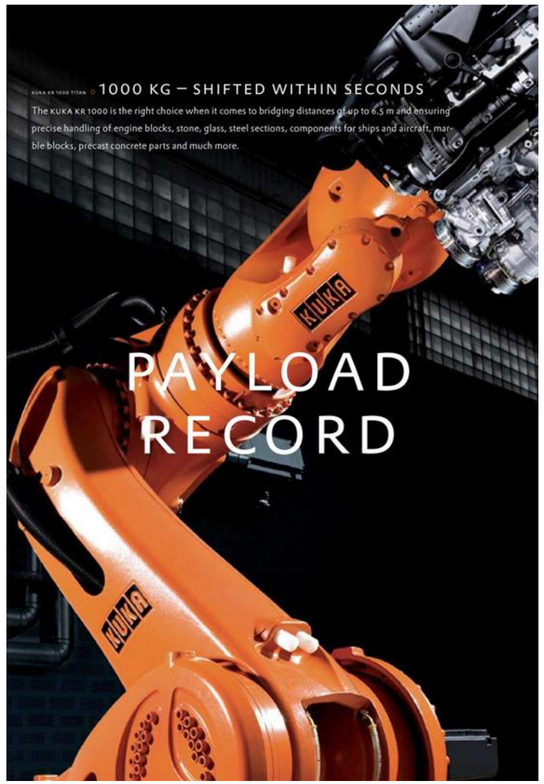
ABB IRB-6, 1976

SCARA, 1978

Infolab.Stanford.edu
International Federation of Robotics

Industrial Robots Through The Years: 90 – 00s

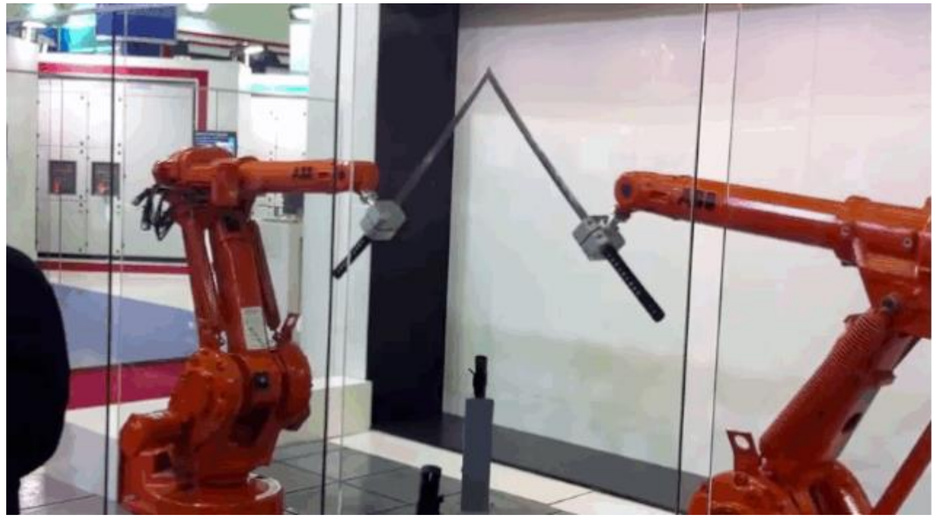
NX-100 Controller

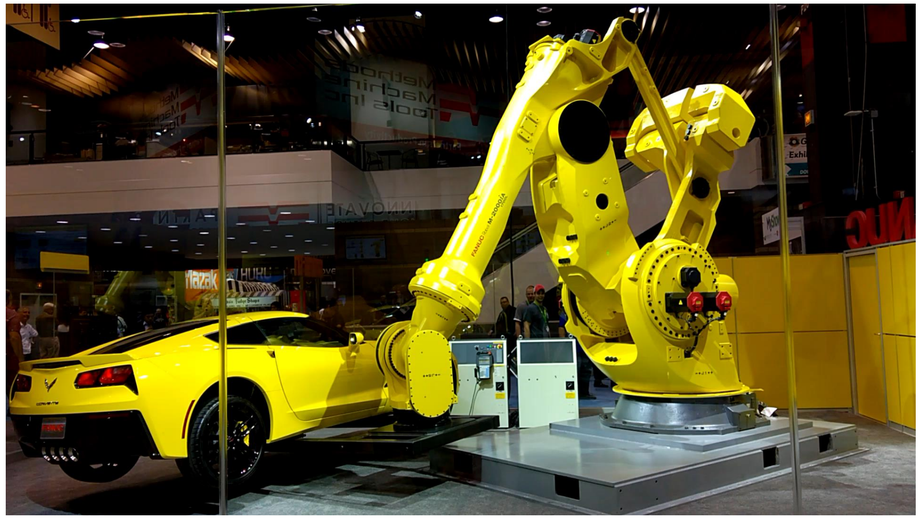


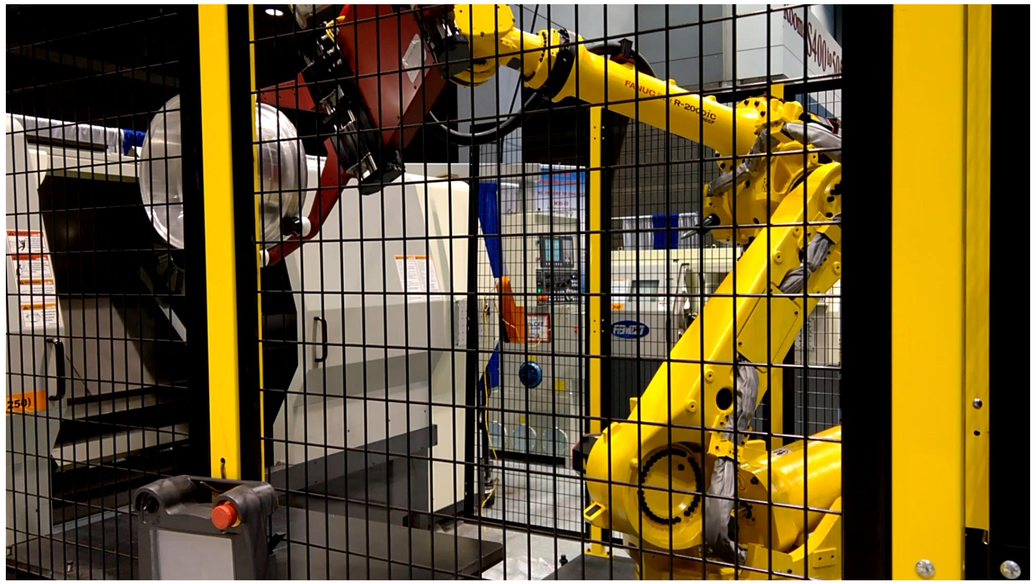
KUKA KR-1000

COMAU Wireless Teach Pendandt

Industrial Robots Through The Years: Present Day



