Kineo: Path Planning for PLM

Etienne Ferré – ICRA2014

Smarter decisions, better products.

Kineo History 2001-2013

- **Spin-off from L.A.A.S./C.N.R.S**
  - Toulouse, France.
  - Created **January 2001**
  - 20 years research legacy from CNRS LAAS

- **Software Components** Editor
  - specialized in **path planning** and **collision detection**
  - **14 people**
  - Over 200 customers in 30 countries

- **2012, Joins Siemens PLM Software**

Toulouse 2001

PLM Component Leadership
Offering open software development and interoperability

PLM XML	Parasolid	D-Cubed	JT
- Product lifecycle interoperability using XML - Based on standard W3C XML schemas	- Solid modeling kernel of choice - CAD, CAM, CAE, AEC, GIS applications - >3.5M Installed base seats	- CAD, CAM, CAE and PLM applications - 2D & 3D geometric constraint solvers - #1 market provider	- Lightweight 3D file format and developer toolkit - Published ISO specification - Visualization, interoperability, archiving

Rulestream	Geolus Search	PLM Vis	Kineo
- Engineer-To-Order (ETO) solution - CAD neutral - Sales Quotation, Order & Manufacturing Engineering	- 3D geometry search engine - Quickly find & reuse previously designed parts	- Component technology for collaborative view and markup - Develop custom visualization applications	- Computer-aided motion simulation for part assembly and disassembly - Robotic movement and path planning optimization

Siemens PLM Software

Path Planning PLM Applications

Product Lifecycle Management

PLAN	DEVELOP	BUILD	SUPPORT
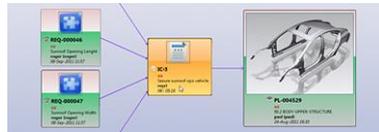
TEAMCENTER | NX
Requirements Management
Systems Engineering
Program Management
Conceptual Design
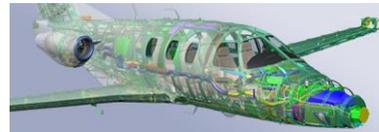
**TEAMCENTER | NX
TECNOMATIX**
Product Design
Product Simulation
Product Data Management

**TEAMCENTER | NX
TECNOMATIX**
Manufacturing Engineering
Plant Optimization
Production Planning
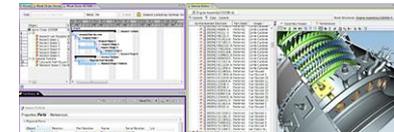
TEAMCENTER
Sustainability
Maintenance, Repair
& Overhaul
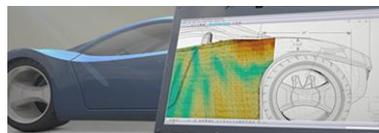
PERFECT COSTING
Product Costing
LMS
Mechatronic Simulation
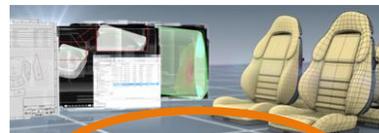
KINEO
Motion Simulation
LMS
Behavioral Simulation
VISTAGY
Composite Engineering

KINEO
Motion Simulation
LMS
Physical Testing
PERFECT COSTING
Tool Costing
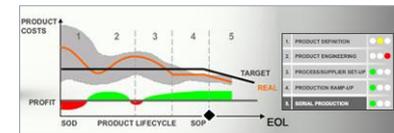
PERFECT COSTING
Lifecycle Costing
VISTAGY
Quality Planning

Piano Mover: Assembly / Disassembly
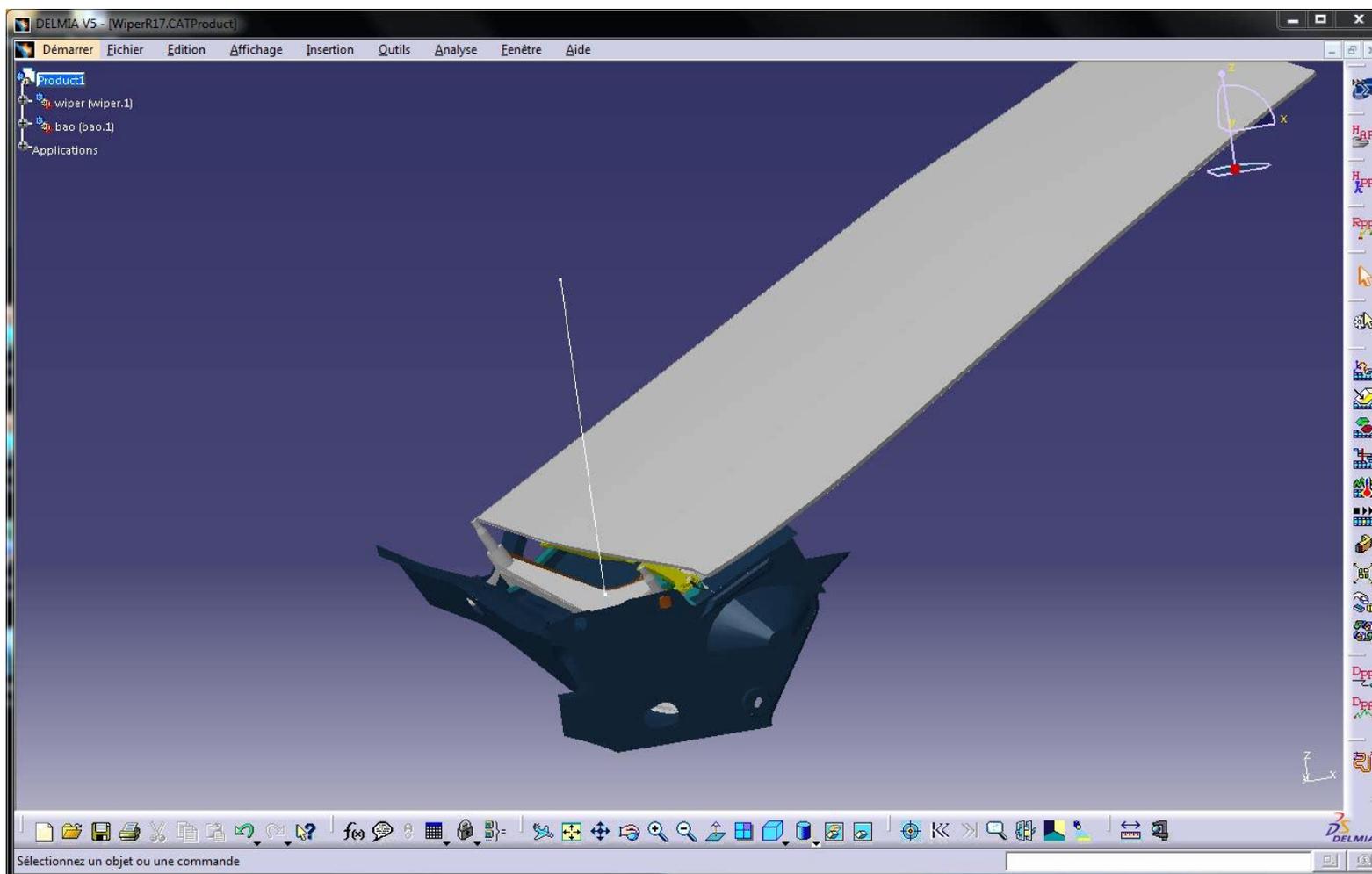
Piano Mover: Assembly / Disassembly
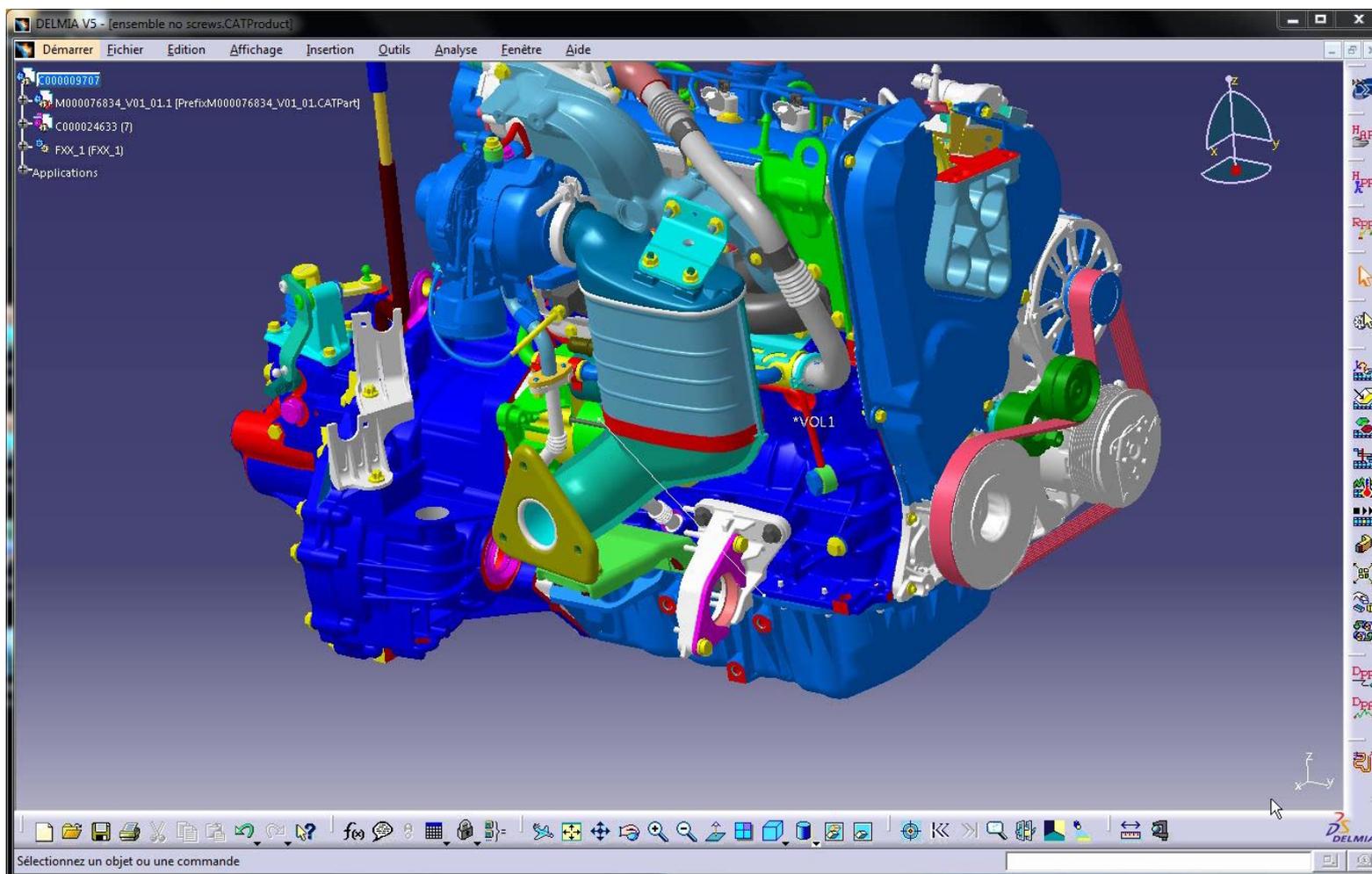
Customer Benefits: Cost Saving

