Model Data Exchange

• why is it needed?
• how it can be accomplished?
• what formats for transfer?

Data Exchange: background

• Computer-aided design industry has grown extensively in recent years.
• Competition between software developers has been high.
• Many different proprietary CAD packages have been developed and installed.
• Most use different formats to define the geometric data of model entities.

Data Exchange: concept

• Share geometric data between locations.
• Share geometric data between different proprietary modelers and CAD systems.
• Transfer geometric data to other software applications.
  – analysis, cnc, etc.

Industry example: U.S. auto industry

• Traditional approach to design/manufacture
  – Components designed by auto manufacturer.
  – Components manufactured to specific instructions by suppliers.

Current trend

• More design authority delegated to suppliers.
• Suppliers must match their designs to a number of specified variants.
• To support process, great deal of design data must be exchanged.
• This requires CAD systems of manufacturers and suppliers to be able to exchange geometric (and other) data.

Data exchange: how to implement

• 3 possible solutions to such an exchange problem.
  – 1) All use the same CAD package.
  – 2) Use special translator applications to change data from one format to specific one needed.
  – 3) Use a neutral format for data exchange.
Neutral format advantages:

- Data descriptions able to be exchanged between CAD systems of various design.
- Allows users the option of changing/updating systems.
- Allows for the use of special application software, able to write directly to the format.

Neutral format use:

- Requires a pair of data converters:
  - A pre-processor to convert outgoing CAD data into the format.
  - A post-processor to convert incoming neutral data.
- Processors usually operate within CAD software
  -- often written by software companies

Data exchange requires standardization:

- A neutral format must be standardized
- Some standards have formal acceptance: National and International standards
- Some are de facto standards, developed by particular companies which chose to make public the specifications.

Principle neutral format at present time is IGES

- International Graphics Exchange Specification
- Established in 1979 and accepted by ANSI in 1981

IGES

- Format consists of a listing of entities and data.
- Stored in ASCII coded text.
  - This binary format simplifies electronic transmission.
- Format used primarily for geometric data transfer
  - Does also support some non-geometric entities such as notes and dimensions.

IGES Entity Examples

<table>
<thead>
<tr>
<th>Entity #</th>
<th>Entity Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>100</td>
<td>circular arc</td>
</tr>
<tr>
<td>108</td>
<td>plane</td>
</tr>
<tr>
<td>110</td>
<td>line</td>
</tr>
<tr>
<td>114</td>
<td>spline surface</td>
</tr>
<tr>
<td>118</td>
<td>ruled surface</td>
</tr>
<tr>
<td>126</td>
<td>NURB curve</td>
</tr>
<tr>
<td>150</td>
<td>CSG block</td>
</tr>
<tr>
<td>162</td>
<td>solid of revolution</td>
</tr>
<tr>
<td>206</td>
<td>diameter dimension</td>
</tr>
</tbody>
</table>
IGES Translation

• Source file data examined:
  – create list of elements and defining data
    • lines, arcs, etc. with sizes, locations, endpoints...
  • Examine source entities and match to corresponding IGES entities.
    – for example, AutoCAD 2D line to entity #100 along with endpoint data.
  • List of IGES entities matched with native entity type is called an entity map.

IGES

• Entity map then converted from neutral IGES format to destination format.
  • Once again, entity matching must take place.
    – IGES entity type and data matched to destination file format.
      – for example, entity #100 to Unigraphics line entity using transferred endpoint data.

IGES

• How processors translate to and from IGES depends on who wrote translation software.
  • Entity map obvious for some geometries.
    – e.g. common entities such as points and lines
  • Other matches not obvious
    – different software may support different geometry definitions
      – example, spline curve may be 3rd order for one system and higher order for another.

IGES Incompatibilities

• Pre-processor must match-up every entity in the sending system with a complimentary IGES entity.
  • When choice is not obvious, selection becomes based upon the judgment of whoever wrote the translation software.
    – may also involve mathematical approximations and rounding
  • Similar problems exist at the post-processing end of translation.

IGES Incompatibilities

• User must consider limitations of both source and target software.
  – what entities supported (2D, 3D ... ?)
  – what data req’d in transfer (only geometry?, notes?)
  • Since software firms create pre and post processors, proprietary attitude affects supported entities.
    – some companies hesitance to make too much info available

IGES

• standard has grown through versions to accept more entities
  • examples:
    – Version 5.1 has:
      • 13 general note entities
        – for data such as superscript, subscript, justification...
      • 12 arrowhead forms
        – filled, open, triangular...
  • more entities offers more choices to software designers but no CAD package supports all entities in IGES list.
IGES and Solids

• Prior to 1988 no solid entities supported.
• 1988 CSG entities added to standard.
• 1991 B-rep entities added.

STEP:
STandard for the Exchange of Product Data

• Represents a new effort to establish a single, workable, internationally accepted standard.
  – Currently in state of evolution
• Extension of IGES, carries data definitions specific to mechanical and civil engineering.
• Will support more than simply geometric data

STEP

• Interface for the exchange of data for the entire product development and production cycle.
• Includes both geometric and non-geometric data
• Non-geometric data
  – test data supporting design
  – process planning for tooling, fabrication, assembly, quality assurance, etc.

De facto neutral formats:

• Gain acceptance through widespread use and availability
• Developed by company but source code made available
• DXF: Data eXchange Format
  – AutoCAD data exchange format
Other techniques

• Many solid modelers beginning to use same solid geometry engine
• Common choices are ACIS and Parasolid
• Data can be shared directly between packages with same engine

### Solid Modeling Engines

<table>
<thead>
<tr>
<th>CAD Package</th>
<th>Manufacturer</th>
<th>Primary Format</th>
<th>Modeling Engine</th>
</tr>
</thead>
<tbody>
<tr>
<td>AutoCAD</td>
<td>AutoDesk</td>
<td>B-Rep</td>
<td>ACIS</td>
</tr>
<tr>
<td>Inventor</td>
<td>EDS/Integraph</td>
<td>B-Rep</td>
<td>Parasolid</td>
</tr>
<tr>
<td>SolidWorks</td>
<td>SolidWorks</td>
<td>B-Rep</td>
<td>Parasolid</td>
</tr>
<tr>
<td>MicroStation Modeler</td>
<td>Bentley</td>
<td>B-Rep</td>
<td>Parasolid</td>
</tr>
<tr>
<td>ProENGINEER</td>
<td>Parametric Technologies</td>
<td>B-Rep</td>
<td>proprietary</td>
</tr>
<tr>
<td>VERTEX</td>
<td>Vertex Mech</td>
<td>B-Rep</td>
<td>ACIS</td>
</tr>
<tr>
<td>IronCad</td>
<td>Vistra Industrial</td>
<td>B-Rep</td>
<td>ACIS/ Parasolid</td>
</tr>
<tr>
<td>Unigraphics</td>
<td>EDS</td>
<td>B-Rep</td>
<td>Parasolid</td>
</tr>
</tbody>
</table>

Example:

• ACIS is used in
  – AutoCAD Mechanical Desktop
  – 3D-Eye TriSpectives
  – 3DScheme
  – SolidDesigner
• File written to .sat format (ACIS storage format) may be shared directly with no geometric data loss.

Effective Data Exchange: conclusions

• Most exchange requires the use of data translators.
• Requires the use of standardized, neutral formats (IGES, DXF)
• At the current time, not 100% seamless, e.g. some error or loss of accuracy may occur with exchange.
• Move to STEP standard and/or common solid engine will improve this.