Automated Planning for iFab

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Sponsor: DARPA iFab Program
Role of Automated Planning in Schedule Compression

- Reduced Number of Design Iterations
- Optimized Operation
- Reducing Number of Setups
- Automated Process and Supplier Selection
- Automated Instruction Generation

Diagram:
- Design
- Operation
- Foundry Configuration
- Setup
- Instruction Generation

Images:
- Robot
- Circuit board
- Scan of documents
- Diagram of workspace
- Diagram of machine
- Diagram of parts
Automated Manufacturability Analysis for Cutting Operations

- Automatically perform manufacturability analysis with respect to a given set of resources:
  - Machines
  - Tools
  - Available stock materials
- Provide descriptions of manufacturability problems (if needed) and cutting time estimates

Enables schedule compression by eliminating time-consuming design iterations!
Automated Instruction Generation for Water-jet Cutting

- Automatically select lead-in, lead-out, and tabs
- Automatically generate cutting instructions
- Does not require human process planner on most routine tasks

Enables going from CAD to part in few minutes!
Automated Motion Planning

- Determines path for an object from initial position to final position in presence of obstacles
- Enables automated selection of assembly tools
- Enables automated generation of instructions for human operators

Enables schedule compression by reducing instruction generation time!
Setup Planning for Welding

- Compute optimal number of welding setups by performing trade-off between weld quality and setup time
- Account for welding cell constraints

### Table of Welding Setups

<table>
<thead>
<tr>
<th>Setup</th>
<th>Description</th>
<th>Welds</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1st Setup</td>
<td>$W_1, W_2, ..., W_{22}$</td>
</tr>
<tr>
<td>2</td>
<td>2nd Setup</td>
<td>$W_7, W_8, W_9$</td>
</tr>
<tr>
<td>3</td>
<td>3rd Setup</td>
<td>$W_{10}, W_{11}, W_{12}$</td>
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<td>4</td>
<td>4th Setup</td>
<td>$W_{13}, W_{14}, W_{15}$</td>
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<tr>
<td>5</td>
<td>5th Setup</td>
<td>$W_{16}, W_{17}, W_{18}$</td>
</tr>
<tr>
<td>6</td>
<td>6th Setup</td>
<td>$W_{19}, W_{20}$</td>
</tr>
</tbody>
</table>

Enables schedule compression by reducing setup time!
Instruction Generation for Assembly Operations Performed by Humans

- Support augmented reality based setup
- Decompose assembly task into subtasks
- Select methods, tools, and parameters
- Generate text, images, and videos
- Voice-based interface for displaying instructions on the shop floor

Enables schedule compression by reducing instruction generation time and eliminating the possibility of assembly errors!
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