User fails in finding a solution manually	→	User will ask to change the design	→	But a solution is found by Path Planning

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User believes a solution exists without testing	→	But the solution does not exist in reality	→	Late change in the design

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Siemens PLM Software
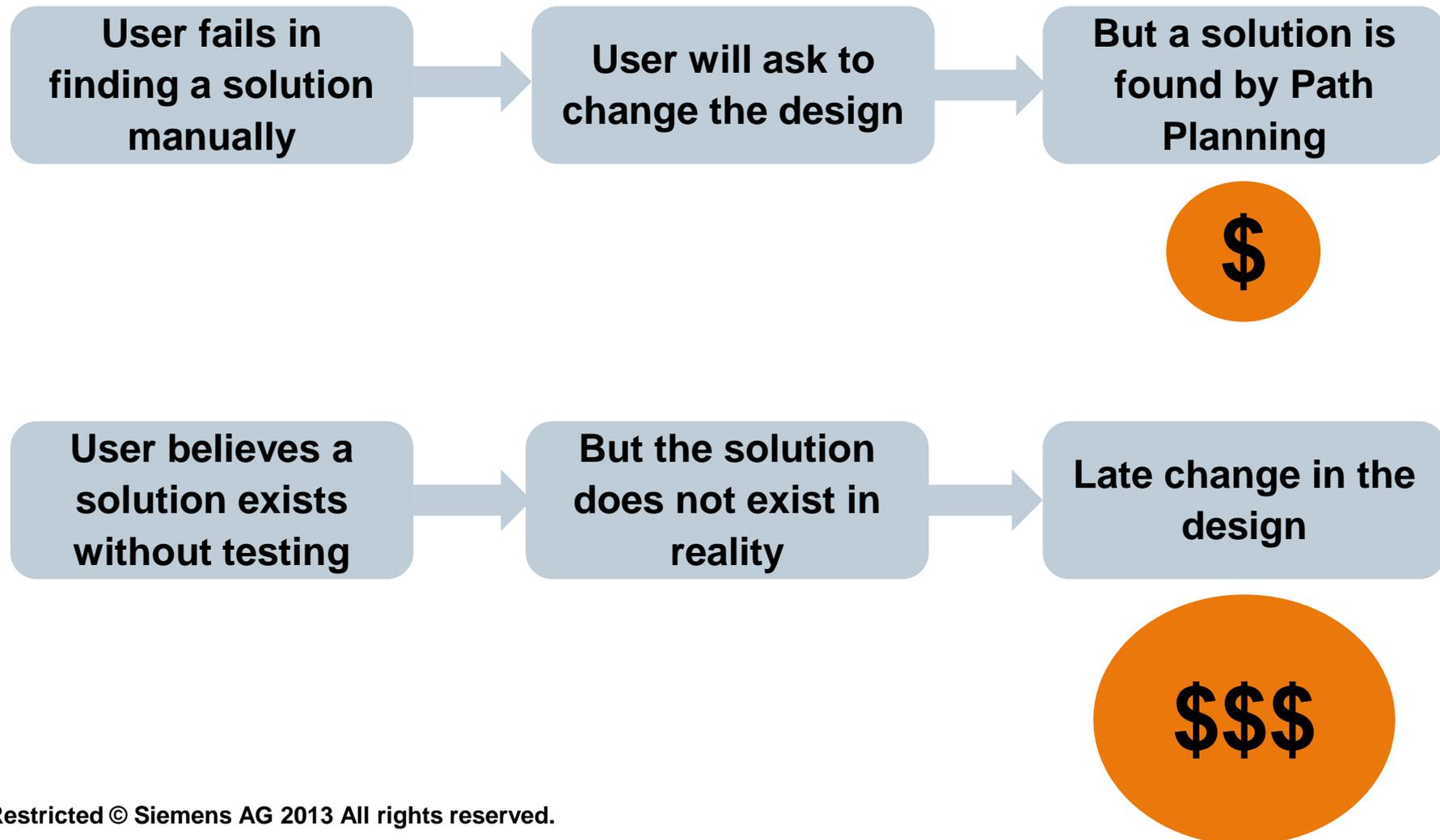
Piano Mover in PLM Software
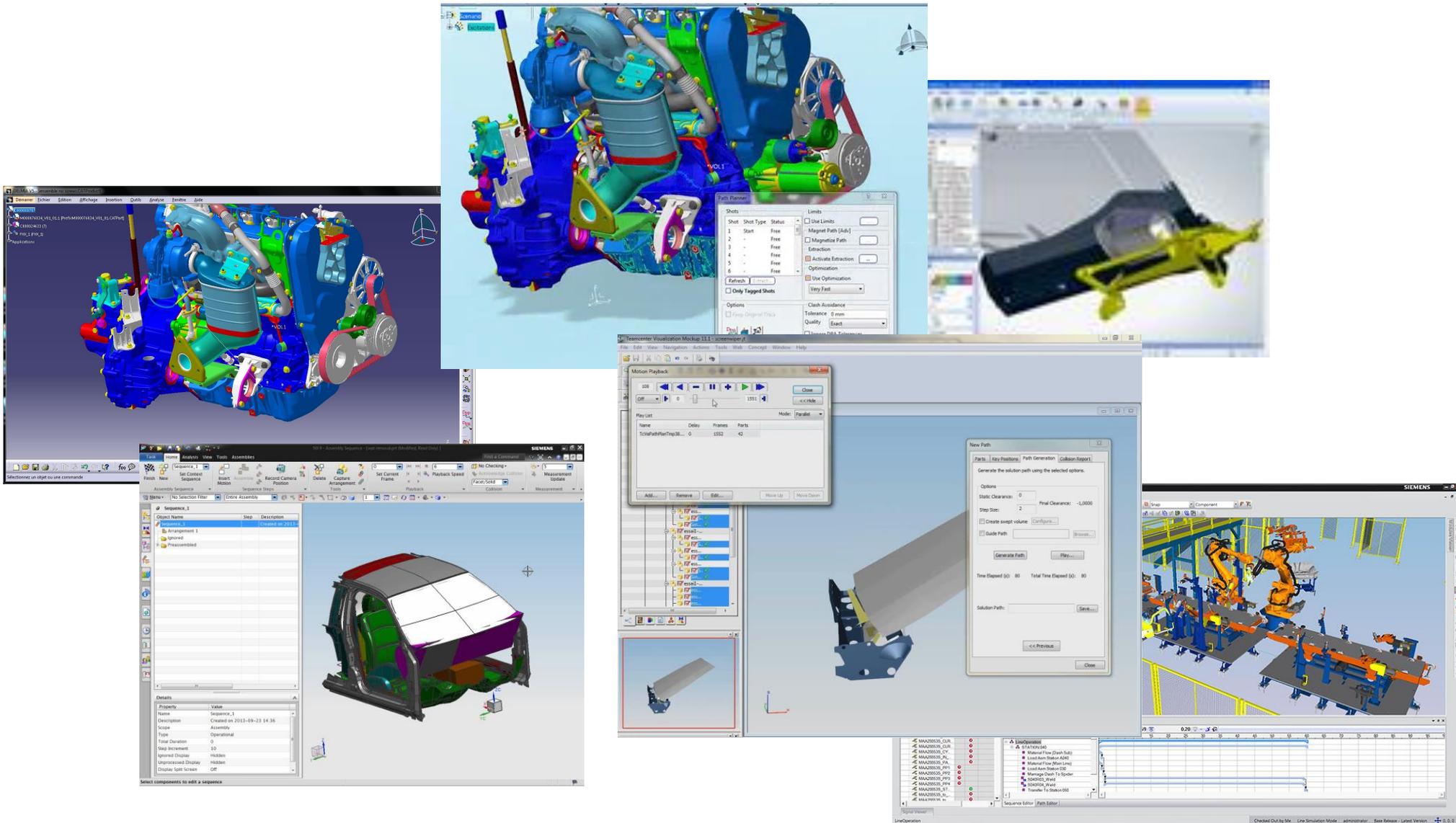
Another Piano Mover: Robotic Spot Welding
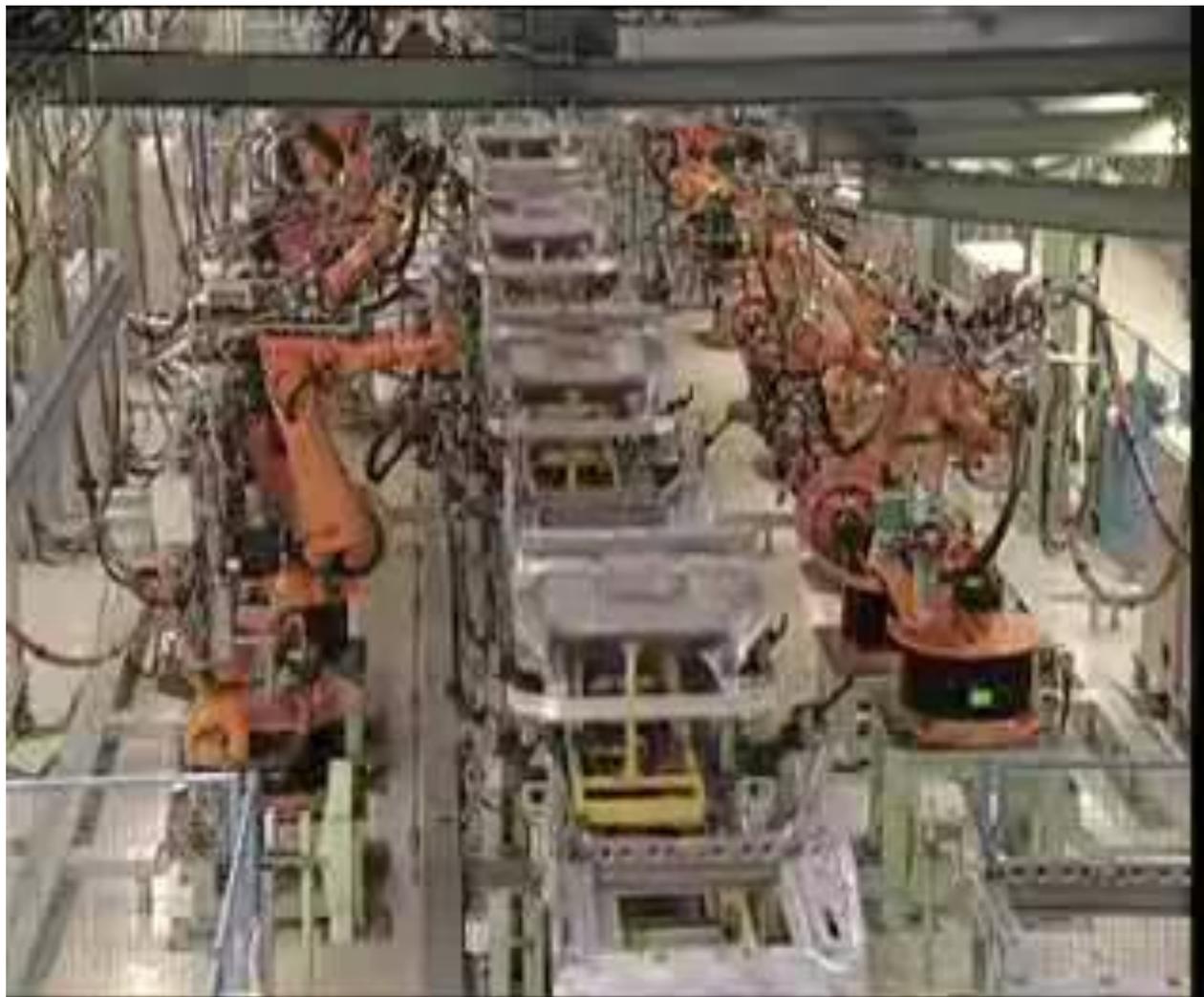
Video from Kuka (youtube)

