Company Background

- “For more than 100 years, Dresser-Rand has been among the largest global suppliers of rotating equipment solutions, with field-proven centrifugal and reciprocating compressors, steam turbines, expanders, gas turbine packages, and control systems.”
- “Dresser-Rand is positioned to deliver a complete package of solutions, from initial concept to equipment retirement for the worldwide oil and gas, chemical, petrochemical, and process industries.”

Problem Statement

The primary objective of this project is to improve the VECTRA® assembly area for a second build stand, while enhancing the work flow. In addition, safety and ergonomics in this area require a thorough review.
**VECTRA Power Turbine**

- Modular power turbine
- Models 30G, 40G, 40G4
- 31,540 HP to 45,964 HP (23519 kW to 34275 kW)

- Speed of 6,200 RPM
- Used in oil and gas, and power generation markets

**Existing Plant Layout**

**VECTRA Power Turbine Assembly Area**

**Existing VECTRA Assembly Area**
**Updated Customer Needs**

<table>
<thead>
<tr>
<th>Need</th>
<th>Tag Product</th>
<th>Importance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sufficient Floor Space for a total of 4 Assembly Stations</td>
<td>Increased Production Rate</td>
<td>Medium</td>
</tr>
<tr>
<td>Meet or Exceed Building Codes (Fire Protection, HVAC, Electric)</td>
<td>Safe Working Environment</td>
<td>High</td>
</tr>
<tr>
<td>Improved Safety and Ergonomics for Plant Workers</td>
<td>Safe Working Environment</td>
<td>High</td>
</tr>
<tr>
<td>Minimum Down Time of Scheduled Production</td>
<td>Maintain Production Schedule</td>
<td>Medium</td>
</tr>
<tr>
<td>Identify Most Cost Efficient Solutions</td>
<td>Increased Profit</td>
<td>Medium</td>
</tr>
<tr>
<td>Improved Assembly Worker Ergonomics and Safety</td>
<td>Safe Working Environment</td>
<td>Medium</td>
</tr>
<tr>
<td>Organized Storage for Tooling Inside VECTRA Area</td>
<td>Increased Production Rate</td>
<td>High</td>
</tr>
<tr>
<td>Proper Material and Work Flow Through Area</td>
<td>Increased Production Rate</td>
<td>Medium</td>
</tr>
<tr>
<td>Reduce Production Time</td>
<td>Increased Production Rate</td>
<td>Medium</td>
</tr>
<tr>
<td>Better Access to Nitrogen/Compressed Air Lines</td>
<td>Increased Production Rate</td>
<td>Low</td>
</tr>
<tr>
<td>Advance Preliminary In-Process Tool Design Development</td>
<td>Reduced Cycle Time</td>
<td>Low</td>
</tr>
<tr>
<td>More Current Handle/Hardware More Compatible</td>
<td>Low Damaged Parts</td>
<td>Low</td>
</tr>
</tbody>
</table>

**Updated Engineering Specifications**

<table>
<thead>
<tr>
<th>Source No.</th>
<th>Source</th>
<th>Importance</th>
<th>Units</th>
<th>Marginal Value</th>
<th>Ideal Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Roundtable Injuries</td>
<td>Injuries/ Month</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>2</td>
<td>Near Miss Incidents</td>
<td>Near Misses/ Month</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>3</td>
<td>VECTRA Production Time</td>
<td>Weeks/ Unit</td>
<td>44</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>4</td>
<td>Economic Factors</td>
<td>$/ Year</td>
<td>46</td>
<td>45</td>
<td>45</td>
</tr>
<tr>
<td>5</td>
<td>Unit Setup Time Delay</td>
<td>Days</td>
<td>45</td>
<td>45</td>
<td>45</td>
</tr>
<tr>
<td>6</td>
<td>Non-Ergonomic Movements</td>
<td>Movements/ Day</td>
<td>TBD</td>
<td>TBD</td>
<td>TBD</td>
</tr>
<tr>
<td>7</td>
<td>Inside Work Surface</td>
<td>R²</td>
<td>july 2010</td>
<td>2010</td>
<td>2010</td>
</tr>
</tbody>
</table>
Updated Risk Assessment