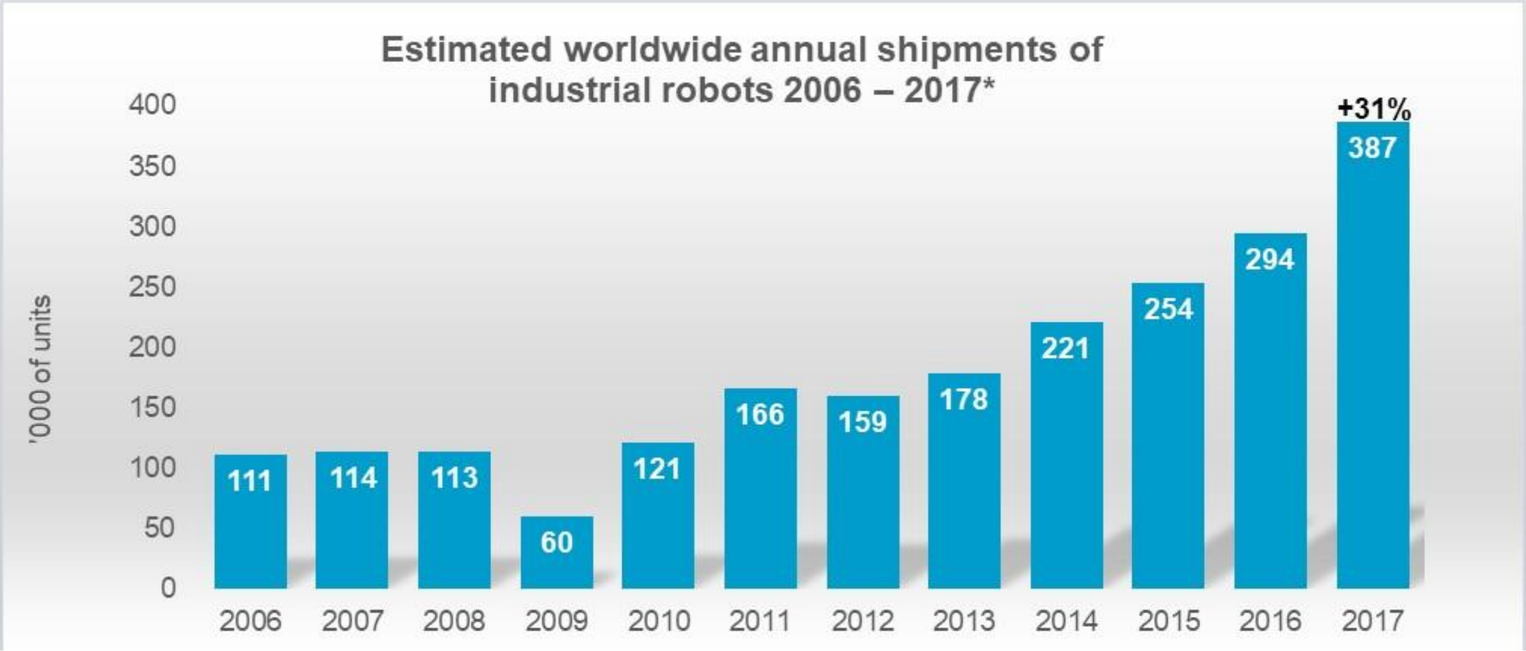




Industrial Robot Supply Trends

2017: record growth of industrial robots

IFR International Federation of Robotics

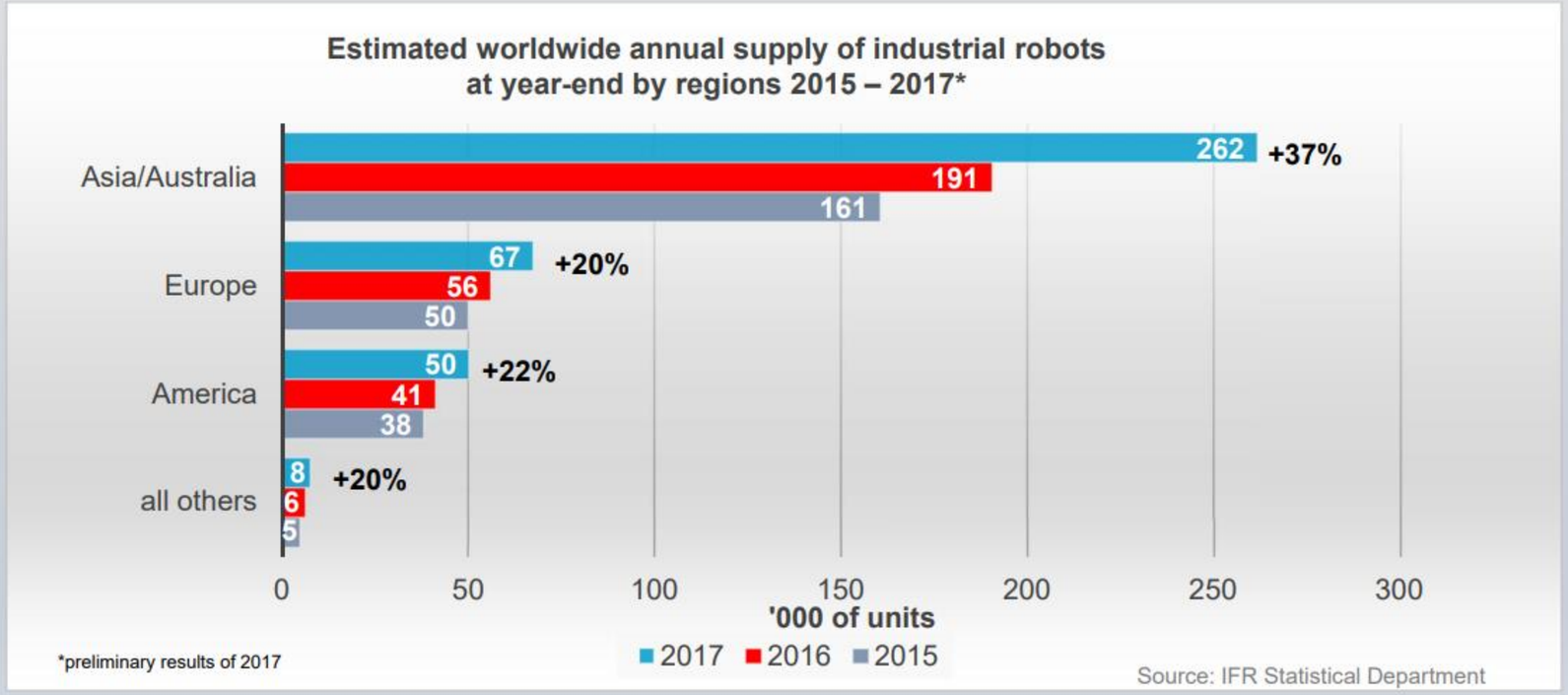


Source: International Federation of Robotics

Industrial Robot Supply Trends By Region

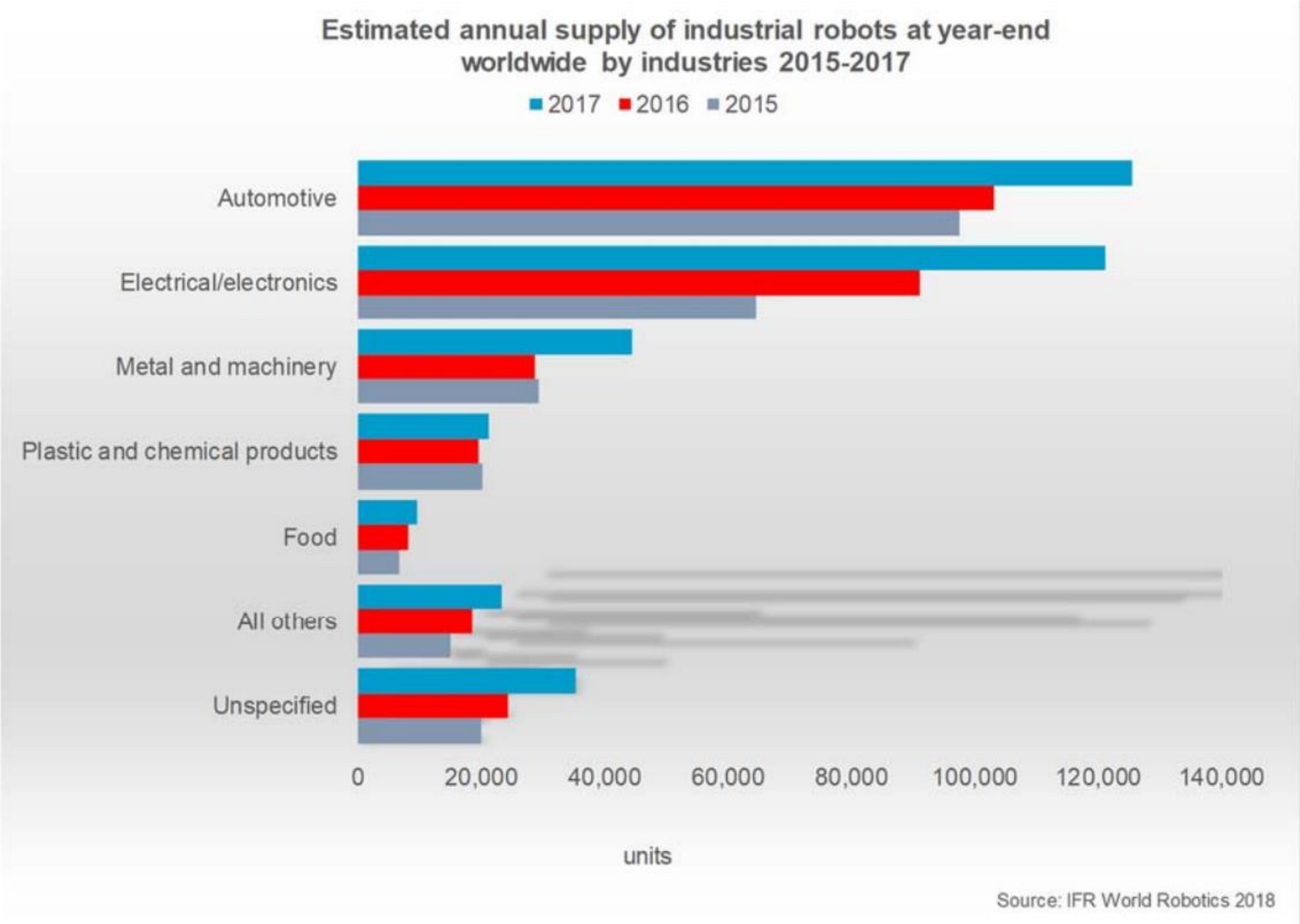
2017: considerable increase in all regions

