CIS-Carbon Footprint Evaluation and Improvement in Production Line

Advisors:
Professor Yiming Rong
Professor Lingsong He
Ms. Wang

Team members:
Tyler Lapierre  Manny Cambra
Liang Ma       Liu Keyan
Zhenlin Qin

16 September 2011
Outline

* Introduction
  • Background
  • Problem Statement
  • Goals & Objectives
  • Work steps

* Carbon Footprint Evaluation
  • Calculation Steps
  • Final result

* Optimizations

* Conclusions & Acknowledgement
Background

Carbon footprint: The total amount of greenhouse gases produced to directly and indirectly support human activities, usually expressed in equivalent tons of carbon dioxide (CO2).
Background

CIS is a global solutions provider specializing in electro-mechanically integrated solutions for a wide variety of industries.

Products

Clients
Background

- Actual production conditions of CIS:

- **F₁:** Stamping accessories & supports
- **F₂:** Die design & manufacturing & maintenance
- **F₃:** Rolling & Stamping production line
- **F₆:** Bought-in components & production goods assembling
Problems Statement

✓ How to figure out the relationship between the energy consumption and carbon emissions.
✓ How to calculate the carbon footprint of one specific product.
✓ How to optimize the machines or the production line to lower the emission of carbon footprint.
Goals & Objectives

✓ Goals

• Aiming at Dell 2U production line, make the statistical analysis and detailed evaluation of the carbon emissions for the entire production line.

• Aiming at one machine or one process flow in above production line, optimize the machine or the production line to reduce carbon emissions with low cost.

✓ Objectives

• Create concrete formula to measure the production lines, do the measurement and calculation.

• Analyze the result and identify the weakest link in production line

• Redesign system or device (line level or machine level) that limits carbon emissions.
Work Steps

1. Target of study
2. Understand the entire production process
3. Evaluate the carbon footprint of DELL-2U
4. Optimize DELL-2U production line to get lower CFP
Carbon Footprint Evaluation

• Calculation Steps:

1. Establish production process map.
2. Determine the system boundary.
3. Get the formula to calculate CFP.
4. Collect data.
5. Calculate carbon footprint.
Production Process Map

Colored parts are what we focus on

Huazhong University of Science and Technology - Worcester Polytechnic Institute
Formula: \[ E = \sum_{i=1}^{n} Q_i \times C_i \]

- \( E \) is the product’s carbon footprint.
- \( Q_i \) is the number or intensity data (mass/Kwh) of substance.
- \( C_i \) is the unit of carbon emission factor (\( CO_2 \) eq/unit).

Data collecting: 

<table>
<thead>
<tr>
<th>Station</th>
<th>Parts Made</th>
<th>Stamps per minute</th>
<th>Time per stamp(s)</th>
<th>Rated Power(kw)</th>
<th>Working Power(kw)</th>
<th>Holding Power(kw)</th>
</tr>
</thead>
<tbody>
<tr>
<td>M-20</td>
<td>10</td>
<td>10</td>
<td>4.5</td>
<td>37</td>
<td>42.53</td>
<td>0</td>
</tr>
<tr>
<td>M-30</td>
<td>13</td>
<td>13</td>
<td>0.82</td>
<td>7.5</td>
<td>8.62</td>
<td>1.04</td>
</tr>
<tr>
<td>M-40</td>
<td>15</td>
<td>15</td>
<td>0.55</td>
<td>4</td>
<td>4.6</td>
<td>0.61</td>
</tr>
<tr>
<td>M-50</td>
<td>13</td>
<td>13</td>
<td>0.62</td>
<td>4</td>
<td>4.6</td>
<td>0.61</td>
</tr>
<tr>
<td>M-60</td>
<td>10</td>
<td>10</td>
<td>3.63</td>
<td>1.5</td>
<td>1.72</td>
<td>0</td>
</tr>
<tr>
<td>M-70</td>
<td>11</td>
<td>11</td>
<td>5.45</td>
<td>0.58</td>
<td>0.67</td>
<td>0</td>
</tr>
<tr>
<td>M-80</td>
<td>16</td>
<td>16</td>
<td>0.55</td>
<td>4</td>
<td>4.6</td>
<td>0.61</td>
</tr>
<tr>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
</tr>
</tbody>
</table>

eg: 1L gas * 2.357 kg/L = 2.357 kg
Conclusions:

- Raw material takes the largest part
- Transportation: too small ratio to be considered
- Focus on the parts producing, packaging and environmental consumption
Parts producing

- The machine is always on, while only part of the time is meaningful
- Take the stamping machine for example
The difference between the three CFP value comes from the difference in holding time.

