IPRO 312

APPLYING RAPID PROTOTYPING TECHNIQUES TO PRODUCTION TOOLING
TEAM MEMBERS

Faculty Advisors:
- William Maurer
- Keith McKee

Student Members:
- Abdulkamal Abdullahi
- Shan Iqbal Hussain
- Daniel Nosse
- Rachid Amine
- Muhammad Atta
- Udit Dave
- Chun Yiu Fu
- Kenneth Hicks
- Sourabh Manjrekar
- Oluwaseun Craig
- Annie Ranttila
- LaShawna Taylor
Our Sponsor

One of the largest caster and wheel manufacturers in North America and beyond

40,000 different combinations of casters and wheels
OUTLINE

- Introduction
- Goals
- Team Organization
- Caster Design Choice
- Equipment
- Finishing Options
- Process Design

- Site Choice
- Building Cost Analysis
- Factory Layout

- Feasibility Analysis

- The IPRO Experience

- Questions
INTRODUCTION

- For 120 years, industrial casters have been manufactured using the same methods

- Custom Caster Orders

- The current process creates lead times of 6 to 8 weeks for custom orders

- Customers reluctantly accept these production times

- IPRO 312 Team came up with a revolutionary solution
GOALS

- Establish / refine caster designs
- Determine the equipment required
- Develop representative prototypes
- Design a facility
- Determine the economics involved
- Product Design Team
- Equipment Team
- Factory Design Team
- Business Team
FIRST PROTOTYPE

- Made from few parts
- No Heat Treating required
- Similar to Colson’s Series 4 Caster
- Easily adaptable for different sizes
- Surpassed performance requirements
SECOND PROTOTYPE

- Introduced a bending radius on the forks
- Changed the shape of the yoke plate
EQUIPMENT

- Mitsubishi Laser
- CNC Lathe / Duraturm 2030
- CNC Lathe / Duraturm 2550
- CNC Lathe / Duraturm 2550
- 100 Ton Enerpac Hydraulic Press
- Miller Multiprocess Welder Model #XMT 456 CC/CV (x 2)
### FINISHING OPTIONS

<table>
<thead>
<tr>
<th>Coating</th>
<th>Zinc</th>
<th>Powder</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quantity of parts</td>
<td>5,000 parts/ mo.</td>
<td>5,000 parts/ mo.</td>
</tr>
<tr>
<td>Used system cost</td>
<td>$20,000</td>
<td>$30,000</td>
</tr>
<tr>
<td>New system cost</td>
<td>$40,000</td>
<td>$60,000</td>
</tr>
<tr>
<td>Line size</td>
<td>Assume 1,500 ft(^2)</td>
<td>1,800 - 2,500 ft(^2)</td>
</tr>
<tr>
<td>Thickness of coat</td>
<td>0.0003 in.</td>
<td>0.003 in.</td>
</tr>
<tr>
<td>Oven Temperature</td>
<td>Assume 375 – 500 F</td>
<td>375 – 500 F</td>
</tr>
<tr>
<td>Power requirements</td>
<td>480V 3-phase</td>
<td>100 amps</td>
</tr>
</tbody>
</table>

- Powder cost per caster = $ 0.64
PROCESS DESIGN

**RAW MATERIALS STORAGE**
- Cold-Rolled Steel
- Steel Tubing
- Steel Rod
- Bronze Bushing
- Thrust Bearings

**LASER**
- Cutting forks and top plates

**CNC LATHE**
- Machining Kingpin
- Machining Bearing Housing
- Machining Yoke Plate

**HYDRAULIC PRESS**
- Bending radius on forks
- Pressing kingpin into counter-bore on top plate

**WELDER**
- Welding forks to yoke plate
- Weld bearing housing to top plate

**FINISHING**
- Powder coating or zinc plating

**ASSEMBLY**
- Insert thrust bearings into bearing housing
- Insert and assemble bushing
- "Peining over" the end of the kingpin
Site Choice
Building Cost Analysis

Total Building Square Footage : 16,200 S.F.
Average Building Cost per S.F. : $55.50
Median Building Estimate : $889,100.00

Location Factor:
Little Rock, AR = 81.2
Fayetteville, AR = 71.8
AR Average = 75.1
Chicago, IL = 111.6

Final Estimated Building Cost:
Little Rock, AR = $766,572.66
Fayetteville, AR = $677,831.49
AR Average = $708,985.31
Chicago, IL = $1,053,565.38
FEASIBILITY ANALYSIS

No. of casters manufactured per month = 4,800
Estimated Manufacturing Cost per caster = $13.11
Total cost to company for Labor = $506,880.00
Estimated Labor Cost per caster = $8.80
Total year 1 Overhead costs = $1,520,640.00
YEAR ONE COST OF GOODS SOLD

