

## APPENDIX D – System Specification

### General

- The system shall provide length estimations for all welds within all levels of construction from stiffened panels to structural units
- The system shall provide length estimations for all welds between
  - Two individual parts
  - Components of a Unit
  - Individual Units
- Weld length information shall be exportable in an NGSS-specified XML format
- The application shall execute on a personal computer running Microsoft Windows 2000 or Windows XP Professional operating systems
- The system shall utilize the following commercial components:
  - Weld Geometry analysis routines within the ACIS kernel from Spatial
  - File import routines within the Spatial 3D InterOp tool set
  - Additional file translation routines within the AutoDesk RealDWG tool set
  - Visual display and interaction in the 3D window within the HOOPS API from TechSoft3D
- The system shall assume that
  - all identified joints are to be welded
  - only structural components will be imported
  - all part files within an analysis have a common reference frame (e.g. in ship coordinates)
  - all parts are solids

### Data Import / Export

#### *Part Import*

- The system shall have the ability to import a single or multiple CAD files
- Shall have the ability to import the following CAD formats
  - Intergraph ISDP (through DXF or IGES file format)
  - CATIA V5 (up to R17) and V4
  - STEP AP 203 and AP 214
  - ProE (Wildfire 18)
  - Inventor 12
  - IGES 5.3

- ACIS SAT
- Preferred: ShipConstructor
- Preferred: AutoCAD dxf & dwg
- The system shall utilize the RealDWG routines from AutoDesk to import dxf, dwg and ShipConstructor formatted files
- The system shall utilize the Spatial 3-D InterOp library to translate CATIA, STEP, IGES and ProE CAD formats
- 3D InterOp also offers ability to import ACIS SAT, CATIA V4, UGS, Parasolid and SolidWorks file formats
- The length units are assumed to be in millimeters, unless:
  - Units are provided in the part file, or
  - Changed by the user at time of import
- At time of file import, the system shall prompt the user to specify part grouping attribute:
  - Loose: considers all components of the file as a single geometric object, used to interrogate welds between CAD files
  - Assembled: considers all components of the file as individual geometric objects, used to interrogate welds within a CAD file.
- The system shall utilize the part naming convention to
  - Create the part relationship hierarchy
  - Identify standard parts

### ***Weld Export***

- The system shall export weld data in an NGSS-specified XML format for loading into TeamCenter
- The system shall export weld data in a comma-delimited (\*.CSV) format that will be readable by Microsoft Office tools, such as Excel for reviewing and printing data
- The Export GUI shall offer the user the ability to change exported units
  - Possibilities include: feet, inches, millimeters, meters
  - Default shall be the units set in the GUI for interactive display of measurements
- Weld data shall be segregated by:
  - Weld process
  - Weld orientation
  - Weld size
  - Part hierarchy level

## ***Rules***

- The system shall utilize an external file to store weld and associated rules
- The system shall provide rules for weld specification, possibly including
  - Weld orientation definitions
  - Weld process definitions
- The system shall the ability to accommodate the following rules, if specified by NGSS at a later date
  - Initial manufacturing orientation based on part footprint and/or maximization of flat welds
  - Weld size classification using specification within the part file
  - Size classification based on mating part thicknesses, weld process type and manufacturing orientation
- The file format shall include ASCII text keywords and structured value strings
- Rules shall be modifiable through direct file manipulation with an ASCII text editor

## ***Configuration File***

- The system shall utilize an external file to store configuration settings
- Configuration settings shall include:
  - Part intersection tolerances
  - Default colors for display
  - Default units for display
- Configuration settings shall be modifiable through
  - Direct file manipulation (ASCII text editor, e.g. Notepad)
  - User interface

## ***Development Option: State Save / Restore***

- Shall have the ability to save current content of the internal data structures
- Shall have the ability to import a saved state to resume work from previously saved point
- Shall have the ability to auto-save state at specified interval
- Saved State shall include:
  - Names and file locations of source CAD part files
  - Parts hierarchy with calculated and/or user specified attributes
  - List of identified welds with calculated and/or user specified attributes
  - Date and time of state save
  - Textual note describing the saved state

## Weld Identification

- The system shall utilize the geometry analysis routines within the Spatial ACIS kernel for weld identification to detect all possible welds within the part hierarchy
- If part file was classified as a “*loose*” assembly, then all welds between the component parts shall be identified
- If the part file was classified as a previously “*assembled*” structure, then only the welding of other parts to this combined group of parts shall be identified
- After the identification of the possible welds, the system shall use available data from the part files, weld rules and configuration settings to initialize the following weld attributes:
  - Unique weld ID number
  - Use Flag set to ON, see Weld List in the Internal Data Structures section below
  - Process (butt or fillet), based on angle of mating parts defining the joint
  - Orientation (horizontal, vertical, overhand), if manufacturing orientation of the parts is set
  - Size, if weld rules are available or provided within the CAD file
  - Weld Length
  - Net Weld Length initialized to Weld Length, unless there is a rule to automatically apply loose settings

## Internal Data Structure

- The data shall be stored in one of three data structures
  - File List – list of files read into the system
  - Parts Hierarchy – hierarchical tree of parts
  - Weld List – flat list of identified welds with attributes

### ***File List***

- The system shall store the list of files read into the system.
- Each filename shall be identified by a unique number

### ***Parts Hierarchy***

- Hierarchical directory of parts and assemblies
- Attributes include:
  - Part ID – unique identifier for each part
  - File ID – link to File List entry for file that contained this part
  - Type: entry level in the hierarchy, single part or assembly of parts
  - Component Grouping: Loose or Assembled

- Parent Assembly
- Children parts or assemblies
- Manufacturing orientation
- Standard Part Type - if identified as a standard part, then set part type otherwise leave blank
- Visible: ON or OFF, display the part in the 3-D graphical window?

