Simulation Based Design Center

Activities-based Cost Estimator (ACE)

NSRP Business Process Technologies Panel Project

NSRP Joint Panel Meeting
New Orleans, LA
December 12, 2007

Activities-based Cost Estimator

- NSRP Business Process Technologies
- Panel Project
  - 6-month specification effort
  - $55K total
- UNO Simulation Based Design Center
- Northrop Grumman Ship Systems

Activities-Based Costing (ABC)

- Basic Premise*
  - Cost object consumes activities
  - Activities consume resources
  - Consumption of resources is what drives cost
  - Relationship is critical to managing cost
  - Trace costs instead of allocating them
  - Determine *"true"* cost for an object

**** From University of Pittsburgh "Introduction to ABC" Online Tutorial***

Activities-Based Costing (ABC)

- Identify money making and money losing activities
- Discover opportunities for cost improvement
- Improve strategic decision making
- Compare different options
  - Design
  - Manufacturing

Activities-Based Costing (ABC)

- When to use?
  - Overhead is high
  - Products are diverse
    - Complexity
    - High Volume
    - Amount of direct labor
  - Cost errors are high
  - Competition is stiff

Activities-Based Costing (ABC)

- ABC Steps
  - Identify activities
  - Determine cost for each activity
  - Determine cost drivers
  - Collect activity data
  - Calculate product cost

Shipyard Efforts

- Numerous production improvement efforts
- Of interest to this project
  - Cost reduction
  - Schedule
  - Change management
  - Design for production
- Through improved planning
  - Efficiency in managing plans
  - Quality and accuracy of content

Shipyard Efforts

- Improved production planning systems
  - Digital planning tools
  - Analysis (e.g. discrete event models)
  - Production database
- Develop, analyze and maintain plans
  - Earlier in design process
  - In higher detail
  - Asses effects of and manage change
  - Build on best practices

Problem

- Problem:
  - Beyond “gross” estimation drivers
  - Require more detailed product attributes
  - Not readily available
  - Manual efforts to collect

ACE Objective

- Develop shipyard-specified tool
- Extract product attributes from CAD
- Translate into production process info
- To support:
  - Work order content
  - Resource requirements
  - Time and cost estimations

ACE Tasks

- Review previous efforts
- Collect shipyard requirements
- Investigate potential platforms
- Create system specification
- Plan for software development

Previous Work

- ICCS bv (Norwegian system, AISC paper)
- Proposed that 50% of the cost of steel structures attributed to the connections
- Needed tool to estimate cost and compare design alternatives
- 9 connector definitions with attributes
  - Components: welds, bolts, plates, …
  - Labor
  - Cost

OneStop System

- NSRP original development at EB
- Effort to improve production schedule
- Identify candidate parts for PAWS
- Review CAD models for welds
- Extract information (length, weight, …)
- Translate models for *EasyPlan*

Product-Centric Facility Design

- Extension of OneStop & PAWS work
- CNST funded work (EB & ARL)
- Goal: reduce construction schedule of Virginia-class submarines
- Extract information from CAD
- Support discrete event models

AutoGen

- NSRP & ONR development
- Automatic Generation of robot control programs
- Identify welds
- Classify and assign attributes
- Collision-free weld programs

Second Tier Design Enhancement

- NSRP Phase II Extension effort
- Weld planning module
- Identify welds
- Assign attributes
- Library of welds to apply
- Generate weld symbols

NGSS Requirements

- Enable more accurate cost & time estimations
- Not specific to any Navy program
- Support ongoing process improvement
- Tool to extract weld attributes
- Applied to structural assemblies

NGSS Requirements

- Interactive tool (batch possible)
  - Import CAD files
  - Infer weld
  - Select weld
  - Query and modify weld attributes
  - Toggle weld for consideration
  - Select construction stage for consideration

NGSS Requirements

- Capability to import multiple CAD formats
  - Intergraph (dxf export)
  - CATIA V5
  - ProE
  - AutoCAD/Inventor
  - ShipConstructor
  - STEP
  - IGES

