Kineo: Path Planning for PLM

Etienne Ferré – ICRA2014
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
## PLM Component Leadership
Offering open software development and interoperability

<table>
<thead>
<tr>
<th>PLM XML</th>
<th>Parasolid</th>
<th>D-Cubed</th>
<th>JT</th>
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</thead>
</table>
| - 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**
- Engineer-To-Order (ETO) solution  
- CAD neutral  
- Sales Quotation, Order & Manufacturing Engineering

**Geolus Search**
- 3D geometry search engine  
- Quickly find & reuse previously designed parts

**PLM Vis**
- Component technology for collaborative view and markup  
- Develop custom visualization applications

**Kineo**
- Computer-aided motion simulation for part assembly and disassembly  
- Robotic movement and path planning optimization
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

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

$\$$
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

<table>
<thead>
<tr>
<th></th>
<th>Expert</th>
<th>Kineo</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trajectory Creation</td>
<td>50 min</td>
<td>2 min</td>
</tr>
<tr>
<td>Nb Via points</td>
<td>22</td>
<td>19</td>
</tr>
<tr>
<td>Cycle Time</td>
<td>41.5 s</td>
<td>33 s</td>
</tr>
</tbody>
</table>
Travelling salesmen robots
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
Free Travelling Salesman

Free approach angle
Generalized Traveling Salesman Problem (GTSP).

How to visit all regions in the shortest way?
TSP solver prototype
TSP solver prototype
Another Example of Application: Visual Control
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

- Algo
- SW Component (KineoWorks)
- End User SW
- Marketing
- Sales

Customer Workflow
Thank you

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