IFR International Federation of Robotics



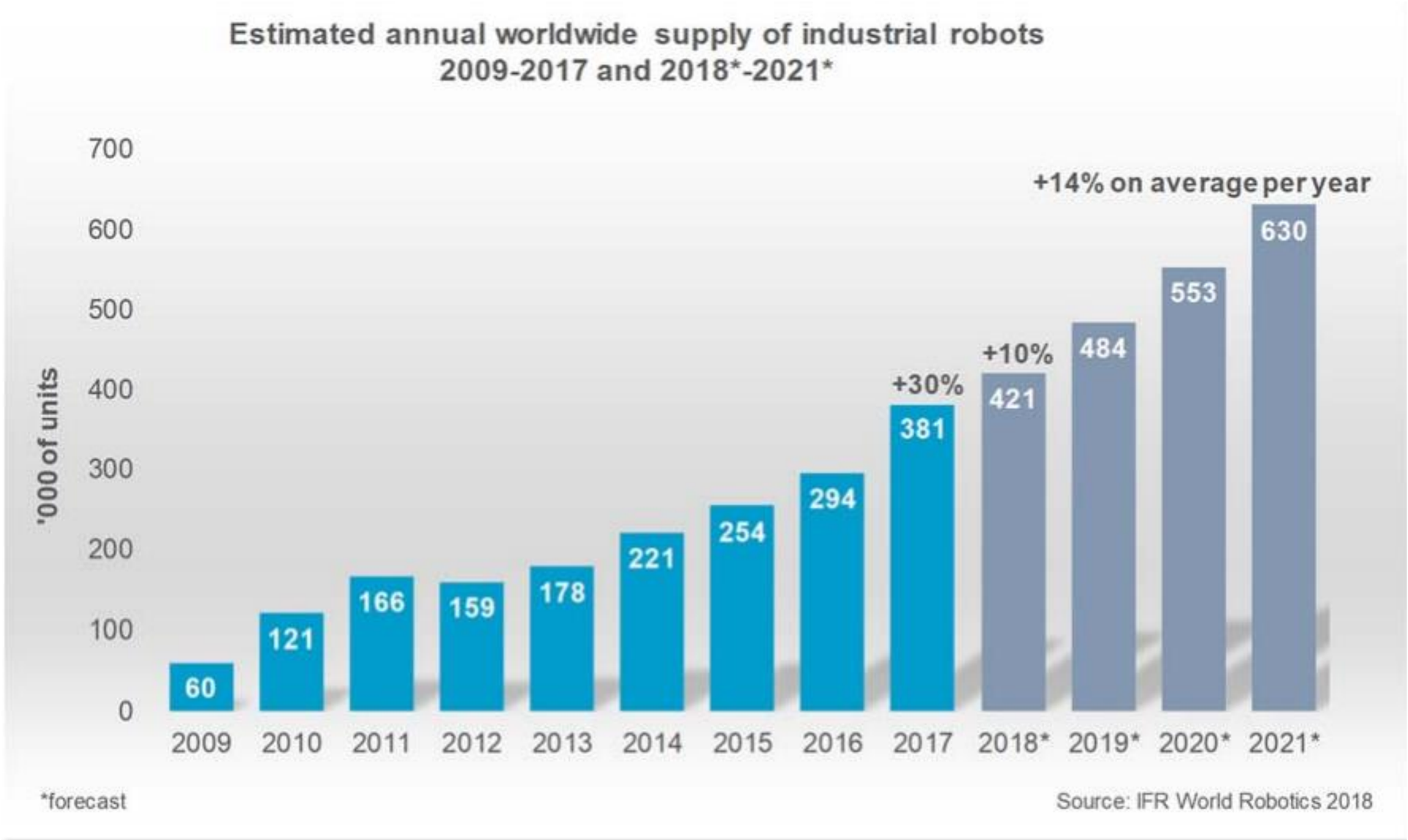
Source: International Federation of Robotics

Industrial Robot Supply Trends: By Industry



Source: International Federation of Robotics

Industrial Robot Supply Trends: Growth Forecast



Source: International Federation of Robotics

Industrial Robot Statistics

73% OF SALES IN FIVE COUNTRIES

China, Japan, Republic of Korea, U.S.A & Germany

ASIAN MARKETS LEAD IN ROBOT DENSITY

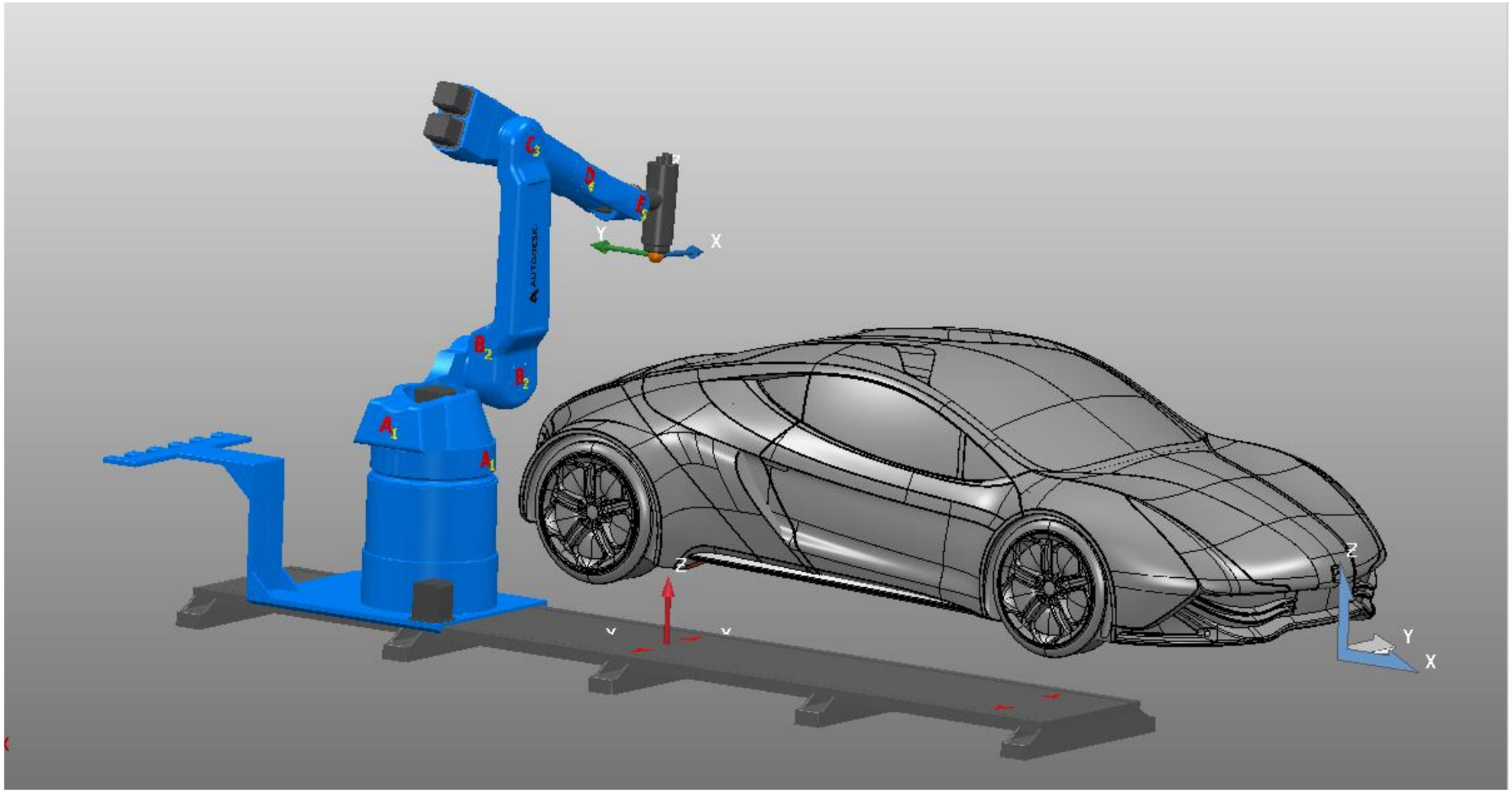
- Korea: 553 robots per 10,000 employees
- Japan: 225
- U.S.A: 117
- Germany: 191

EMERGING MARKETS IN THE AMERICAS

Mexico and Canada

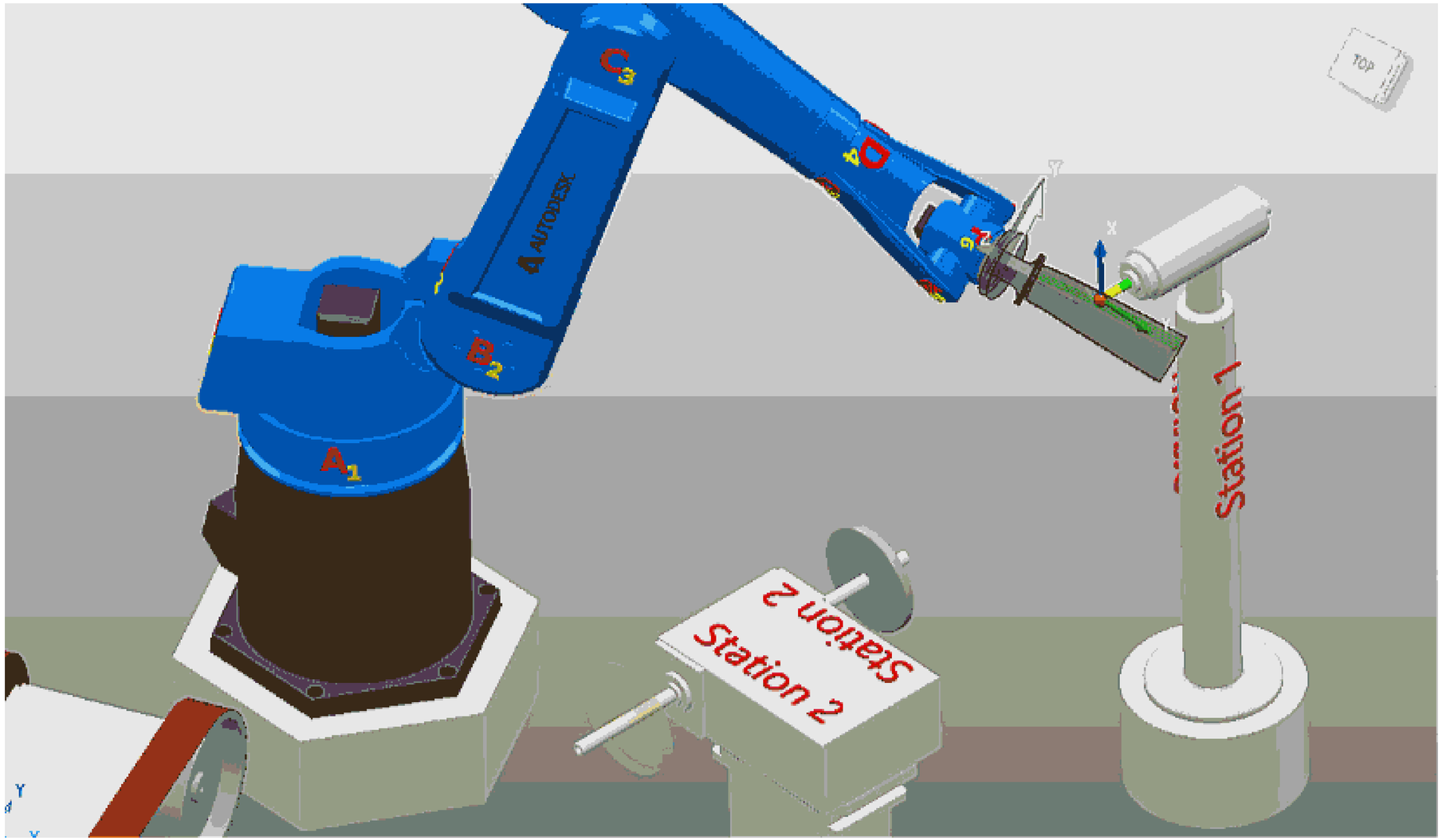
Advantages of Robots in Subtractive Manufacturing