Number of casters sold annually  
57,600

Cost of goods sold per caster  
$40.12

Total year 1 cost of goods sold  
$2,310,912
## CAPITAL EXPENSE

<table>
<thead>
<tr>
<th>Item</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Buildings</td>
<td>$709,000</td>
</tr>
<tr>
<td>Land</td>
<td>$250,000</td>
</tr>
<tr>
<td>Property Tax</td>
<td>$57,540</td>
</tr>
<tr>
<td>Facility Maintenance</td>
<td>$35,450.00</td>
</tr>
<tr>
<td>Machinery and equipment</td>
<td>$1,285,731</td>
</tr>
<tr>
<td><strong>Net property/equipment</strong></td>
<td><strong>$2,337,721</strong></td>
</tr>
<tr>
<td>Description</td>
<td>Value</td>
</tr>
<tr>
<td>--------------------------------------------------</td>
<td>-----------</td>
</tr>
<tr>
<td>Number of casters sold annually</td>
<td>57,600</td>
</tr>
<tr>
<td>Average sales price per caster</td>
<td>$70.21</td>
</tr>
<tr>
<td>Annual revenue</td>
<td>$4,044,096</td>
</tr>
<tr>
<td>Description</td>
<td>Amount</td>
</tr>
<tr>
<td>-------------------------------------------------------</td>
<td>--------------</td>
</tr>
<tr>
<td><strong>Revenue</strong></td>
<td></td>
</tr>
<tr>
<td>Gross revenue</td>
<td>$4,044,096</td>
</tr>
<tr>
<td>Cost of goods sold</td>
<td>$2,310,912</td>
</tr>
<tr>
<td>Gross margin</td>
<td>$1,733,184</td>
</tr>
<tr>
<td><strong>Total revenue</strong></td>
<td>$1,733,184</td>
</tr>
<tr>
<td><strong>Operating expenses</strong></td>
<td></td>
</tr>
<tr>
<td>Depreciation</td>
<td>$398,946</td>
</tr>
<tr>
<td>Maintenance, repair, and overhaul</td>
<td>$192,860</td>
</tr>
<tr>
<td>Other</td>
<td>$4,000</td>
</tr>
<tr>
<td><strong>Total operating expenses</strong></td>
<td>$595,806</td>
</tr>
<tr>
<td>Operating income</td>
<td>$1,137,378</td>
</tr>
<tr>
<td>Interest expense on long-term debt</td>
<td>$104,893</td>
</tr>
<tr>
<td>Earnings before taxes</td>
<td>$1,032,485</td>
</tr>
<tr>
<td>Taxes on income (30%)</td>
<td>$309,745</td>
</tr>
<tr>
<td><strong>Net income (loss)</strong></td>
<td>$722,739</td>
</tr>
<tr>
<td><strong>HIGHLIGHTS (FOR YEAR ONE)</strong></td>
<td></td>
</tr>
<tr>
<td>-------------------------------</td>
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<tr>
<td><strong>Net capital investment</strong></td>
<td>$2,337,721</td>
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<tr>
<td><strong>Selling Price per caster</strong></td>
<td>$70.21</td>
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<td><strong>Net revenues</strong></td>
<td>$1,733,184</td>
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<td><strong>Net income</strong></td>
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<tr>
<td><strong>Return on Investment</strong></td>
<td>37%</td>
</tr>
<tr>
<td><strong>Monthly amortization payment</strong></td>
<td>$43,997</td>
</tr>
</tbody>
</table>
5 YEAR REVENUE AND INCOME PROJECTIONS

Net Revenues (in millions)

<table>
<thead>
<tr>
<th>Year</th>
<th>2007</th>
<th>2008</th>
<th>2009</th>
<th>2010</th>
<th>2011</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$1.73</td>
<td>$1.76</td>
<td>$1.84</td>
<td>$1.95</td>
<td>$2.10</td>
</tr>
</tbody>
</table>

Net Income (in thousands)

<table>
<thead>
<tr>
<th>Year</th>
<th>2007</th>
<th>2008</th>
<th>2009</th>
<th>2010</th>
<th>2011</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$722</td>
<td>$753</td>
<td>$810</td>
<td>$895</td>
<td>$1,012</td>
</tr>
</tbody>
</table>
BARRIERS/ OBSTACLES

- Working as a team
- What part various disciplines play
- Understanding how research is done
- Information sharing
- Gathering information
ACHIEVEMENTS

FASTER
+ 
MORE RESPONSIVE
+ 
FLEXIBLE
↓
HAPPY CUSTOMERS,

FAST ROLLOVER,

COMPETIVENESS
FUTURE WORK

- Reduce equipment cost
- Incorporating new caster families into the production line
- Work with marketing department at Colson
THANK YOU!

- **Project Sponsors:**
  - Mr. Robert Pritzker
  - Colson Associates

- **Faculty Advisors:**
  - Professor William Maurer
  - Professor Keith McKee

- **External Resources:**
  - Mr. Chuck Harris, Colson Associates
  - President Joe Arvin, Arrowgear

- IPRO Faculty and Staff
QUESTIONS

http://www.iit.edu/~ipro312f06