Spot Welding in Process Simulate APP
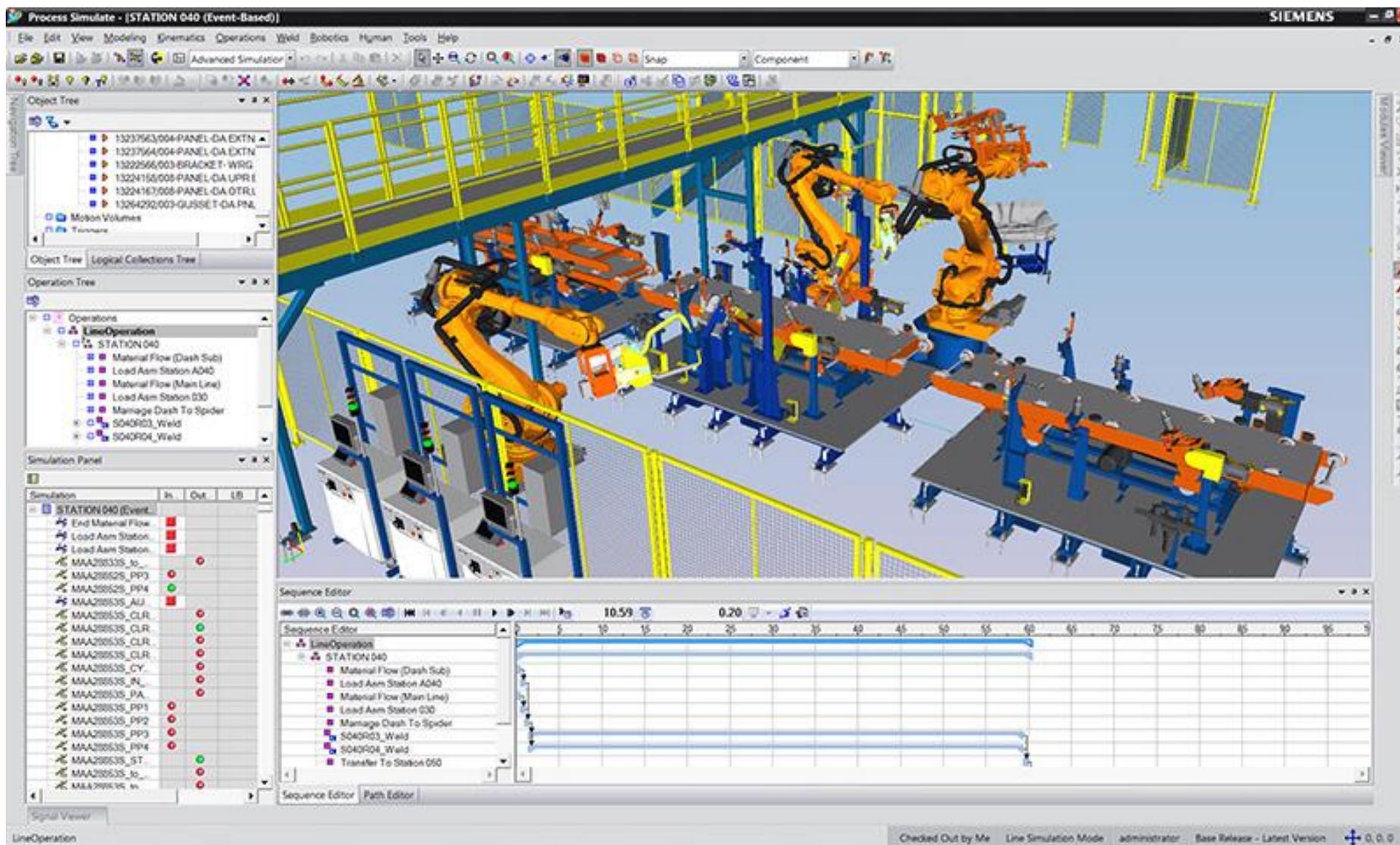
Kineo vs Human Expert

	Expert	Kineo
Trajectory Creation	50 min	2 min
Nb Via points	22	19
Cycle Time	41.5 s	33 s

Travelling salesmen robots

Travelling Salesman Robot
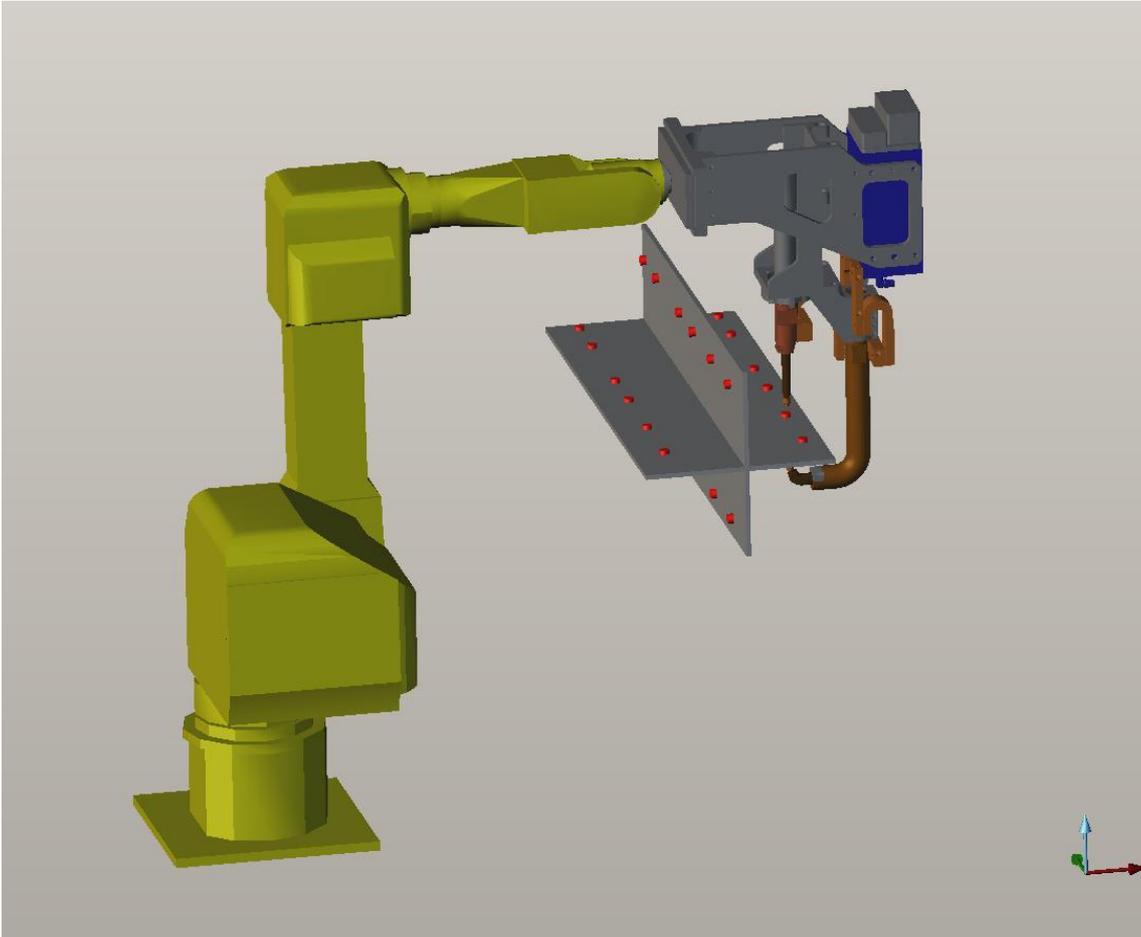
What is the trajectory to weld the red points ?