Machining Workspace



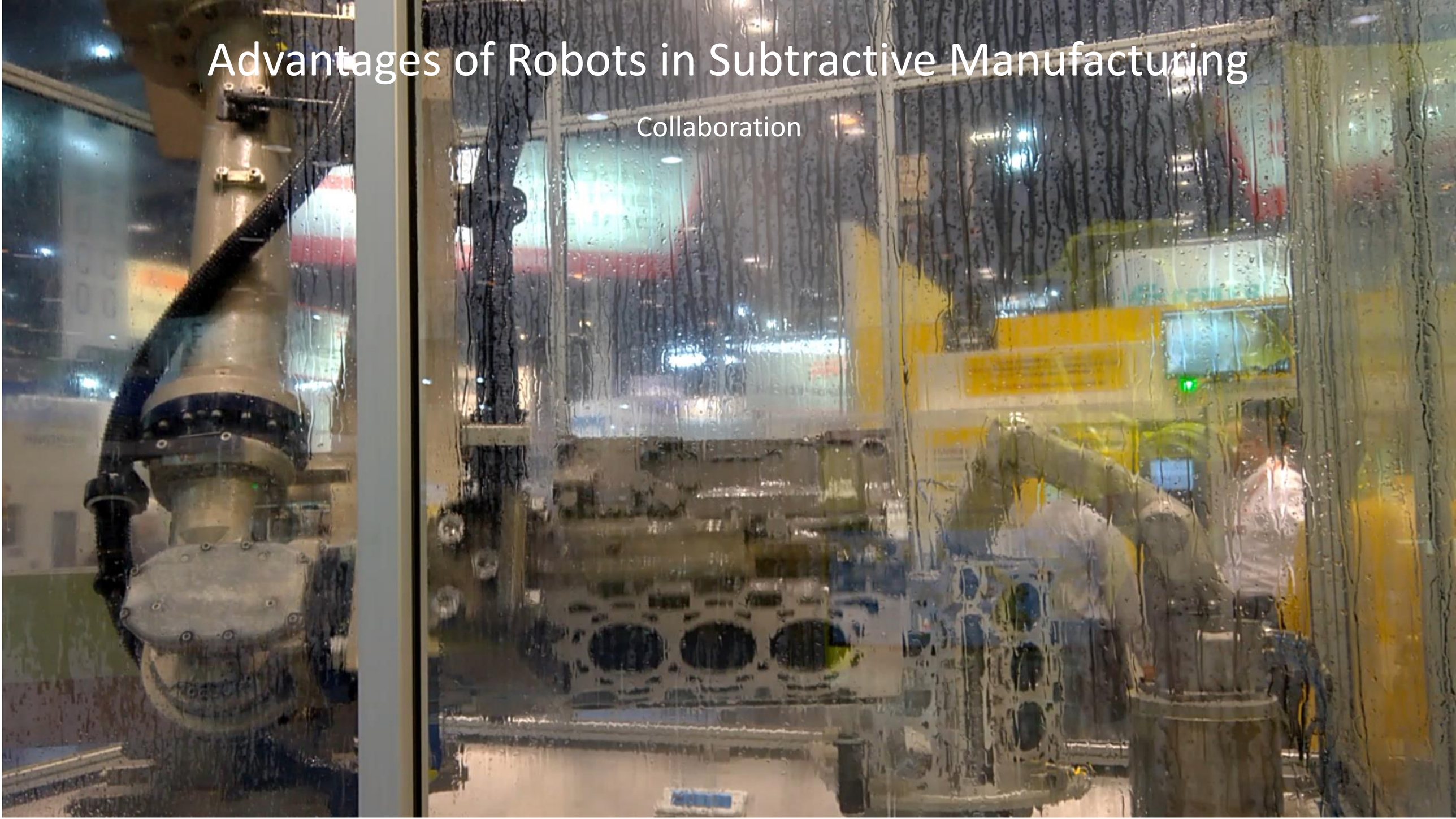
Advantages of Robots in Subtractive Manufacturing