NGSS Requirements

- Files imported are considered
  - Loose collection of parts for assembly
  - Single, previously welded assembly
- Specify manufacturing orientation
  - Primary orientation for assembly
  - Alternative orientation
  - Set or modify orientation for weld(s)
- Identify weld, interactive specification

NGSS Requirements

- Count number of standard parts
- Automatically extract following data
  - Length
  - Process Type (fillet, butt)
  - Orientation (horizontal, vertical, overhand)
- Rules
  - Orientation definitions
  - Leave loose

NGSS Requirements

- Present information at multiple levels
  - Each individual weld
  - Roll-up at file level or selected group
- Provide ability for query & modification
- Export data in two formats
  - XML
  - CSV

NGSS Requirements

- **Users:** Production Planning and IE
- Run on Microsoft Windows PC *(2000, XP)*
- **Owners:** NGIT
- No development standards requirements
- No requirement for direct interfaces
- Develop User's manual

NGSS Assumptions

- All joints to be welded
  - Between individual parts of assembly
  - Between previously welded assemblies
- Parts are individually named
- Naming convention imparts hierarchy
- Weld symbol may or may not be available

Additional Guiding Capabilities

- Infer weld specification

From other entities:

- Automatically apply weld specification
- Refine search from weld library
- Auto-infer manufacturing orientation
- Apply cost rates

Potential Platforms

- Investigate commercial libraries
- Systems:
  - Technosoft AML
  - UGS Parasolid
  - Spatial ACIS
  - AutoDesk Object ARX/OEM
  - ShipConstructor
  - PTC Granite

System Specification

- Components:
  - ShipConstructor API (import & weld infer)
  - Spatial 3D InterOp (add'l CAD import)
  - AutoDesk Object ARX (3D graphics)
  - Microsoft MFC (2D windows interface)
- Use intermediate SAT format
- Internal File, Parts, & Weld databases

System Specification

- Address all specified requirements
- Assumptions:
  - All joints to be welded
  - Only structural components
  - All parts have common reference frame
  - All parts are solids
  - Parts have naming convention that
    - Infers hierarchy
    - Identifies standard parts

System Specification

- Interface
  - Set and change units
  - Project save/import option
  - Change and save environment/configuration
  - Specify “Loose” vs. “Assembled” for CAD file
- ASCII text editable rules file
  - Orientation
  - Type
  - Standard Part ID’s