<table>
<thead>
<tr>
<th>Risk Experienced</th>
<th>Reason for Risk</th>
<th>Effect</th>
<th>Probability</th>
<th>Action Taken to Reduce Risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>Increased water intake</td>
<td>Increased water intake from change in storage method, increased demand for water, and increased risk of contamination</td>
<td>2</td>
<td>5</td>
<td>Increased storage to minimize possible conditions, developed water treatment protocols, increased storage water capacity</td>
</tr>
<tr>
<td>Proposed new water intake</td>
<td>Proposed new source of water</td>
<td>2</td>
<td>5</td>
<td>Developed new water source and treatment protocols, increased storage capacity</td>
</tr>
<tr>
<td>New demand for labor</td>
<td>New demand for labor due to increased production and new equipment</td>
<td>2</td>
<td>5</td>
<td>Developed new labor protocols, increased training for new employees</td>
</tr>
<tr>
<td>New demand for maintenance</td>
<td>New demand for maintenance due to increased production and new equipment</td>
<td>2</td>
<td>5</td>
<td>Developed new maintenance protocols, increased training for maintenance personnel</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Type of Cost</th>
<th>Existing VECTRA</th>
<th>New Oven</th>
</tr>
</thead>
<tbody>
<tr>
<td>Equipment</td>
<td>$0</td>
<td>$15,379</td>
</tr>
<tr>
<td>Utility</td>
<td>$700</td>
<td>$200</td>
</tr>
<tr>
<td>Ventilation</td>
<td>$500</td>
<td>$0</td>
</tr>
<tr>
<td>Base</td>
<td>$750</td>
<td>$0</td>
</tr>
<tr>
<td><strong>TOTAL CAPITAL</strong></td>
<td><strong>$1,950</strong></td>
<td><strong>$15,379</strong></td>
</tr>
</tbody>
</table>

**Economic Outcomes**

- **Simple Payback (Years):** 3.40
- **Initial Rate of Return (Simple):** 28.61%
- **Initial Rate of Return (with 3% Risk Equilivalency):** 30.27%
- **Net Present Value at 10 Years:** $23,822

Oven Replacement

- **MODEL: TBR-540 ELECTRIC**

Oven Economic Analysis

- **Type of Cost:** Old Oven, New Oven
- **Floor Space:** $5,955, $5,955
- **Annual Maintenance:** $1,290, $0
- **Annual Energy:** $1,766, $1,331
- ****TOTAL ANNUAL** | **$7,041** | **$8,999**

**Existing VECTRA Assembly Area**

- **Existing Clean Room**

**Existing Build Area**

- **New Oven**

**New Oven**

- **MODEL: TBR-540 ELECTRIC**
Proposed 1 & 4 Quadrant Build Stands in VECTRA Assembly Area

Second Layout Choice Justification
- Customer input/feedback
- Disruption of current process
- No need to dig trench
- Steel support plate may be installed outside of current room
- Access to nitrogen supply
- Additional cranes may be installed outside of current room
- Minimal access in between build stands in quadrants I & IV
- Personnel accessibility
- Equipment accessibility

VECTRA Area Quadrant Selection Matrix - Top Choices

<table>
<thead>
<tr>
<th>Selection Criteria</th>
<th>Weighted Score</th>
<th>Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>Personnel Access</td>
<td>25% 0.75</td>
<td></td>
</tr>
<tr>
<td>OSHA/Safety</td>
<td>20% 0.80</td>
<td></td>
</tr>
<tr>
<td>Building Support</td>
<td>5% 0.15</td>
<td></td>
</tr>
<tr>
<td>Total Score</td>
<td>3.70 4.30</td>
<td>2</td>
</tr>
</tbody>
</table>

Expanded Clean Room
- No need to dig trench

Second Layout: 1 & 2 Quadrant Build VECTRA Assembly Area
Build Stand Orientation Selection Matrix Summary