Versatility



Advantages of Robots in Subtractive Manufacturing

Collaboration



Disadvantages of Robots in Subtractive Manufacturing

Machinable Materials

Disadvantages of Robots in Subtractive Manufacturing

Achievable Tolerances

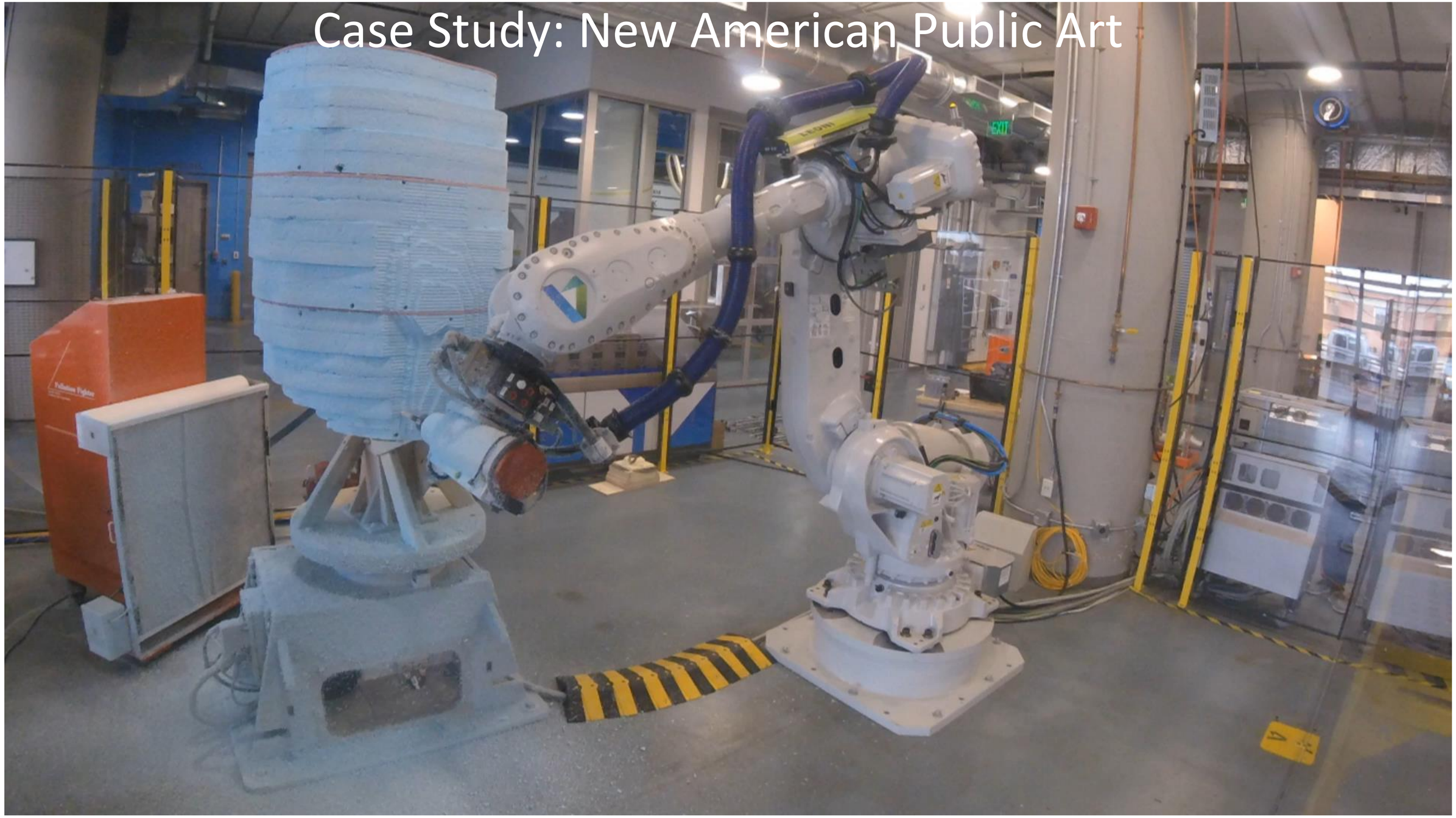
Case Study: New American Public Art

http://www.newamericanpublicart.com/kempelens-owls

Case Study: New American Public Art

Case Study: New American Public Art

Case Study: New American Public Art



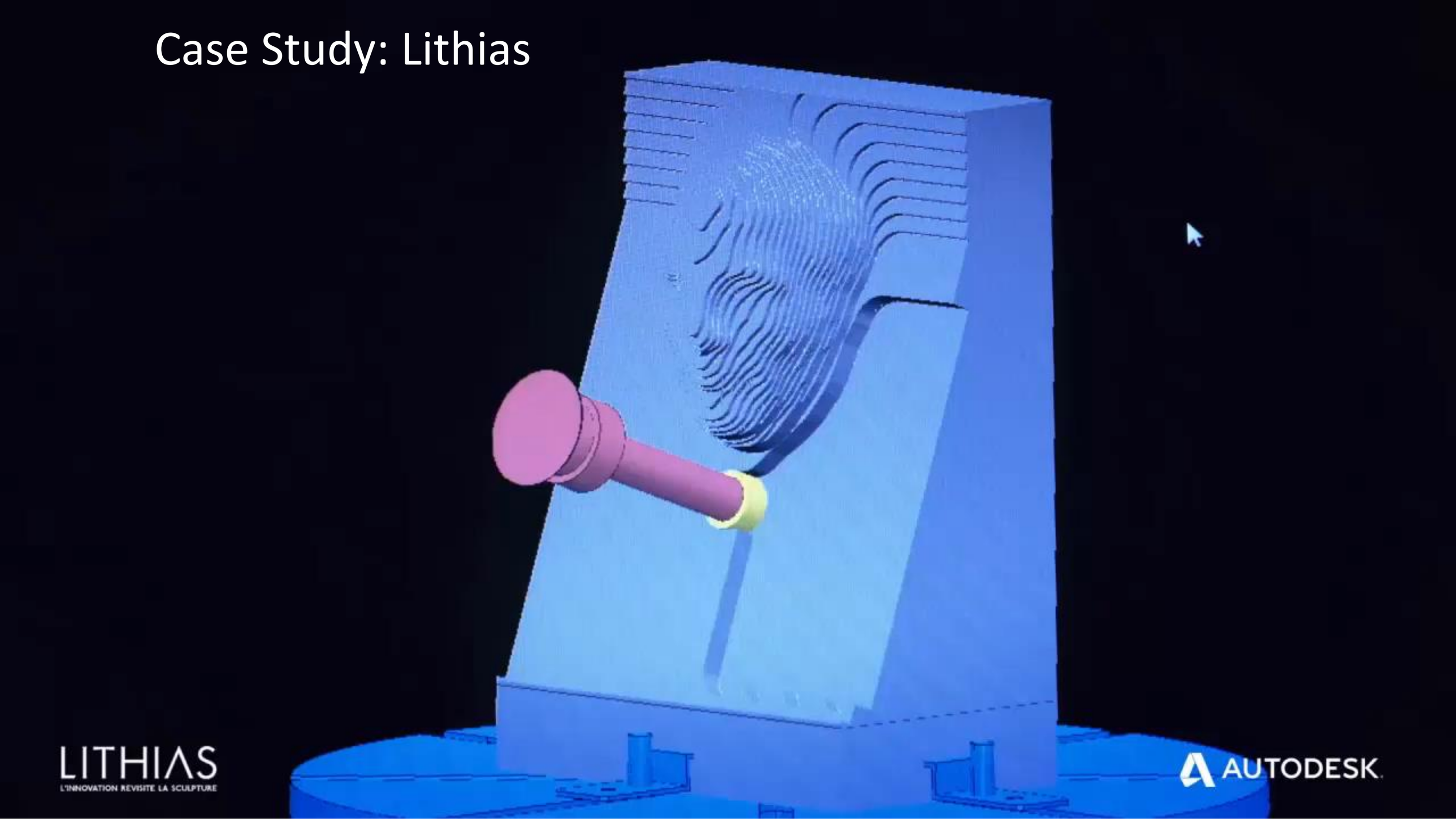

Robotics
ROBOTICS

Case Study: Artem

artem.com


Delcam TV
PRUHEALTH
Vitality
RYG

Case Study: Lithias



LITHIAS
L'INNOVATION REVISITE LA SCULPTURE

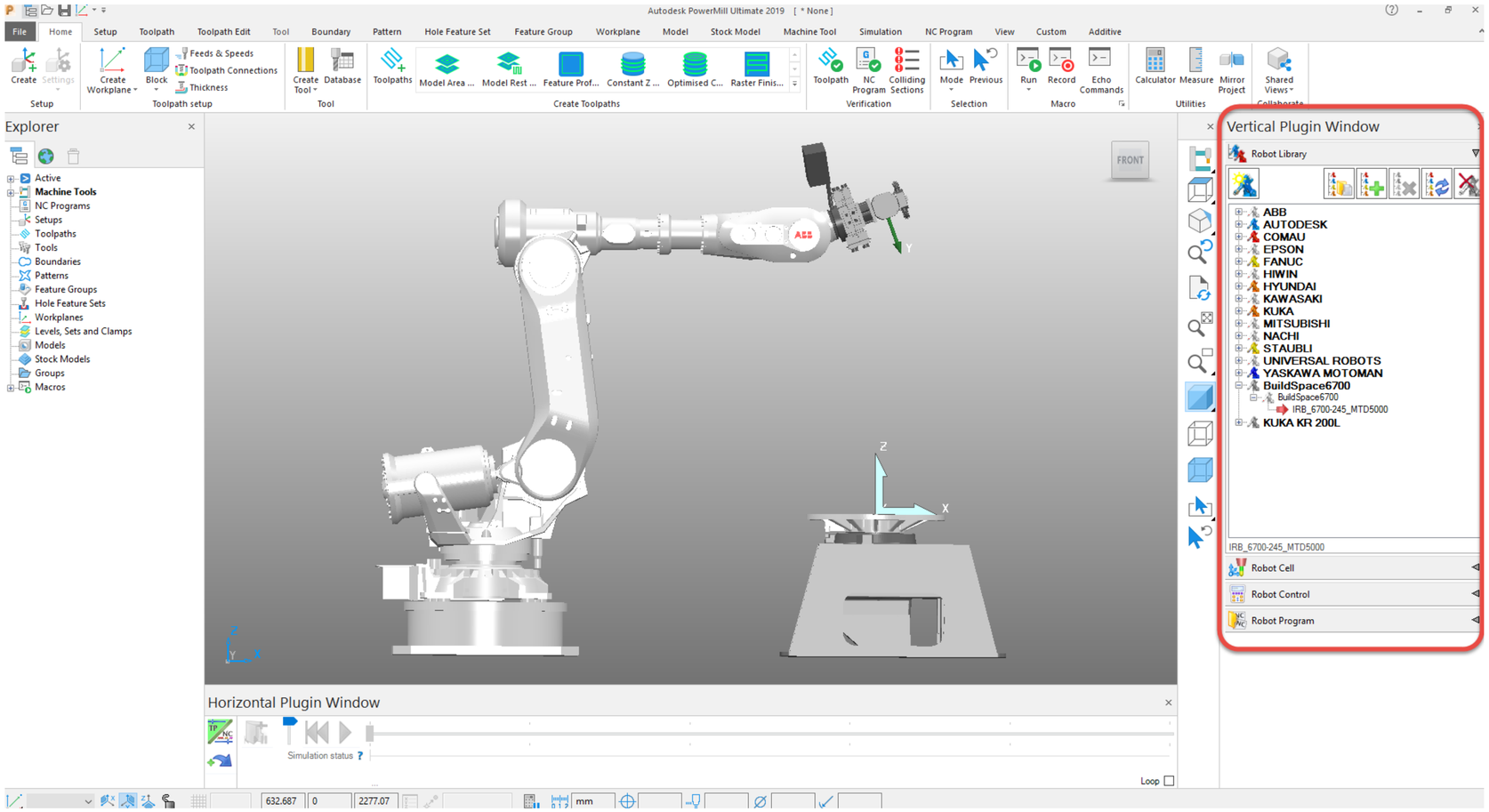
AUTODESK.

Case Study: Symplexity

Case Study: Guy Martin Design

Adaptive Machining

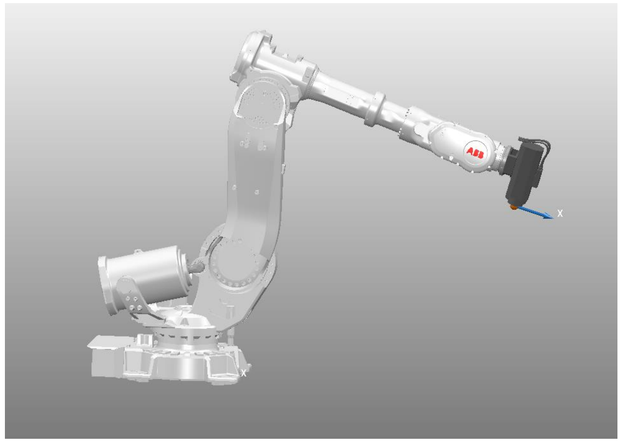
What is PowerMill Robot?