### ***Weld List***

- The system shall store the list of welds in a flat matrix of row entries
- The Weld List shall include the following attributes (in columns) for each weld entry (in rows):
  - Weld ID – unique identifier
  - Use Flag – boolean flag for turning weld OFF (0) or ON (1) for length accumulation, default is ON
  - Visible – boolean flag for the display of a weld OFF (0) or ON (1), default is ON
  - Process: fillet, butt
  - Orientation: horizontal, vertical, overhead
  - Size – user assigned weld differentiator
  - Passes – number of passes identified for that weld, default value is 1
  - Length – length of the identified joint to be welded
  - Net Length – weld length minus any applied leave loose rules
  - Part 1 ID – unique identifier for first part comprising weld joint
  - Part 2 ID – unique identifier for second part comprising weld joint
  - Joint Angle – angle between two mating parts, used in calculations to classify weld process and orientation (degrees)

### **Part Data Access**

- The system shall provide a user interface to select a single part or multiple parts
- Once selected, the user shall have the options to apply, modify or query part attributes

### ***Select / Deselect Part(s)***

- The user shall be able to select parts through 3 separate methods
  - Interactively within the 3D display window
  - Selecting a weld in the Weld List selects the two parts associated with that weld
  - From the Part Hierarchy display area
- The GUI shall use the following click modifiers:
  - Ctrl Button: toggle selection state of selected part
  - Shift Button: used within the Part Hierarchy area, select current part and all parts between the current part and the previously selected part in the tree

- If no modifier is used, then selecting a part shall cause all other selected parts to be unselected.

### ***Apply / Modify / Query Part Data***

- Once a part or group of parts is selected, the GUI shall offer an interface to assign, modify and/or query the following part attributes:
  - Visibility
  - Component grouping: consider as a previously “*assembled*” part or a “*loose*” collection of parts
  - Manufacturing orientation
  - Standard part classification
  - Total count of standard parts in each identified category (query only)
- Manufacturing Orientation shall only be applicable to an assembly
- When setting the manufacturing orientation for an assembly, only the first level of parts under the assembly shall be affected by the orientation setting

## **Weld Data Access**

- The system shall provide a user interface to select a single weld or multiple welds
- Once selected, the user shall have the options to apply, modify or query weld attributes

### ***Select/Deselect Weld(s)***

- The user shall be able to select welds through 3 separate methods
  - Interactively within the 3D display window
  - Selecting a part, selects welds associated with that part
  - From the Weld List
- The GUI shall use the following click modifiers:
  - Ctrl Button: toggle selection state of selected weld
  - Shift: used within the Weld List, select current weld and all welds between current weld and previous weld in the list
- If no modifier is used, then selecting a weld shall cause all other selected welds to be unselected.

### ***Apply / Modify / Query Weld Data***

- Once a weld or group of welds is selected, the GUI shall offer an interface to assign or modify the following weld attributes:
  - Use Flag

- Visibility
- Size
- Process
- Number of Passes
- Orientation
- Leave loose rule – distance from end of identified joint to not weld
- Once a weld or group of welds is selected, the GUI shall offer an interface to query the following weld attributes:
  - Use Flag
  - Size
  - Process
  - Number of Passes
  - Orientation
  - Applied leave loose rule(s), if any
  - Accumulated weld length
- The user interface shall display the accumulated weld length of selected welds within:
  - A pop-up window
  - The status bar at the bottom of the window

## Graphical User Interface

- The system shall have the following major components in the graphical user interface
  - Menu bar of available actions
  - Tool bar for easy access to selected system actions
  - Status bar, providing system state and accumulated weld length if a weld or group of multiple welds is selected
  - Tree window showing the part hierarchy
  - Spreadsheet-like, row-column table interface for list of identified welds
  - 3-D graphical window for part and weld display and interaction
- The system shall provide resizable windows and dockable toolbars
- The Menubar shall offer the following actions:
  - New – clear current system data, user prompted to confirm action
  - Open – open a previously save state file
  - Save – save the current state of the system
  - Open Part File – open a new part file
  - Remove Part – remove a part and all associated data from the internal data structures, user prompted to confirm action
  - Remove Part File – remove all parts within a previously imported file and all associated data from the internal data structures, user prompted to confirm action
  - Export weld information – dialog to export XML format and/or CSV data
  - File History – list of most recent opened files

- The user shall have the ability to change the units for display of weld length
  - Possibilities include: feet, inches, millimeters, meters
  - The user shall have the ability to set a default for display as well as defaults for file import and export
- The Toolbar shall offer icon buttons representing a subset of the actions offered in the Menubar
- The Part Hierarchy tree area shall display the part hierarchy in a collapsible/expandable tree, similar to a file directory list
- The Weld List shall display the identified welds in a table format
- Each weld shall occupy a single row in the matrix with columns presenting the associated weld attributes
- The Weld List interface shall have the following capabilities:
  - Sort the welds based on a specified column ranking
  - Select an individual weld or multiple welds
  - Modify weld attributes
  - Accumulate weld lengths from selected welds (shown in Status Bar)
- The three-dimensional display area shall provide the following capabilities:
  - Change camera position
  - Center the view on the collection of parts
  - Zoom in/out
  - Reset zoom to extents of the image
  - Select a part or weld within the display
  - Utilize the CTRL selection modifier for selecting/deselecting multiple parts or welds
  - Change the color of selected parts or welds