HEAT TREATMENT MAXIMIZATION SOFTWARE

AN INFORMATION TOOL FOR THE METALS INDUSTRY

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1. THE BACKGROUND

Heat treatment of metal is the process by which thermal energy is added to a metal in order to alter its properties. Some of the most common heat treatments include aging, annealing, quenching, and tempering. Changes in the heating/cooling rates, the treatment temperature, and the duration of the treatment all result in changes in the properties (hardness, strength, ductility, etc.) of the final product. Heat treatments are often batch processes and are a point of congestion in manufacturing.

A. Finkl & Sons is the world's leading supplier of forging die steels, plastic mold steels, die casting tool steels and custom open-die forgings, processing over 100,000 tons of steel each year. Finkl extensively uses batch heat treatments in their manufacturing process

2. THE ISSUE

As a result batch size limitations, Finkl experiences a production bottleneck at the heat treatment stage of their operation. Optimizing the heat treatment process requires loading the maximum amount of steel per batch. What parts can be loaded is dependent on what parts are physically available in the heat treatment area Since most part shapes are custom and non-uniform, the loading process is difficult for operators and batch size suffers. Years of experience and trial-and-error techniques are the only tools available to assist in load design and part placement.

3. THE CHALLENGE

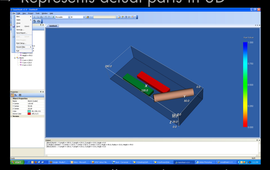
To develop a software solution capable of optimizing the heat treatment process at A. Finkl & Sons.

The software must be capable of:

- Maximizing batch size
- Outputting the best loading pattern based on:
  - Available parts (in heat treat area)
  - Work order priority
- Functioning with Finkl's work order database
- Utilizing files output by popular CAD packages such as ProEngineer or UGS
- Accepting upgrades developed by future IPROs that could include:
  - Migration to a handheld device
  - Thermodynamic modeling functionality

4. THE PAST WORK

- IPRO 330 -Spring 2006 and AutoStack Software
  - Strengths:
    - ➡ Represents actual parts in 3D



    - ➡ Adequate collision detection between multiple parts
    - ➡ Laid the foundation for our solution
  - Weaknesses:
    - ➡ Non-solid, planar modeling (hollow representation with incomplete data about total part)
    - ➡ Difficult user interface
    - ➡ Incompatible with Finkl work order database
    - ➡ Incompatible with CAD Packages
    - ➡ Difficult to upgrade functions

5. THE CURRENT GOALS

1. Reconstruct the AutoStack Software in order to eliminate the points of weakness, thus allowing development of a fully functional solution.

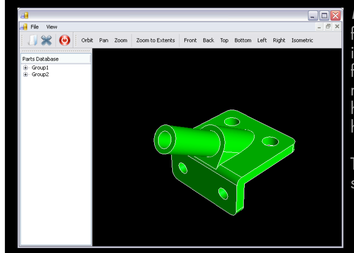
2. Construct a template portfolio of files representing actual Finkl parts, modeled with ProEngineer, that are compatible with the the existing Finkl work order database (an SQL database)

6. THE TOOLS

Various technologies were employed in the reconstruction of the program and the development of the part templates for use in the work order database.

- Software development
  - Microsoft Visual Studio
  - Qt
  - HOOPS 3D Application Framework (Graphics Engine)
  - 3D ACIS Modeler (3D Modeling Engine for CAD/CAM)
- Management of Software Development
  - TRAC Project Management
  - Subversion (Central source code repository)
- Part Template Development
  - ProEngineer
    - ➡ Wildfire 2.0

7. THE SOLUTION



HeaTreat The software solution created by IPRO 304-A represents the achievement of the first goal of the semester. The HeaTreat environment, seen at left, utilizes fully solid 3D modeling with a simple, but effective user interface. HeaTreat is fully compatible with ProEngineer files and the Finkl work order database. Since the HeaTreat environment utilizes fully solid modeling and part files compatible with ProEngineer, thermodynamic modeling of the entire heat treatment furnace is only a step away. The growing trend of increased power of handheld computers suggests a complete migration to a handheld device is nearly within reach.

The template portfolio of actual Finkl parts has also been completed. The images below represent actual Finkl parts available for purchase.

8. THE ETHICS

The development of the HeaTreat program required several software packages. Each package is licensed for use as an educational tool or for developmental purposes. The User Agreements of these licenses forbid commercial use or sale of their respective programs. As such, before delivery to a Finkl, IPRO 304-A and any future IPRO teams must inform A. Finkl & Sons of the steps they must take to secure official legal licenses for the components of the HeaTreat software, as well as pay any required royalty fees. Additionally, some tools utilized by IRPO 304-A are open source programs – the original source code must be attached to the program and made freely available.

9. THE FUTURE

Using the solution developed by IPRO 304-A, students in upcoming IPROs can successfully address the remaining challenges:

- Complete a comprehensive shape database
- Maximizing batch size
  - Use the Maximum Volume Principle currently utilized by cargo shippers to maximize load size
- Migration to a handheld device
- Thermodynamic modeling functionality

Thanks to the robust capabilities of solid-modeling, the HOOPS Application Framework and the 3D ACIS Modeler, adding functionality to the software will be much faster and easier than adding to the AutoStack Software previously developed.

10. THE ACKNOWLEDGMENTS

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  - Sean McCann (Project Engineer) - Primary Liaison with Finkl
  - The Metallurgy Staff
  - The IT Staff
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- Spatial Corp. - Educational Licensing for 3D ACIS Modeler and HOOPS 3D Application Framework
- IPRO 330 (Spring 2006) - Taking the for steps towards a fully functional solution.

IPRO 304-A

A. Finkl & Sons Co.

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