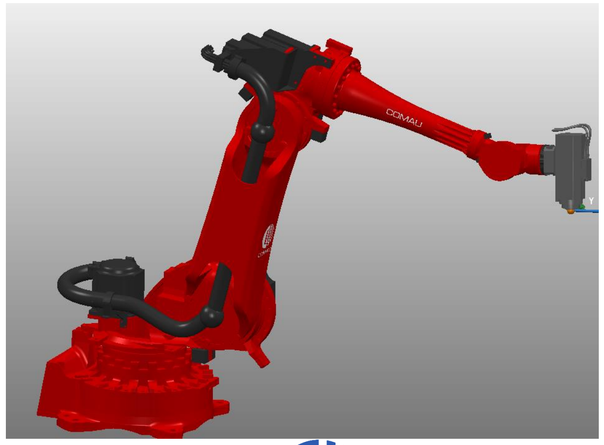
PowerMill is an expert 5 axis CAM software with great toolpath editing and control

PowerMill Robot is a plugin within PowerMill that applies toolpaths to a robotic arm

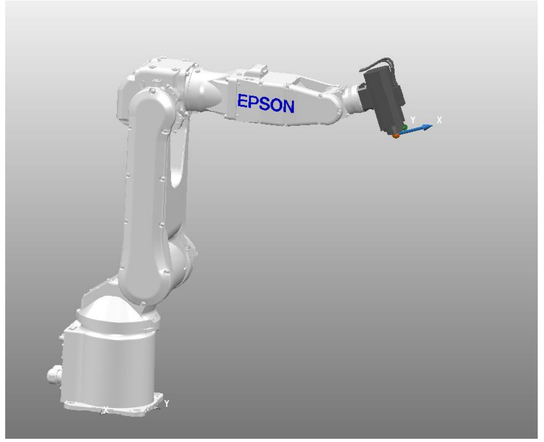
Supported Manufacturers in PowerMill Robot



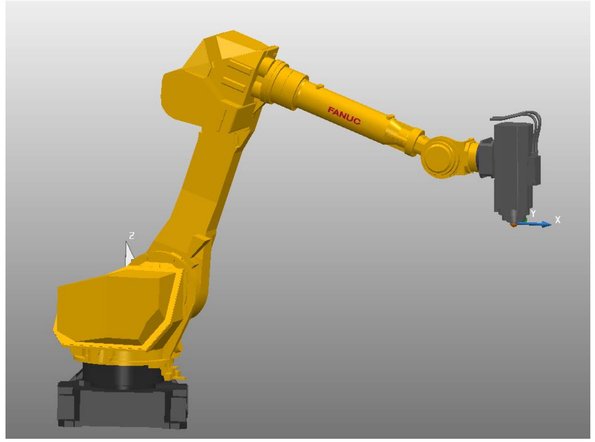
ABB



COMAU

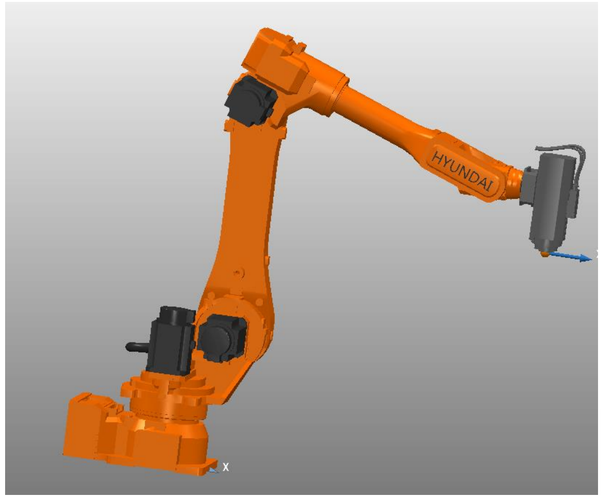


EPSON®



FANUC

HIWIN®
Linear Motion Products & Technology

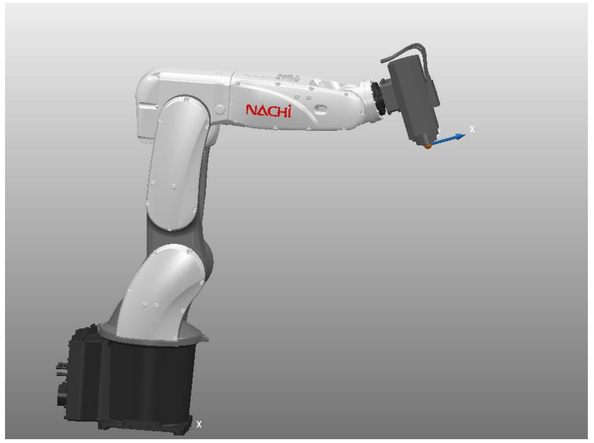


HYUNDAI

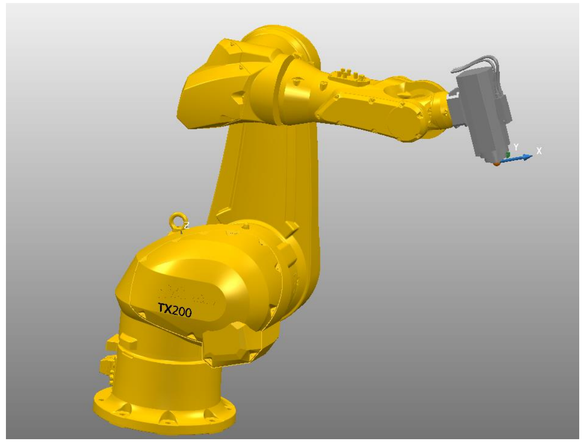
KUKA

MITSUBISHI

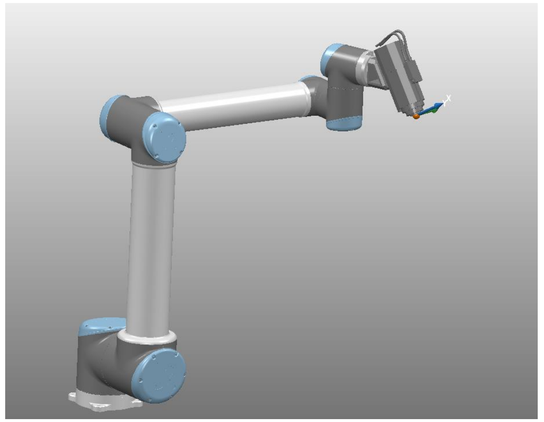
Supported Manufacturers in PowerMill Robot …contd



