Utilizing Modern Computer Development Tools In Implementing The Resource Consumption Model for Process Design (RCM)
RCM Research Objectives

**Better Analysis of Process Design Alternatives**

- Cost, Time, and Capacity
- Economy of Scale
- Compare alternatives
- Greater detail for better understanding
- Easy sensitivity analysis
Other Methodologies

- Engineering Economics
- Cost Accounting
- Break-even Analysis
- Cost Estimating
- “Design For” Methodologies
Modern Computer Tools

- Object-Based Programming
- Object-Oriented Programming
- Database Modeling and SQL
- Object Linking and Embedding (OLE)
Object-Based Programming

• Graphical User Interface (GUI)
• Object-Based versus Procedural-Based
• Visual Objects
• Products
  • Visual Basic
  • Visual Foxpro
  • Many Others
## Data Screen

### Resource Cost Model for Process Design

#### Data

<table>
<thead>
<tr>
<th>Projects</th>
<th>Cost</th>
<th>Time</th>
<th>Utilization</th>
<th>Summary</th>
</tr>
</thead>
<tbody>
<tr>
<td>P1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>P2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>P3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Alternatives

<table>
<thead>
<tr>
<th>A1</th>
<th>P1</th>
<th>Purchase Cannon</th>
</tr>
</thead>
<tbody>
<tr>
<td>A3</td>
<td>P1</td>
<td>Purchase HP</td>
</tr>
<tr>
<td>A4</td>
<td>P1</td>
<td>Purchase Epson</td>
</tr>
</tbody>
</table>

#### Resources

<table>
<thead>
<tr>
<th>Select?</th>
<th>P_ID</th>
<th>A_ID</th>
<th>R_ID</th>
<th>Resource</th>
<th>Cost</th>
<th>Saved Pcs</th>
<th>Time</th>
<th>Prod</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>P1</td>
<td>A1</td>
<td>R1</td>
<td>Printer C</td>
<td>370.00000</td>
<td>1.00000</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>P1</td>
<td>A1</td>
<td>R2</td>
<td>Print Head</td>
<td>45.00000</td>
<td>1.00000</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>P1</td>
<td>A1</td>
<td>R3</td>
<td>Ink Cartridge Refills</td>
<td>22.00000</td>
<td>1.00000</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>P1</td>
<td>A1</td>
<td>R4</td>
<td>Setup Labor (20 min)</td>
<td>0.25000</td>
<td>1.00000</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>P1</td>
<td>A1</td>
<td>R5</td>
<td>Labor: Load Paper</td>
<td>0.20000</td>
<td>1.00000</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>P1</td>
<td>A1</td>
<td>R6</td>
<td>Labor: Replace Print</td>
<td>0.20000</td>
<td>1.00000</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Exit**
Object-Oriented Programming

- Different from Object Based
- OOP Components
  - Inheritance
  - Encapsulation
  - Polymorphism
- Advantage
  - Improved programming efficiency
  - Faster development time
  - Easier to understand and debug
rcmccalculations Event

**frmMain.rcmccalculations - Microsoft Visual FoxPro**

- **Object:** frmMain
- **Procedure:** rcmcalculations

- **Author:** Rick Jerz
- **Application:** RCMCALCULATIONS
- **Create Date:** 97/02/03
- **Last Modify:** 97/10/11
- **Description:** Calculations for RCM

Recalculates a single resource costs
Includes: Quantity, Time, Consumption, and System Constraints

Puts the results of the calculations into gnSummary[] array.
Note: Must be careful to adjust for difference in array starting point.
PEGraph starts at 0, VFP starts at 1.

**DIMENSION lnCost[3]** & Array that holds the cost for the 3 constraints.
**DIMENSION lnTime[3]** & Array that holds the time for 3 constraints.
**DIMENSION lnUtilization[3]** & Array that holds the utilization for the 3 constraints.
**DIMENSION lnNumPur[3]** & Array that holds the number of resource pur...
Database Modeling & SQL

- Databases contain company information
- SQL is the standard access method
- Data in RCM is contained in a database
System Time Calculations

\[ g_1 \{ r_1, t_1, a_1, p_1 \} \]
\[ g_2 \{ r_2 \} \]
\[ g_3 \{ r_3, r_4, r_5, r_6, r_7, r_8 \} \]
\[ t_R \]
\[ o_r \]
SQL Select

* Calculate the overall controlling cycle time accounting for all overlaps.
  * (to be used for system constraint calculations)

* Fix for when only one setup resource is being considered. (Might need to double check logi
  * lnMinAvailability must be defined.
  * lnMinAvailability = 1

* First, get the overall time for groups in series without overlap
  SELECT MAX(nresprodtime*(1-nrespcntover)/nresprodpcs) as ControlTime;
  FROM rcm!resources;
  WHERE Resources.cprojid = lcCurrentProjectID;
      AND Resources.caltid = lcCurrentAlternativeID;
  GROUP BY Resources.ngroup;
  into cursor lnControlTime

* Combine the controlling sequence time and the largest individual resource time for an alte
  select sum(controlTime);
  from lnControlTime;
  union;
  SELECT MAX(Resources.nresprodtime/nresprodpcs);
  FROM rcm!resources;
  WHERE Resources.cprojid = lcCurrentProjectID;
      AND Resources.caltid = lcCurrentAlternativeID;
  into cursor lnControlTime
Object Linking & Embedding

- RCM - Graphing Need
- Third-party objects
- Advantages
  - Faster development
  - Better quality
Alternative Comparison

Resource Cost Model for Process Design

Data | Plotting | Cost | Time | Utilization | Summary

Average Part Cost ($) vs Production Volume

Proj: Should the tandem or single torch robotic system be purchased? for Selected Alternatives

Tandem Torch Single Torch Manual Welding

R. Jerz

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3/19/01
Resources Selected

Average Part Cost($) vs Production Volume
Proj = P3, Alt = Tandem Torch, Selected Resources

Average Part Cost($) vs Production Volume

Average Part Cost($) vs Production Volume
Proj = P3, Alt = Tandem Torch, Selected Resources
Alternatives Time Comparison

Total Time (hrs) vs Production Volume

Proj: Should the tandem or single torch robotic system be purchased?, for Selected Alternatives

- Tandem Torch
- Single Torch
- Manual Welding

Production Volume vs Total Time (hrs)
Conclusions

- RCM modeling very difficult w/o tools
- Graphic environment standard
- OOP improves programming efficiency
- Databases understanding is valuable
- Third-party controls are important
- IE’s command of tools provides research advantages