1. What is the order?
2. What is the trajectory between two points

Travelling Salesman

Go through all the points
- **in the shortest way**
- **without collision**

Problem known mathematically as the **Travelling Salesman Problem** (TSP).

How to visit all cities in the shortest way?
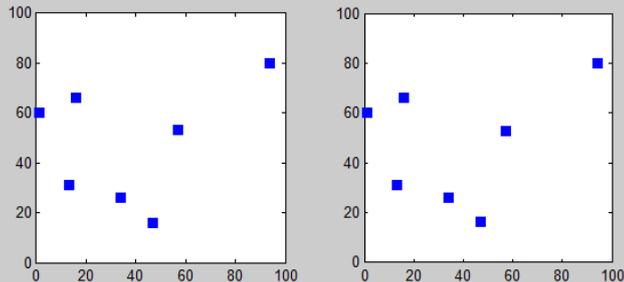
Wikipedia
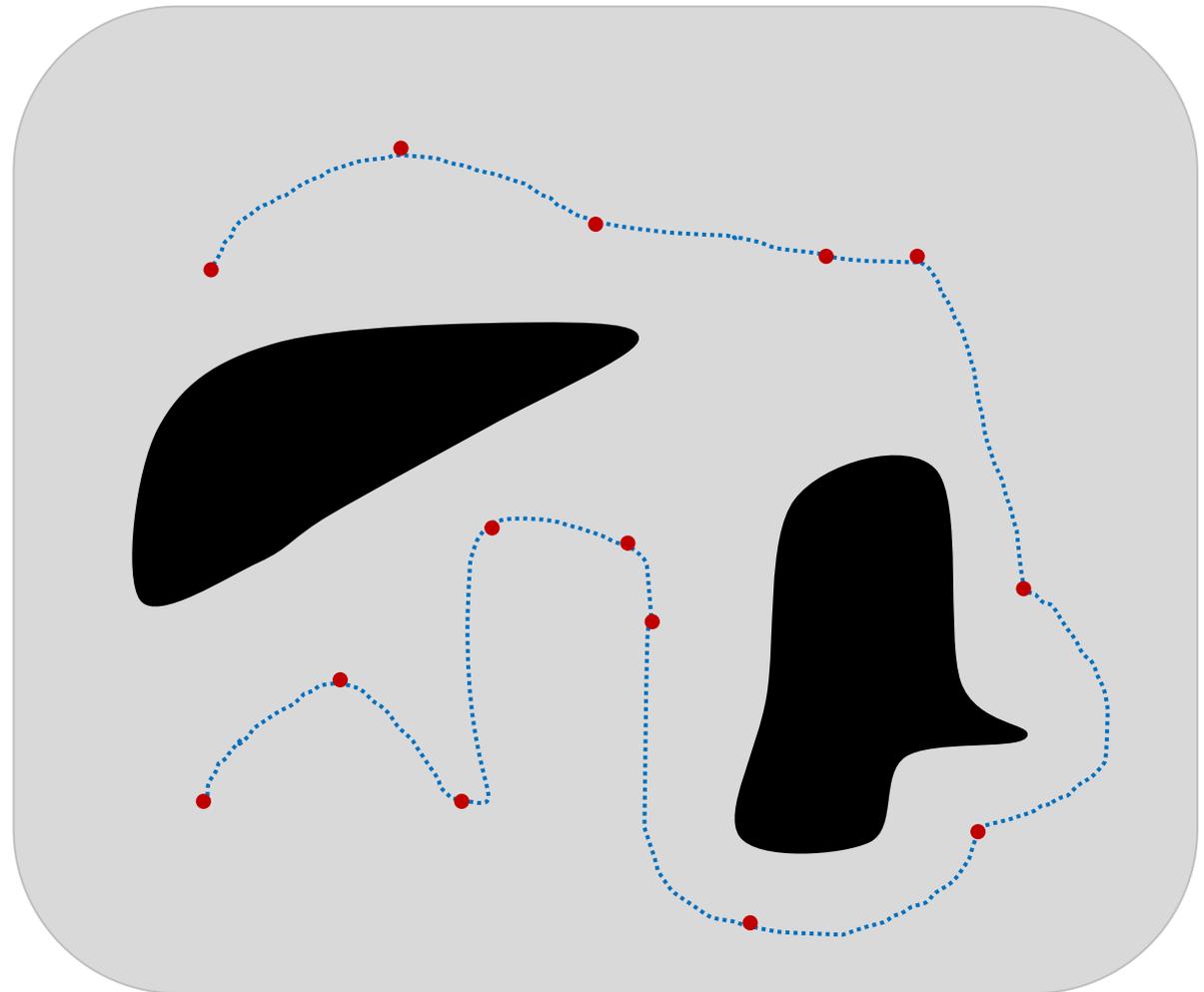
Configuration Space

Free Travelling Salesman

Free approach angle

SIEMENS
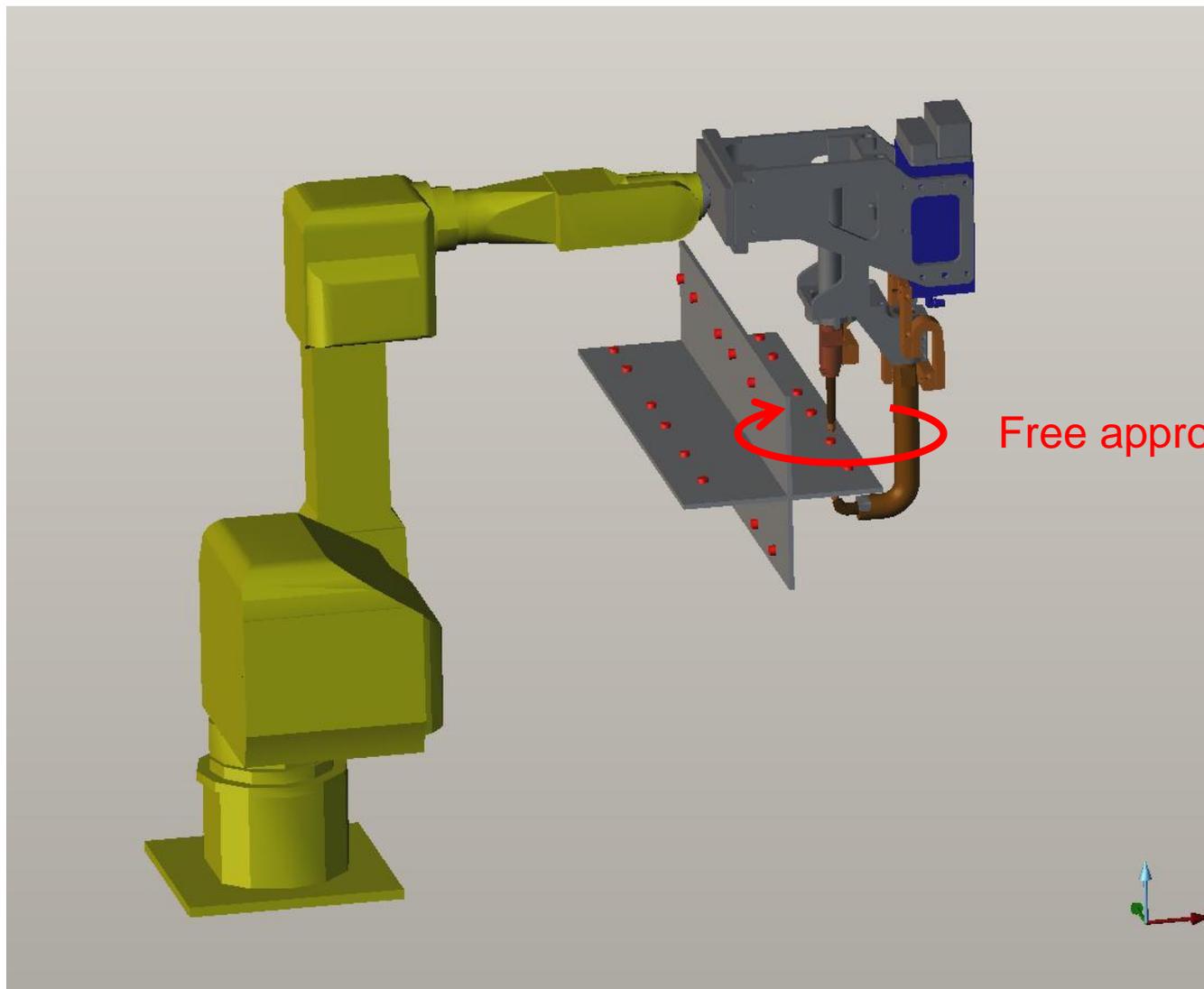
Generalized Traveling Salesman Problem (GTSP).