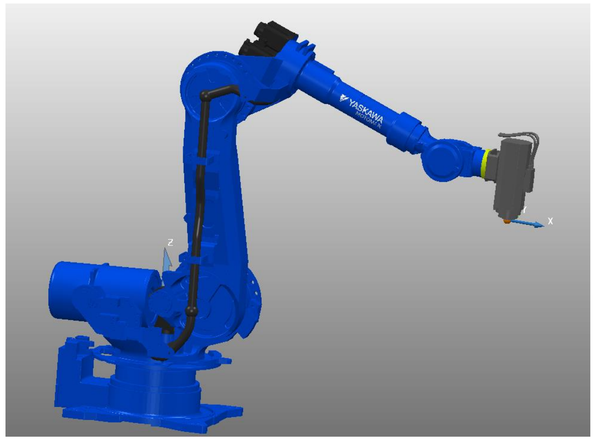
NACHI



STÄUBLI

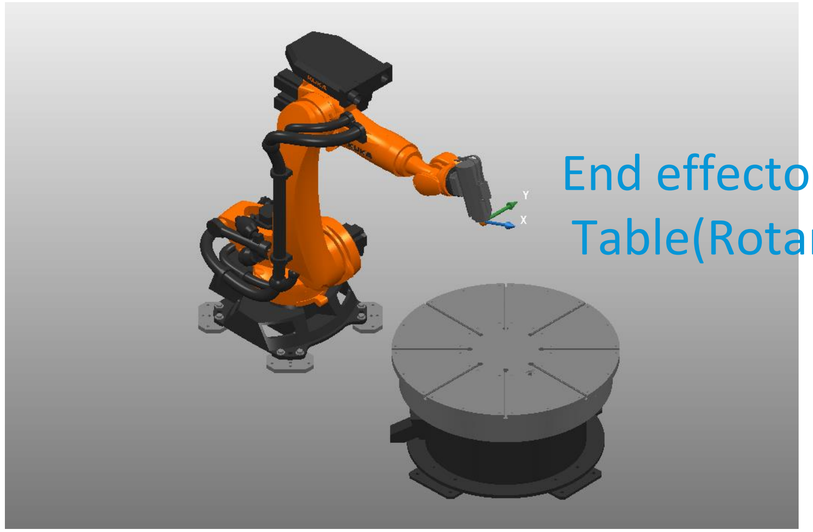


UNIVERSAL ROBOTS



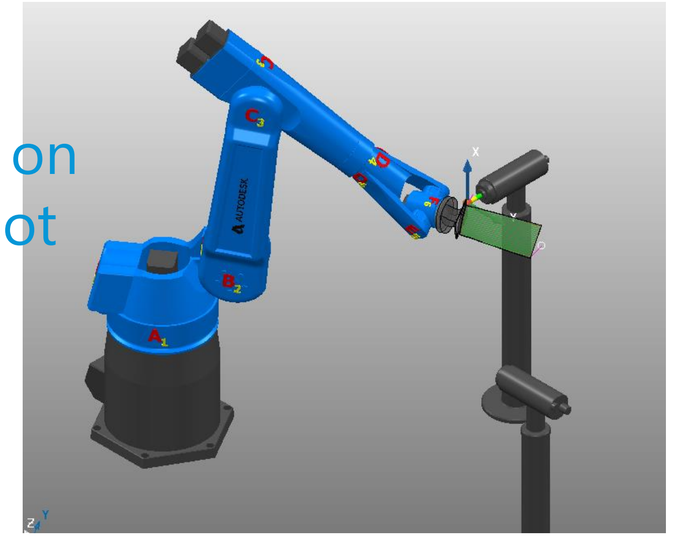
YASKAWA

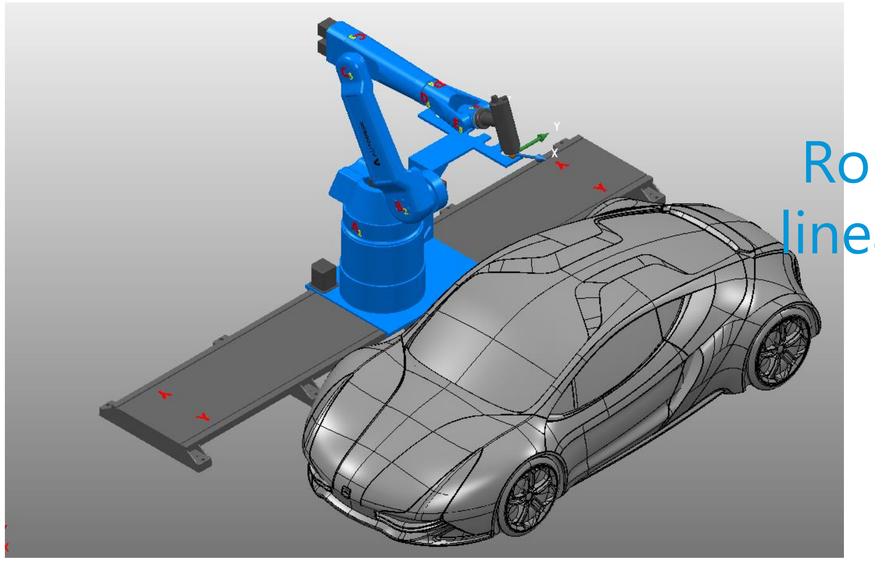
Supported Kinematics



End effector on robot + Table(Rotary or Static)

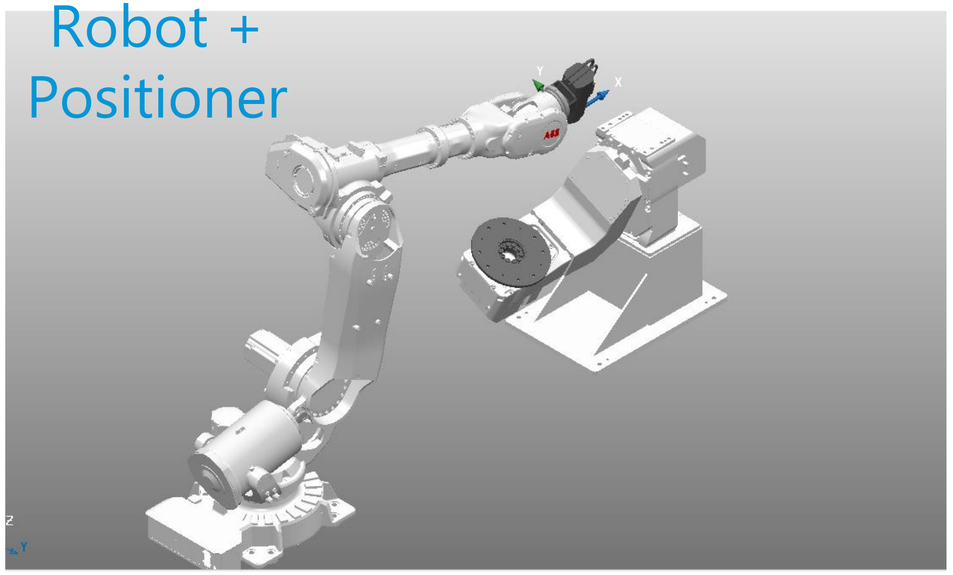
Part on robot



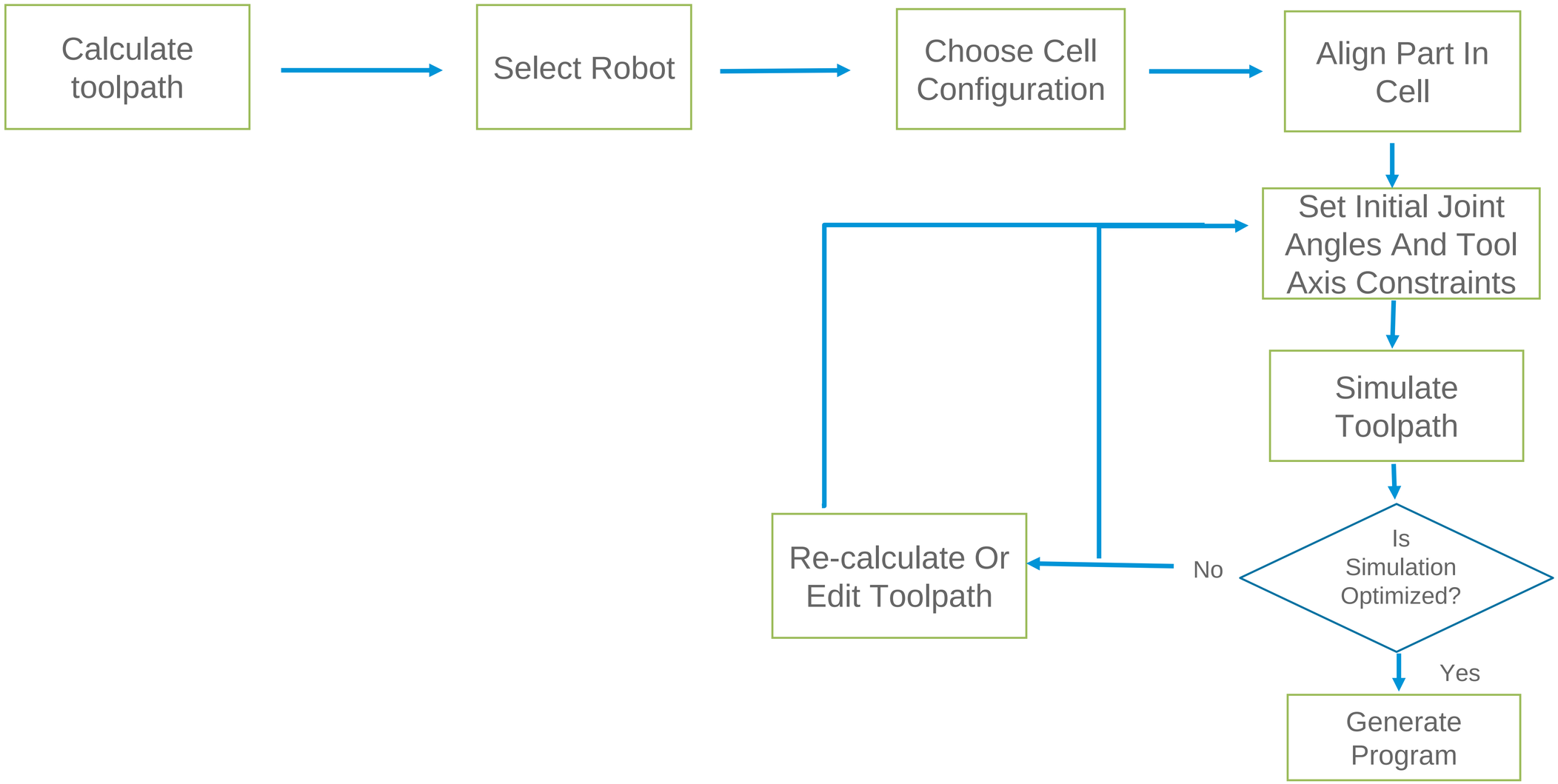


Robot on linear track

Robot + Positioner

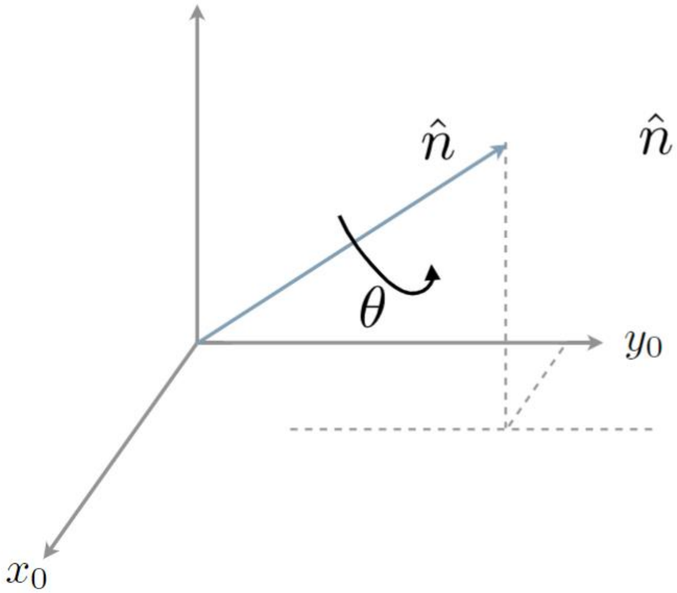


Workflow


Calculate toolpath
Select Robot
Choose Cell Configuration
Align Part In Cell
Set Initial Joint Angles And Tool Axis Constraints
Simulate Toolpath
Is Simulation Optimized?
No
Yes
Re-calculate Or Edit Toolpath
Generate Program