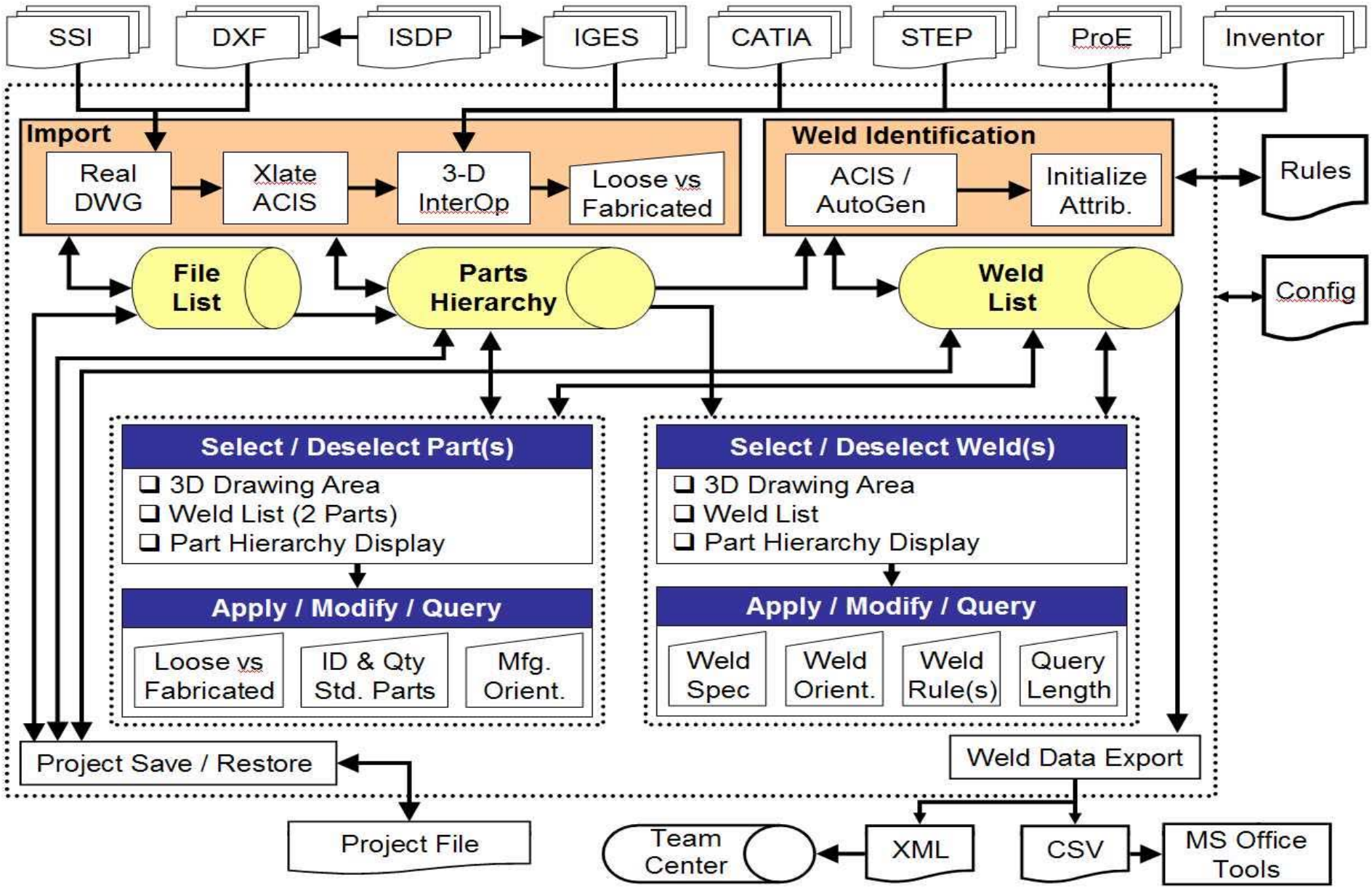
System Specification

- Part Entry Attributes
  - Unique ID
  - File ID (link to file list)
  - Type: single part or assembly of parts
  - Component Grouping: loose vs. assembly
  - Children (parts and/or assembly)
  - Manufacturing Orientation
  - Standard Part ID
  - Visibility Flag

