IPRO 330 - Operator Information Tool to Manage Heat Treat Furnace Parts for A. Finkl & Sons

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Outline

• Problem description
• Furnace evaluation
• Software solutions
• Conclusions
• Future work
The Problem

• The tempering process
  – Production bottleneck
  – Some parts not up to specification
  – Furnace stacking is suspected to be the cause

• Stacking records: “pen and paper” method
  – Not effective
  – No way to correlate configuration with failures
Project Objectives

• Furnace Analysis:
  – Why do certain piece not achieve proper hardness after heat treatment?
  – Are the failures systematic?

• Software Development:
  – Better record keeping
  – Individual piece tracking
Problem solving approach: Furnace Analysis

• Furnace survey:
  – Empty furnace
  – Loaded furnace
• Furnace temperature range specification
• Characteristic temper curves for specific steel alloys
Problem Solving Approach: Software Solutions

- Currently available software solutions
- Potential development kits
  - OpenGL
  - VTK
  - ACIS
- Foreseeable snags
  - Collision detection
  - Database interfacing
Furnace Survey Overview

- Furnace surveys were performed to determine the temperature distributions in the tempering furnaces.
- Surveys were performed both in an unloaded and loaded furnace.
- Approximately 20 thermocouples were used for each survey.

![Diagram of Furnace](image)
Temperature Distributions

Unloaded 1100°F Set Point

- 1125 °F
- 1120 °F
- 1115 °F
- 1110 °F
- 1105 °F
- 1100 °F
Temperature Distributions

Loaded 1150°F Set Point
Shelldie® Tempering Curve

BHN vs. Tempering Temperature for Shelldie

Brinell Hardness [kg/mm²] vs. Tempering Temperature [°F]

Tempering Temperature [°F]

BHN vs. Tempering Temperature for Shelldie

Brinell Hardness [kg/mm²]
Furnace Survey Conclusions

- Temperature distributions in both loaded and unloaded furnaces are acceptable.
- Air temperatures near the floor are cooler in a loaded furnace, however part temperatures are still relatively even.
- The firing lanes are typically hotter than the loading zone volume.
- Parts must be loaded completely within the loading zone.
Development Tools

• C++
• MFC (Microsoft Foundation Classes)
• VTK (Visualization Toolkit, www.vtk.org)
• OpenGL (www.opengl.org)
• Codejock Xtreme Toolkit (www.codejock.com)
• Microsoft Visual Studio 2003
• Collision Detection Engine by University of North Carolina (www.unc.edu)
• VTK Routines by Cineca, Italy (www.cineca.it)
Achievements

- ≈8000 lines of code
- Commercial grade application
- Fast scene rendering with per pixel lighting, normal mapping, specular highlighting
- State of the art collision detection
- HTML rendering engine
- Minimal system requirements
- Platform independence
Conclusions

• Furnace Survey
  – Furnace #30 was fine
  – Only tested 1 of several furnaces
  – Only tested 1 stacking set-up

• Software’s benefits and limitations
  – Represents actual stacking in 3-D
  – Replaces old hand-written files
  – Currently, only able to create simple shapes

• Groundwork for final solution has been laid
Future IPROs

• Portable Handset Display
  – Palm or Tablet PC
  – Run stacking software quickly and easily
  – Real-time capabilities

• Enhance Shape Data Base
  – Predefine all components
  – Interface with existing database
  – Improve current collision detection
Future IPROS

- **Furnace Testing**
  - Survey more furnaces (empty and loaded)
  - Evaluate different stacking sequences
  - Change location of control thermocouples

- **Statistical Analysis of Temp. Ranges**
  - Limit temp. ranges for different grades
  - Construct temper curves

- **Bar Coding Blocks**
  - Withstand harsh environments
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Question & Answer