The CFP in parts production can be greatly decreased.
Parts producing

- The difference between the three CFP value comes from the difference in holding time.
- The CFP in parts production can be greatly decreased.
Problem:
The holding time is long, during which the machine consumes electricity but don’t make a difference.
Solution:

- Change or redesign the inefficient machine
- Design a feeder
- Redesign the hand tool used by workers
### Optimization: replace 45T stamping machine

<table>
<thead>
<tr>
<th>Type</th>
<th>Working current (A)</th>
<th>No-load current (A)</th>
<th>Force (KN)</th>
<th>Die height (mm)</th>
<th>Height adjustment (mm)</th>
<th>Motor power (KW)</th>
</tr>
</thead>
<tbody>
<tr>
<td>OCP-45N</td>
<td>9.6</td>
<td>5.4</td>
<td>450</td>
<td>240</td>
<td>60</td>
<td>5.5</td>
</tr>
<tr>
<td>JE21-40C</td>
<td>7</td>
<td>1.1</td>
<td>400</td>
<td>270</td>
<td>60</td>
<td>4</td>
</tr>
</tbody>
</table>

**Problem:** the no-load current of OCP-45N is large, thus consuming more electricity but making no difference.

**Suggestion:** replace the OCP-45N with JE21-40C

**Proof:** the force and die height of JE21-40C can meet the requirement of stamping.

**Purpose:** save electricity and reduce carbon emissions
Basic idea:

• Feeder feed stamping machines
• Feeder transfer between machines

M-100

M-110
Optimization - feeder

- Cylinders drive
- Height difference compensation
- PLC, travel switch and iron block control
- One operator
Efficiency analysis

- The feeder cost no more than 100k RMB
- Cost of worker: 2000 per month
- Electricity price: 0.8/kwh
• A device that helps load the 80T machine and others like it.

• NOTICE due to its low clearance the second part can’t be placed in efficiently (seen in video).
• The design is a four bar linkage on a piston that accurately place the parts into the machine.
Optimization - hand tool
Advantages of paper mould:

- The price is lower than EPS foam, for its main raw material is waste paper.
- The process is environment-friendly, it is recyclable and easy to break.
- The size is smaller than EPS foam and it can be placed overlapping to save space and transport costs.
- With good shock protection.
**Problems:** water and dust depositing in main air pipe directly get into the intake manifold
- Water makes machines easy to rust. Oil mixed with water will reduce the lubricating effect, increase wear of machines and shorten the life of machines.
- Dust may block up air valves, increase air flow resistance and wear of machines.

Damage to the machine extend the production time, resulting in an increase in carbon emissions, on the other hand increase maintenance costs.
Using the connector above decreases the amount of water and dust from getting into the intake manifold. This reduces the failure rate of machine and electricity consumption, thus reducing carbon emissions of product.

**Suggestion:** Connector up
**Function:** blow away saponification liquid on the slides

**Problem:** air flow quantity can only be determined by the main airway, it can not be adjusted according to the actual production conditions, such as producing big, medium, or small ones.

**Suggestion:** install adjustable throttle valve before the outlet

**Purpose:** adjust the air flow quantity according to actual production conditions

**Price:** 10~100 yuan
Suggestion: remove the air pipe not in use or install valve at the joint to shut off the air flow.

Purpose: reduce the gas leakage caused by these useless pipes, thus reducing electricity consumed by air compressor and carbon emissions.
Problem:

✓ No-load time: working time is 20:1
✓ If one can not work, some stamping machine must stop working
✓ Extend the production time and waste energy

Suggestion:

✓ Purchase one more air compressor to make them work by turn
1. After the measurement and calculation, we get the carbon footprint of DELL-2U: 8301.0g per pair.

2. We focus on the parts producing, packaging and environmental consumption for optimization, including:
   - 45T stamping machine replacement;
   - Automatic feeder designing;
   - Magnet hand tool updating;
   - Packaging material updating;
   - Air pipe/outlet valve optimization;
   - Air compressor.
Sincere thanks to CIS for the cooperation.

Acknowledge the support from Ms. Wang at CIS

Thanks for the help from Prof. Tang, Prof. Li and Prof. Chen at HUST.

Special thanks to Professor Rong and Professor He for their valuable guidance and support.
Questions?