The Integration of Jack Human Simulation Software into the Design Process: A Case Study

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Who is Sandalwood?

- Michigan based Engineering Firm established in 1989

- **Philosophy:** to work with industry, government and academic leaders to combine existing and emerging knowledge into deployable process improvement

- Three technical specialties;
  - Ergonomics
  - Information Technology
  - Process optimization
Sandalwood Partnerships

Technology Partners
What is Jack?

• Jack is a Human Simulation Tool that can be used as a stand-alone product or integrated within a variety of UGS suite of tools.

• Jack provides anthropometrically and biomechanically representative 3D human models for use in various applications:
  – Product Design
  – Manufacturing
  – Serviceability
  – Training
  – Research
  – Athletics
  – Entertainment
Jack users include:

- Ergonomists
- Product Design Engineers
- Process Design Engineers
- Manufacturing Engineers

• Applicable to multiple users with different perspectives and training
What Can Jack Do?

- Static Ergonomic/Human Factor/Biomechanical Analysis
  - Allows you to manipulate the human within a virtual environment

- Provides engineers with Real time data with how their parts/process interface with the human

- Custom animations can improve process flow and cycle times.
Ergonomic Assessment Tools

- Fatigue Analysis
- Lower Back Analysis
- Manual Handling Limits
- Metabolic Energy Expenditure
- NIOSH
- Ovako Working Posture Analysis
- Predetermined Time Standards
- Rapid Upper Limb Assessment
- Static Strength Prediction
Importing CAD models into the Jack Software

Import CAD models:

- Vis (.jt)
- IGES (.igs)
- VRML (.wrl)
- Stereolithography (.stl)
- IV formats (.iv)
**Why use specialty ergo tools?**

**Industry transition to digital data:**
- Industries adopting all digital product design. Ergonomic evaluations can now be completed in the digital environment.

**Pro-active vs. reactive ergonomics:**
- Identify ergonomic/human factors issues prior to product or process physical build.
- Visibility, Reach, Serviceability, Risk of Worker Injury, etc…

**Cost advantage:**
- Value of high end human simulation is prior to physical build, where design changes are inexpensive.
How is Jack used with Other Tecnomatix Products?

Vis Jack
- This software allows you to place the digital human into Vis Mockup.
  

Motion Capture Toolkit
- With the MoCap Toolkit, engineers, designers or users can be immersed in a virtual design to evaluate the human factors issues first hand
  
Sandalwood was contacted about the Jack Human Simulation Software and how the software was capable of using CAD data.

The company ergonomics engineer was working on a future program and was having difficulty performing ergonomics analyses because there was no physical parts.
Case Study: An Automotive Frame Supplier

- The following case study will highlight one way that a company gets introduced to the value of the Jack Human Simulation Software as an ergonomics assessment tool.

- To highlight the benefits of how the Jack software could be used we completed an Ergonomics assessment of a pre-determined assembly operation.
Overview of the Ergonomics Assessment

- Retrieved digital product data
- Reviewed Process – pictures, measurements, video
- Built digital work cell
- Generated task animation
- Reviewed animation and conducted assessments to identify improvement opportunities

Ergonomic risks were evaluated and improvements suggested were based on the following requirements:

- Strength requirements to complete the task
- Reach and accessibility of the parts
- Lifting demands
Video of the assembly operation
Identifying Basic Ergonomic Concerns

Current Process: unsafe lift due to reach, part weight, & vertical loading height

Simple Process Improvement Opportunity

- Reduce horizontal distance to load by 4 inches
- Increase % of population capable of safely performing task
Identifying Basic Ergonomic Concerns

Current Process: unsafe lift due to reach, part weight, loading height and hand orientation

Simple Process Improvement Opportunity

- Reduce vertical loading height by 6 inches
- Increase % of population capable of safely performing task
Creating the Assembly Environment

- For this study the company was unable to provide 3D data of the assembly layout.
- Using the various shapes and objects in the Jack software we were able to re-create the environment.
Workstation layout
Creating a custom animation
Cost benefits of making the recommended changes?

- Reduce the amount of Injuries
- Reduce the overall injury costs
- Reduce the high turn-over rate
- Improve quality
Cost benefits of making the recommended changes?

**Direct Costs**
- Medical Expenses

**Indirect Costs**
- Internal Medical Expenses
- Absenteeism
- Training Costs for New Workers
- Lost Productivity & Efficiency

In general indirect costs are approximately 4 times greater than the direct costs!
## Cost Per Injury Type

<table>
<thead>
<tr>
<th>Injury Type</th>
<th>Direct Costs</th>
<th>Indirect Costs</th>
<th>Total Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carpal Tunnel</td>
<td>$14,000</td>
<td>$28 - 70,000</td>
<td>$42 - 84,000</td>
</tr>
<tr>
<td>Neck or Back</td>
<td>$28,000</td>
<td>$56 - $140,000</td>
<td>$84 - $168,000</td>
</tr>
</tbody>
</table>

Source: North Carolina Worker Compensation
• The Process improvements were only a Band-Aid solution.
  • Full re-design of the equipment and the workstation was more of a long-term solution/plan

• To make a significant impact to their process the company needed to have input during the design phase of their parts and tooling
Proactive vs. Reactive Ergonomics

**PROACTIVE**
- During initial design process
- OPTIMAL

**REACTIVE**
- After installation, before complaints
- After Complaints
- After Injuries
- TOO LATE

**Money Available** vs **Cost of Change**

Program Timeline:
- DESIGN
- BUILD
- PRODUCTION
Virtual Verification of New Tooling Design

Facilitated by Sandalwood at Supplier Site
• Digital data for proposed tooling design was loaded into the Jack at the Supplier site for both our client and their supplier engineers to review.
• Ergonomic issues were discussed and assessed on the spot using the Jack Task Analysis ToolKit.
• The necessary modifications were identified and supplier agreed to make changes in order to obtain the company’s Ergonomic Buy-off.
Ergonomic Issue #1:

The proposed tooling design would cause a blind operation leading the operator to assume an awkward posture to see their parts.
Assessment:

The line of sight to part attachment location for small female was assessed

Solution:

Changes agreed upon to ensure small females would be able to see attachment points on tooling.

The overall tooling was lowered 6 inches to accommodate the 5th Percentile Female

The clamp that holds the part was opened
Ergonomic Issue #2

Design of the tool forced the operator to load the part at shoulder height, thus joint strength was a concern.
Assessment:

A static strength posture prediction was completed.

Solution:

Identified the tooling orientation that would invoke the least demands at the shoulder joint.

Therefore the tooling was angled toward the operator by 20 degrees.
Conclusion

- The company ended up purchasing the Jack Human Simulation Software and planned to not only utilize it for ergonomics, but also to help improve process flow, lean manufacturing, training and management demonstrations.
Questions?