Some Key Terminology

Quaternions: A compact way to represent rotations in 3D



$$\hat{n} = \begin{bmatrix} n_x \\ n_y \\ n_z \end{bmatrix} \qquad |\hat{n}| = 1$$

$$Q = (\cos(\theta/2),\ n_x \sin(\theta/2),\ n_y \sin(\theta/2),\ n_z \sin(\theta/2))$$

Q = (1, 0, 0, 0) represents 0 deg rotation

Q = (-1, 0, 0, 0) represents 360 deg rotation

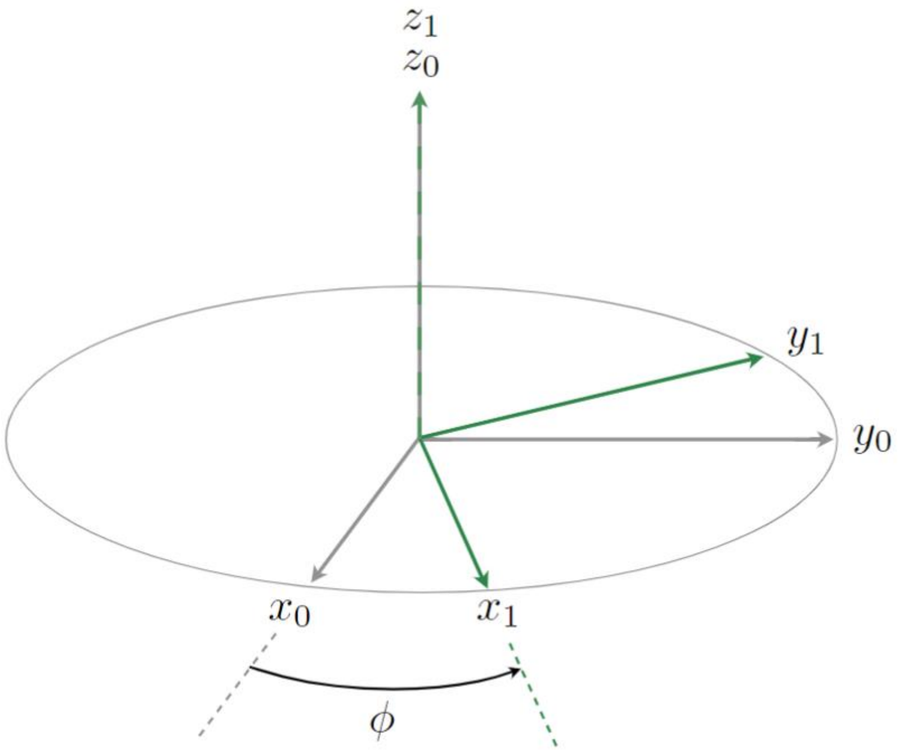
Q = (0, 1, 0, 0) represents 180 deg rotation about X axis

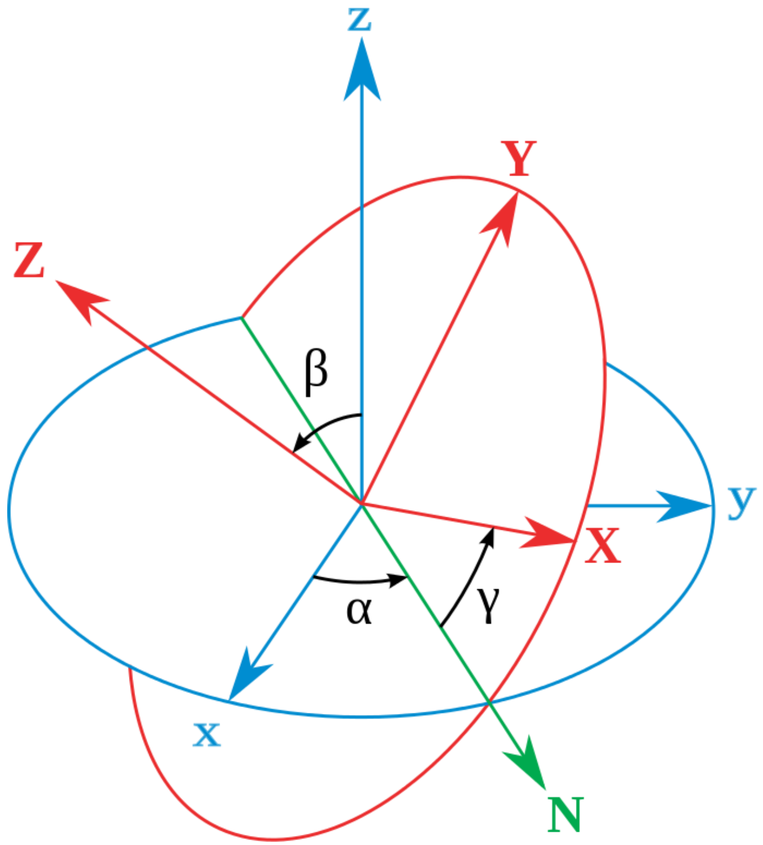
Q = (0.866, 0, 0, 0.5) represents 60 deg rotation about Z axis

https://alliance.seas.upenn.edu/~medesign/wiki/index.php/Courses/MEAM520

Some Key Terminology

Euler Angles: Define orientation with 3 rotations
about intermediate coordinate systems



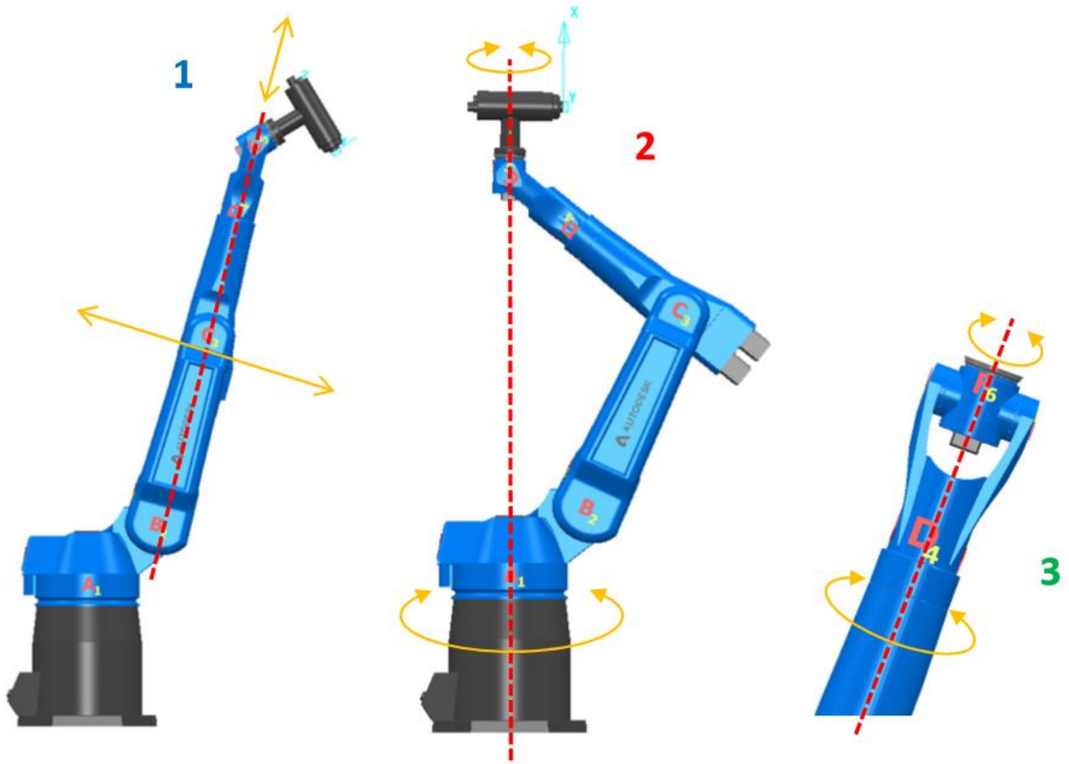


There are 12 conventions, e.g Z-Y-Z, Z-X-Z,
Y-X-Y but we use Z-Y-X in PowerMill Robot

https://alliance.seas.upenn.edu/~medesign/wiki/index.php/Courses/MEAM520

Some Key Terminology

Singularities



When multiple axes are aligned resulting in infinite number of solutions

AUTODESK®

Make anything™