How to visit all regions in the shortest way?

$\theta_{approach}$
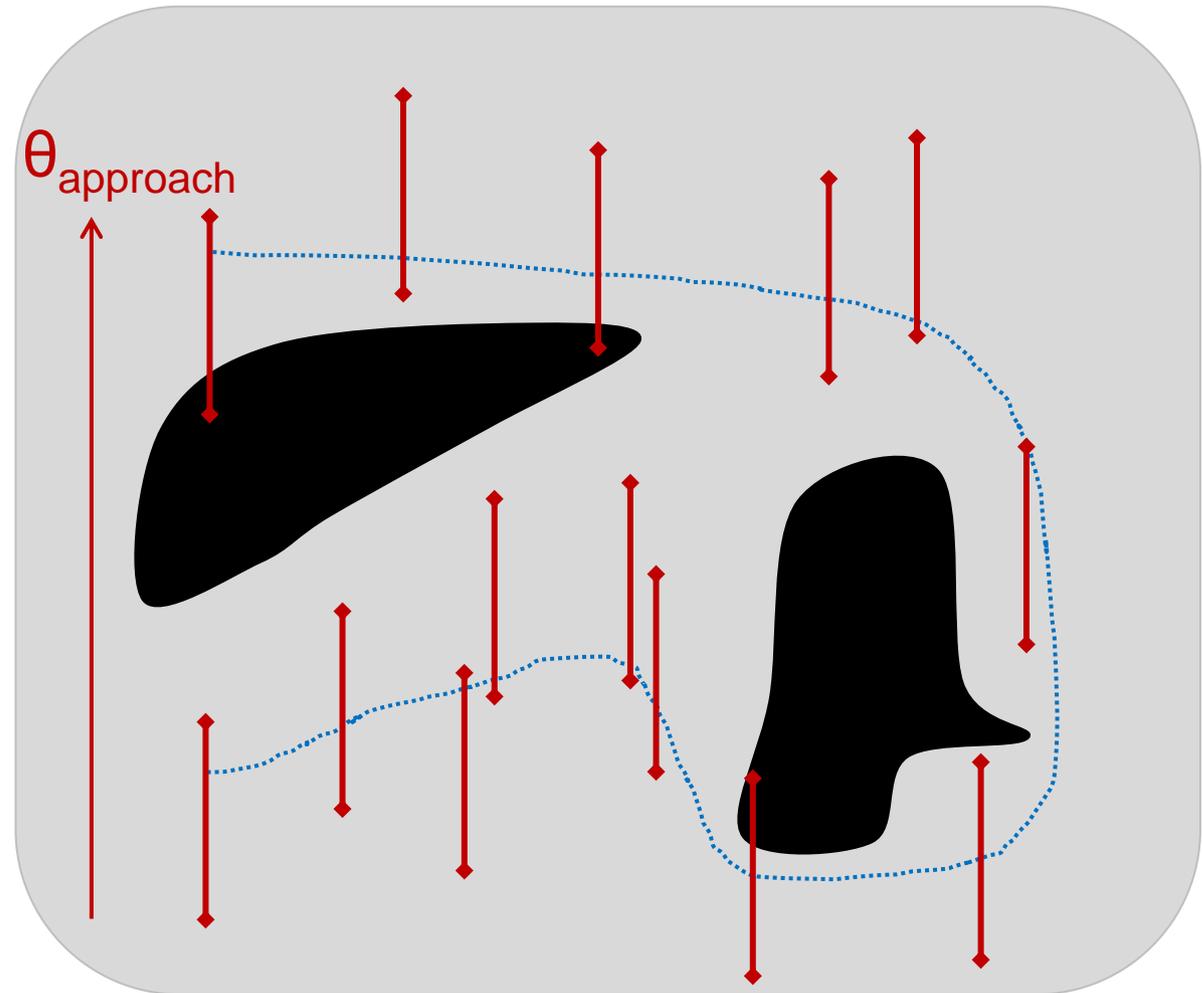
Configuration Space

TSP solver prototype

TSP solver prototype

Gaussian