- (2) Orientation Options
- (4) Selection Criteria
- Weighted Criteria (%) based on Importance
- Rating Scale 0-5

- Option A Outstanding Criteria
  - WIP Space Available

- Option B Outstanding Criteria
  - Personnel Movement Around Build Stand

Updated Build Stand Layout

Crane Type Selection Matrix Summary

- (4) Crane Types
- (6) Selection Criteria
- Weighted Criteria (%) based on Importance
- Rating Scale 0-5

- Free Standing Jib Outstanding Criteria
  - Disruption of Current Process
  - Ease of Installation
  - Clean Room Capability

- Mast Style Jib Outstanding Criteria
  - Disruption of Current Process

Crane Location Selection Matrix Summary

- (9) Crane Configurations
- (7) Selection Criteria
- Weighted Criteria (%) based on Importance
- Rating Scale 0-5

- DAB Outstanding Criteria
  - Access Between Build Stand and WIP
  - Disruption of Current Process
  - Swing Arm Logistics

- ACD Outstanding Criteria
  - Access Between Build Stand and WIP
  - Disruption of Current Process
Final Crane Layout

Storage Item Needs
- Inventory
  - Large parts/Pallet sized
  - Small parts
  - Nuts/bolts
- Non-Inventory
  - Tools
  - Jigs & Fixtures

Current Storage
- Shelving Units (3 Units)
  - Average Shelf Utilization: 67%
  - Actual total volume = 40 ft³ x 3 units = 120 ft³
  - Total Required space = 80 ft³
- Small Parts Inventory Cabinet
  - 85% Utilized Space
  - (Unorganized)
  - Volume = 33 ft³

New Storage Options
- 3 Units (5ft x 2ft x 6ft)
  = 60 ft³ x 3 units = 180 ft³
  - 1 unit (2 ft x 3 shelves) = 6 ft tall
  - 2 units (1.5 ft x 4 shelves) = 6 ft tall
  (Height is from shelf to shelf; assuming shelves are 2” thick.)
- 3 Cabinet Units (30” x 27” x 33”)
  = 15.5 ft³ x 3 = 46.5 ft³
  [Under the Workbench]
  - 5 drawers x 3 = 15 drawers
Work Surface

**Current Work Surface**
- Total Surface Area = 40ft²
- 25% additional surface area needed.
- Second build stand requires double capacity of work surface.
- 250% increase = 100ft²

**Proposed Work Surface**
- Counter Top
  - Surface Area = 31 ft²
- Work Surface with under-Cart Storage
  - Surface Area = 21 ft²
- Work Surface (back wall)
  - Surface Area = 43 ft²
- New Total Work Surface Area: 95 ft²

---

Ergonomic Movements

<table>
<thead>
<tr>
<th>Non-Ergonomic Movements in the old design</th>
<th>Changes in the new Design</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Long hours of standing and walking. Oil spilled under the build stand.</td>
<td>1. Anti-slip/Anti-fatigue mats placed on the sides of the build stand and next to the work surfaces.</td>
</tr>
<tr>
<td>2. Sliding under frame on cardboard mat to work on the underside of the VECTRA</td>
<td>2. Creepers with proper back support &amp; trouble light to work under the frame.</td>
</tr>
<tr>
<td>3. Lower rotor table used sometimes as temporary work surface.</td>
<td>3. Taller work surface so there is less bending.</td>
</tr>
<tr>
<td>4. Tripping on the base of control panel next to the build stand.</td>
<td>4. Build stand control panel on the wall. (No tripping)</td>
</tr>
<tr>
<td>5. Frequent re-stocking of small parts from supermarket.</td>
<td>5. More small inventory parts in cabinets, so there is less walking to supermarket.</td>
</tr>
<tr>
<td>6. Short stairs (without railing) used to work on the top part of VECTRA frame.</td>
<td>6. Addition of 2 dedicated stairs with railings on the side.</td>
</tr>
</tbody>
</table>