Manufacturing Applications of STEP

Martin Hardwick, Ph.D.
President

STEP Tools, Inc.
Rensselaer Technology Park
Troy, New York 12180

(518) 276-2848    (518) 276-8471 fax
info@steptools.com    http://www.steptools.com
Goals

**Model Driven e-Manufacturing**
- Direct control of machine tools from 3D data
- Using STEP-NC specification under development in Europe and Far East for 3 years
  - Milling, Turning, Grinding, Bending, Cutting
  - Extensions for Robotics and Assembly anticipated
- Process planning and manufacturing control savings of between 35% and 75%
Project Organization

• **Industrial Review Board**
  – GE Fanuc
  – CNC Data (MASTERCAM)
  – CADKEY
  – Alibre
  – Boeing
  – General Electric
  – General Motors
  – Gibbs and Associates
  – Hurco Machine Tool Products
  – Lockheed Martin
  – IBM
  – Monarch Machine Tools
  – NASA (GSFC)
  – NCMS
  – Unigraphics Solutions
  – Suppliers

• **Subcontractors**
  – Allied Signal
  – Bridgeport Controls
  – Liberty Consulting
  – RPI

• **Pilot Projects**
  – GD Tank Automotive
  – Lawrence Livermore
  – NIST Intelligent Systems
Key personnel

• Martin Hardwick, Ph.D
  – President
  – 20 years experience
  – STEP expert (50+ papers)

• Mike Kutcher
  – Marketing Consultant
  – 45 years experience
  – manufacturing expert

• David Loffredo, Ph.D
  – VP Programming Tools
  – 10 year experience
  – programming expert

• Blair Downie, MS
  – VP Desktop Tools
  – 12 years experience
  – geometry expert

• John Valois, Ph.D
  – 5 years experience
  – EXPRESS expert

• 10 programmers

“Ownership” of Parts 14, 21 and 24 of STEP
“Ownership” of Parts 3 and 51 of STEP-NC
There are now more than one million STEP enabled CAD stations in the world

With CAM and CAE systems following
Why do manufacturers seek ISO certification?

ISO 9000  ISO 9001  ISO 9002

Quality processes need quality data!

STEP will be “ISO 10,000”
The supplier creates the production process from a 3D product model instead of paper drawings*

<table>
<thead>
<tr>
<th></th>
<th>Without STEP</th>
<th>With STEP</th>
<th>Saving</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Max</td>
<td>Min</td>
<td>Average</td>
</tr>
<tr>
<td>Time to make a process plan</td>
<td>100</td>
<td>4</td>
<td>16</td>
</tr>
<tr>
<td>Time to replan a process plan</td>
<td>20</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>Number of iterations</td>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total Hours</td>
<td>28</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of plans per Year</td>
<td>1000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Burdened cost per hour</td>
<td>$50</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total Cost</td>
<td>$1,400,000</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Numbers are for a “typical” machine shop
STEP is used to automatically prepare visuals for process plans.

GOAL: Reduce manufacturing costs

- 50% of total process plan effort is composing visuals.
- STEP-based system using to produce process plan visuals.
- Projected 75% reduction in man hours spent in visuals preparation (25 hours vs. 100 hours).

Other stories at Boeing, Lockheed Martin the German Automotive industry and more
Nothing changes here except for the explicit path for manufacturing feedback to specific design and/or manufacturing features and the data format.
Feedback from Manufacturing World

Feedback to Design World

The CAM World (To-Be)

AP224 features become input data to CAM process planning. Process planning output captured as AP213.
One necessary and sufficient database containing all the information required to unambiguously manufacture the product.

Eliminate hundreds of files with one DB in a format that is good for 25+ years

Information delivered to the shop floor in service packs for

- Milling
- Turning, etc.
Implementing the “Super Model” solution

“Super Model” = STEP Database +Translation, +Visualization, +Mapping

Database implemented using ST-Repository™

Data sent as Manufacturing Service Packs with ST-Viewer™

Interface implemented using ST-Developer™

STEP Interface

Contractor

Supplier

Manufacturing Process

CAD 1
STEP Interface
Example - set manufacturing contact

• Microsoft Access database of people and addresses
  – XML data sent to MS Access by ST-Repository™
  – Visual Basic OLE/COM interface to ST-Viewer™
Feature Manufacturing Service Pack

MS Excel

<table>
<thead>
<tr>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
<th>G</th>
<th>H</th>
<th>I</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Selection</td>
<td></td>
<td></td>
<td>Features</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Entity ID</td>
<td></td>
<td></td>
<td>Type</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>#895</td>
<td></td>
<td></td>
<td>advanced_face</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>#898</td>
<td></td>
<td></td>
<td>advanced_face</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>#899</td>
<td></td>
<td></td>
<td>advanced_face</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>#900</td>
<td></td>
<td></td>
<td>advanced_face</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>#904</td>
<td></td>
<td></td>
<td>advanced_face</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>#905</td>
<td></td>
<td></td>
<td>advanced_face</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>#908</td>
<td></td>
<td></td>
<td>advanced_face</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Feature Editor**

- Start ST-Viewer
- Open STEP File...
- Assort in ST Viewer
- Remove Selection in ST-viewer
- Remove All Selections
- Define Primary Contour...
- Define Curve...
- Define Boss...
- Define Pocket, Bottom...
- Define Hole Bottom...
- Define Taper...
- Define Swept Profile...
- Define Slot End...
- Remove All Features

**Measurements**

- Length
- Radius
- Diameter
- Angle

For Help, press F1
Operation of Feature Service Pack

Windows Desktop

- **ST-Viewer™**
- **Measurement Library ST-Developer™**
- **MS Excel with Macros**

**ST-Repository™**

**+Mapping Service**
Map to XML using EXPRESS-X

**+Translation Service**
From design

- **Select Data**

**OLE/COM**

**AP-203**
**AP-224**

**+Viewing Service**

**AP-203 or AP-224**

**XML**
CNC Milling Service Pack

Windows Desktop

OLE/COM

Geometry Kernel

NC Kernel (C++)

Part 3 (Java) Library

+Viewing Services

+Mapping Service

ST-Repository™

14649-51

AP-203 or AP-224 or 14649-51

+Translation Service

Data made by CAD/CAM tools

Project Schedule

Year 1 - Partial milling model
Year 2 - Whole milling model
Year 3 - Turning, Grinding or EDM

Data made by AP-203 or AP-224 or 14649-51
Summary

• **STEP is for manufacturing**
  • “Super Model” database =
    – STEP Integrated Resources
    – +Translation, +Visualization, +Mapping
    – Data for all the manufacturing tools

• **We are implementing using**
  – ST-Repository™ database
  – ST-Viewer™ desktop checker
  – ST-Developer™ programming

• **Benefits are significant**
  – 35% cost reduction for Process planning
  – 75% cost reduction for Manufacturing control
  – Replace hundreds of files with a Master Model on the Internet
Reasons to get started

• **Aerospace**
  – 70% of a wing is machined using CNC machine tools

• **Automotive**
  – Time to produce a new Power Train needs to be reduced from four years to two years

• **Ships**
  – Production costs must be reduced by further automation

• **Action**
  – Join Industrial Review Board
  – Start a pilot project