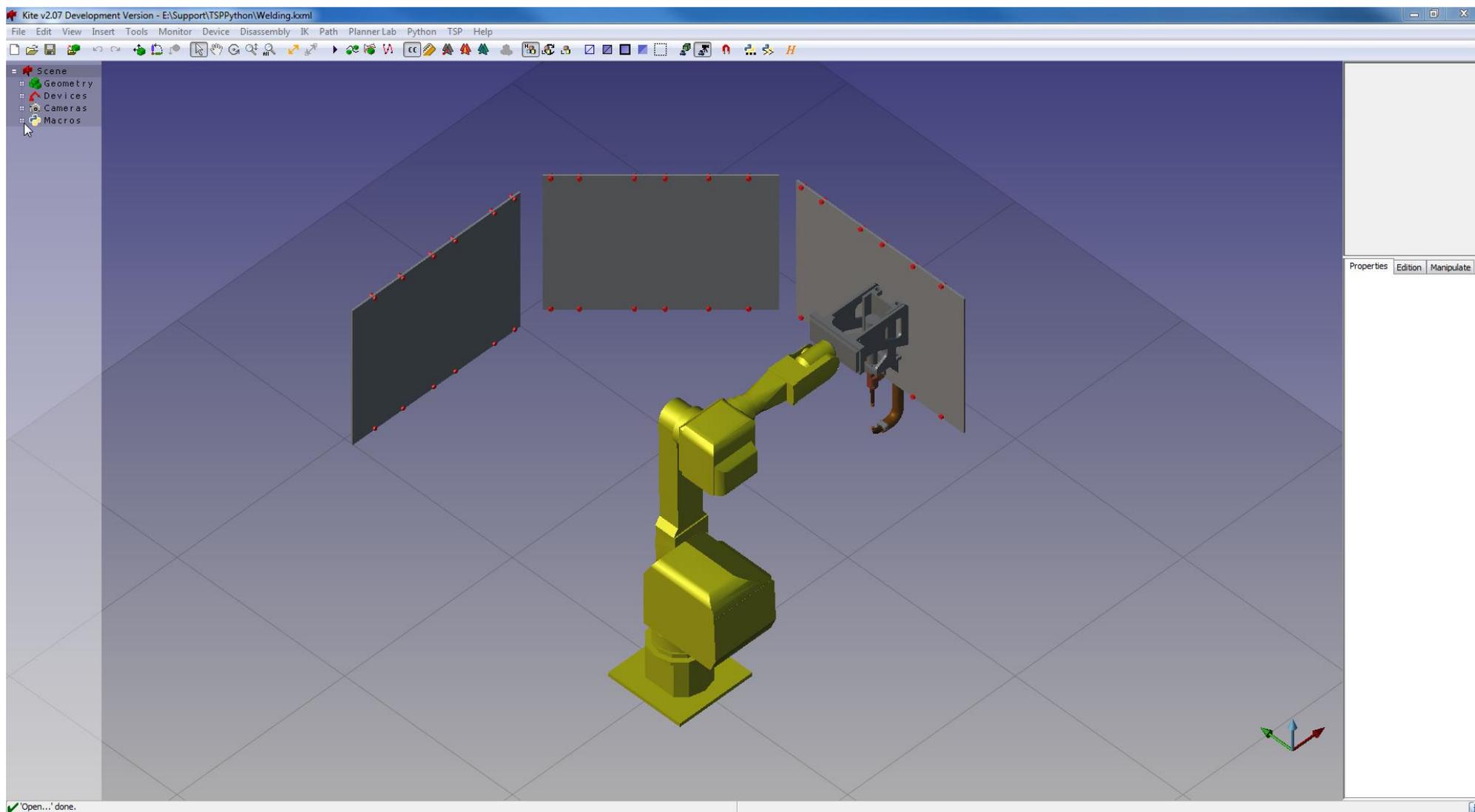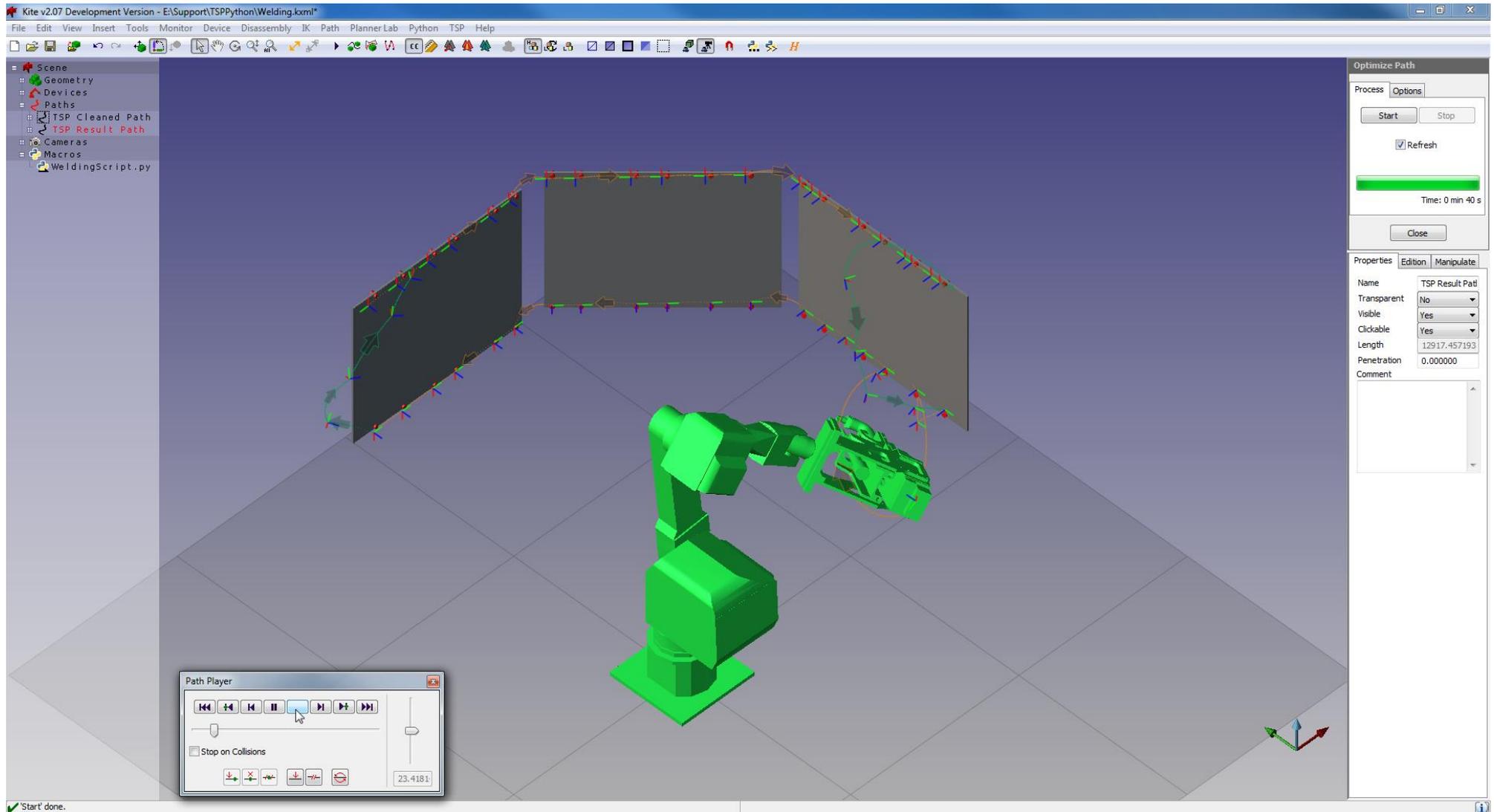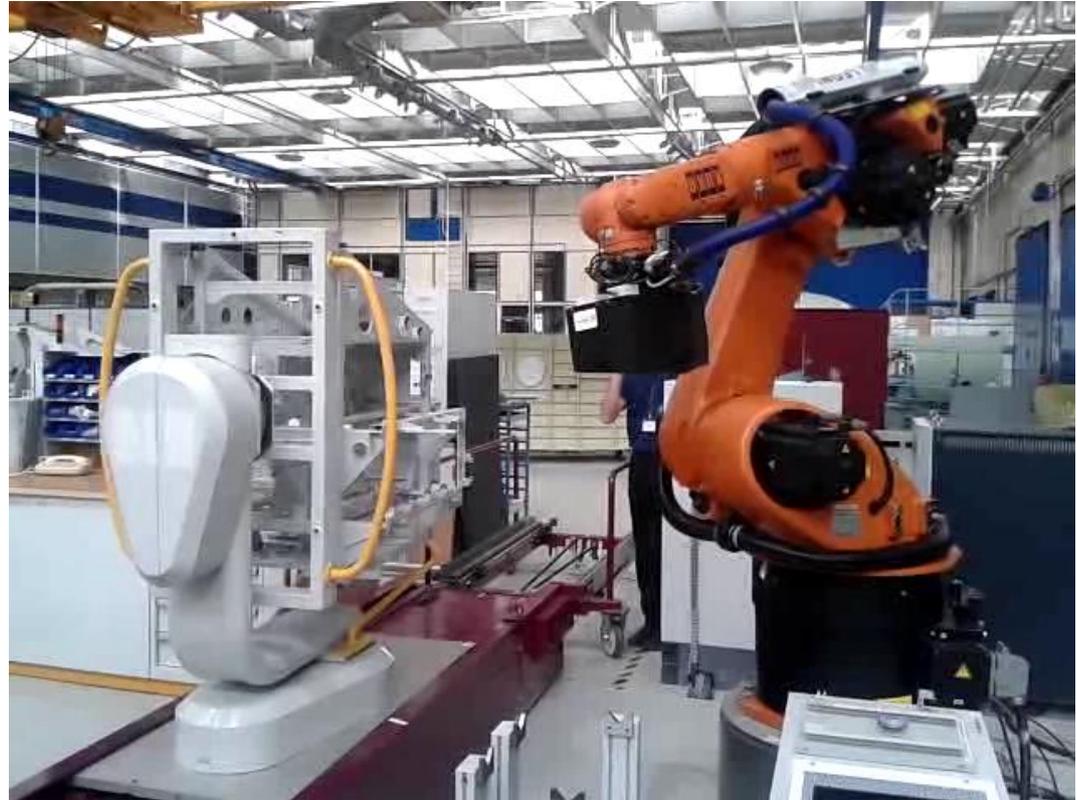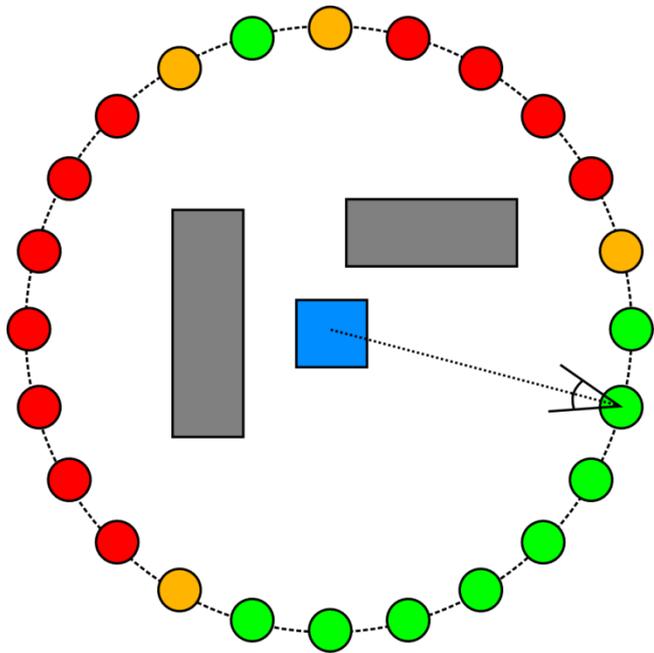
Future work