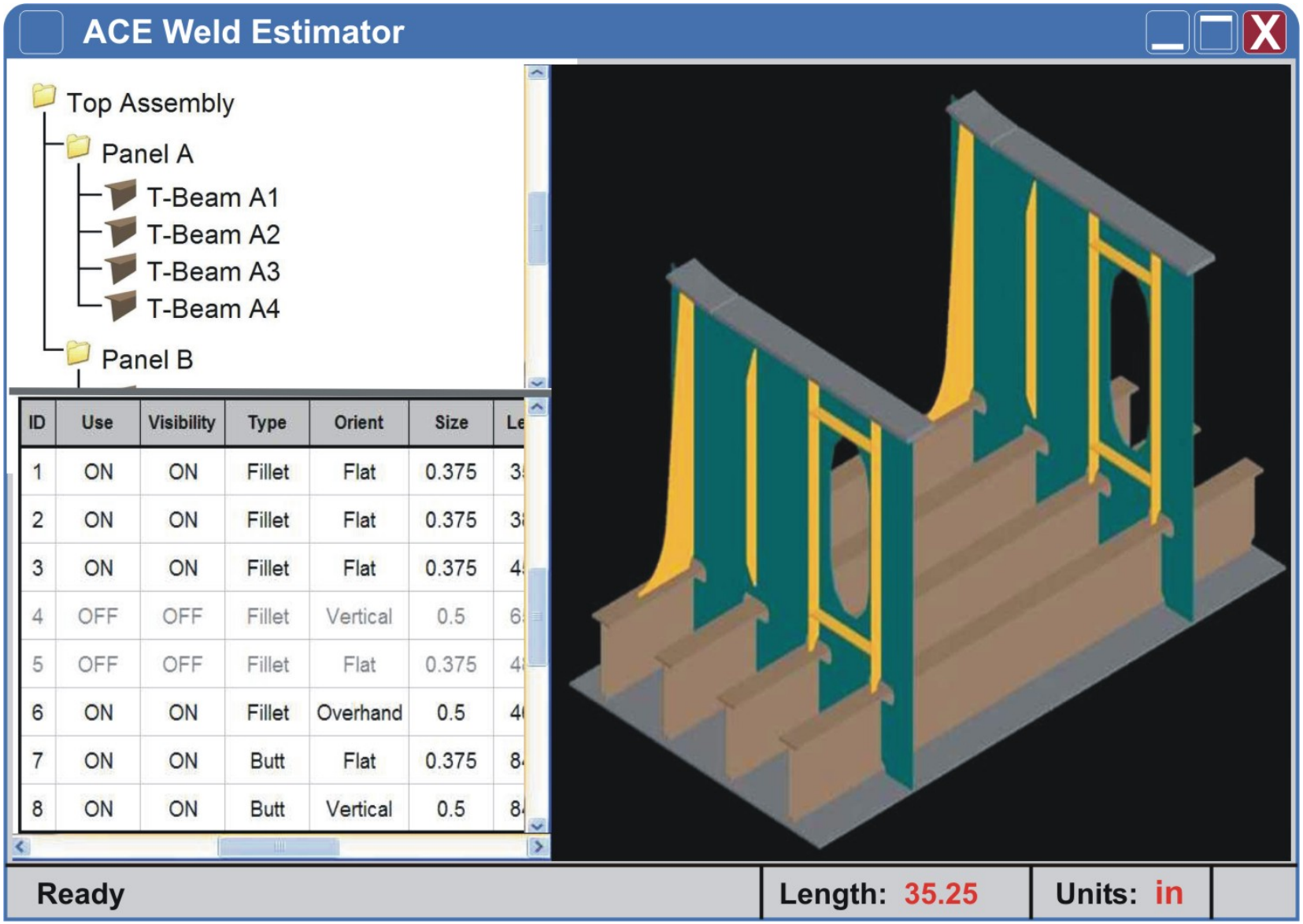
System Specification

- Weld Entry Attributes
  - Unique ID
  - Use & Visibility Flags
  - Process Type
  - Orientation
  - Size (if rules available or set by user)
  - Length
  - Net Length (if leave loose applied)
  - Associated parts / assemblies
  - Joint angle

System Schematic



Proposed GUI



Development Plan

- Three strategies for building software
  - ***"Grand Design"***
    - Once through all tasks
    - Requirements, design, build, test, fix, deliver
  - **"Incremental"**
    - Define requirements
    - Sequence of builds, adding capabilities
  - **"Evolutionary"**
    - Develop system in builds
    - System requirements and design not set upfront

Development Plan (Tasks)

- Setup development environment
- Setup test environment
- Gather test data
- Train on system components
- Refine and detail use cases
- Detail system design
- Develop system
- Shipyard testing

Development Plan (Tasks)

- Planned 5 intermediate releases (+ Final)

1) Basic capabilities & GUI, import single file, identify all welds, export weld info
2) Import multiple files, welds between assemblies
3) Interactive query and modification of weld & part attributes
4) Leave loose, trace to assembly, standard parts
5) Interactive orientation, length roll-up

Component Tasks w/each Release

- Internal testing at UNO
- Release tool to NGSS
  - Intro to new capabilities
  - Demo on how to use
- NGSS review & resting
- Gather feedback
  - Identified bugs
  - New Capabilities
  - Prioritize, risk assessment, schedule

Proposed ROI

- Sample stiffened panel

Component	Manual	ACE
Man Hours per Panel	5	0.5
# of Panels (One Vessel)	1500	1500
Cost per Man-Hour	$50	$50
Total Cost	**$375,000**	**$37,500**
Potential Savings	**$337,500**	

Questions?

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