- Release the End-User Software in Tecnomatix Process Simulate (End of 2015)

- Weld Points Distribution (Clustering and GTSP)

- Multi-robots trajectory planning (Synchronisation, Interlock zones)
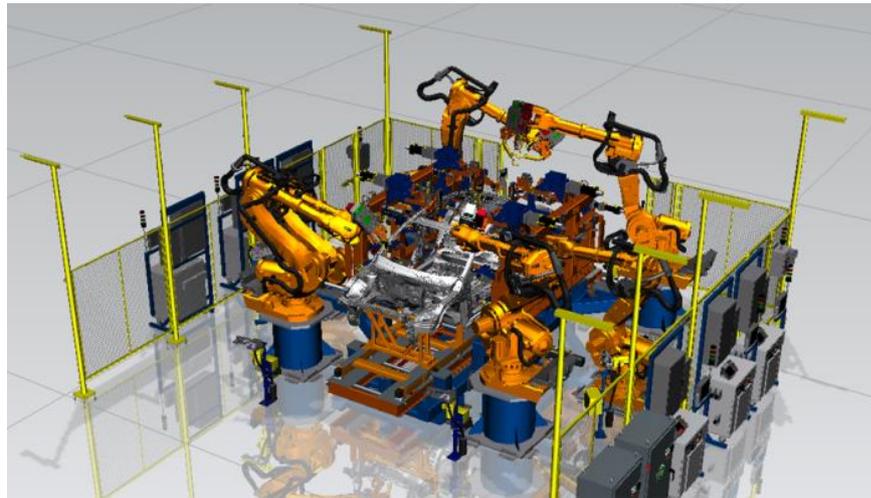
Path Planning Business

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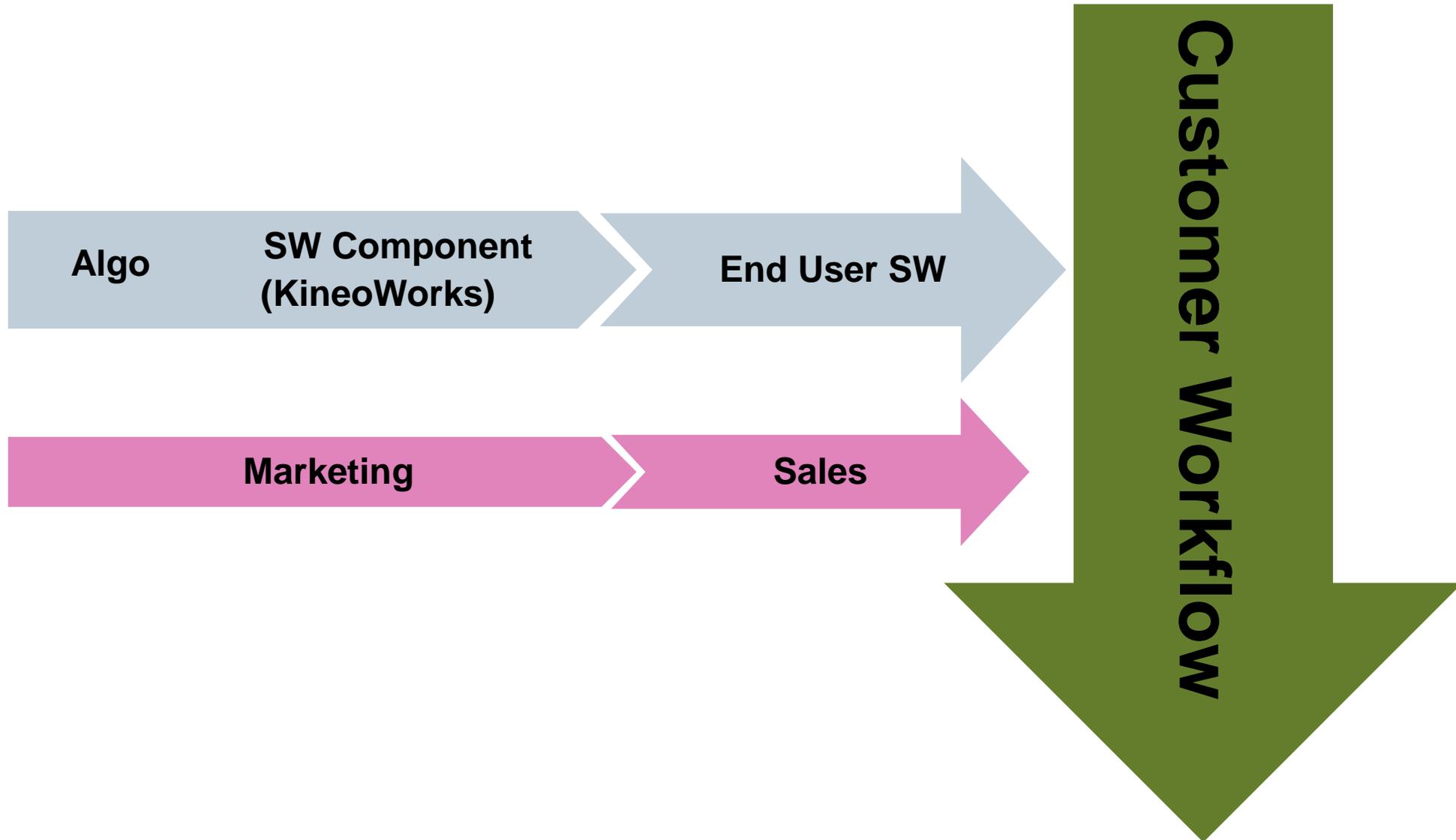
Thank you

etienne.ferre@siemens.com

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