

[REDACTED]

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To the Faculty:

The attached report contains information and results of the Wind Turbine Design Project and is being submitted for evaluation. A majority of the report outlines the team's design process throughout the duration of the project and includes a technical description of the final design. Final lift results and the performance ratio of the crane are also discussed within this document.

The final report pertaining to the Hoistinator Design project provides an assessment and analysis of the team's success. Strong design rationale as related to the truss structure and plastic optimization is demonstrated in this report. Three successful lifts were conducted and a final performance ratio of [REDACTED] was achieved. The final design was cost effective while retaining the capability to lift [REDACTED]. In comparison to competing designs our team had the [REDACTED].

For any questions or comments about topics mentioned within this report, you can reach [REDACTED] or [REDACTED] through email at [REDACTED] or [REDACTED], respectively. Thank you to all engineering and writing faculty whose assistance and knowledge has allowed our team to reach such a high level of achievement.

Sincerely,

\_\_\_\_\_  
[REDACTED]


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[REDACTED]

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[REDACTED]

# The Hoistinator Design Project

Team 

  
Sophomore Engineering Clinic I, Fall 2006

Section 

Professor Wolff

due date

## Executive Summary

The objective of the Hoistinator Design Project was to develop a successful truss structure that maximized the load it could support, while minimizing the cost of materials. The substructure to which the truss was attached is shown in Figure 1. Originally, three families of trusses were developed as shown in Figure 3, 4, and 5. Force calculations of each member are given in Tables 1, 2, and 3. Uneven distribution of forces from the load across members led to the decision to discard the first truss family. High cost of materials eliminated the second truss family as a design possibility (Appendix I). The third family was chosen for optimization due to its relatively low cost and potential for optimization.

Initial optimization involved redefining angles, lengths, and flipping the structure vertically. Figure 2 shows the final product while attached to the I-beam after optimization. Each member of the design was fully defined by evaluating theoretical equations to determine the length, width, and material. Only pin connections, aluminum alloy 2024-T3, and TIVAR UHMW (ultra-high molecular weight) plastic were used in the assembly of the truss structure described in the Final Design section. Cost of the aluminum alloy was set to \$3 per kilogram. Cost of plastic was a parameter the team was responsible for decreasing in order to further optimize the truss structure. Through optimizing the plastic manufacturing process the final cost of plastic was reduced to \$0.7150 from \$1.42. Appendix N describes the method used to lower the cost of plastic.

Development of the truss structure and supports applied mathematical modeling based on Statics and failure analysis of pin connections. Lateral movement was canceled through the design of diagonal cross-brace supports. Found in Figures 13 and 14 are the two lengths of diagonal cross-bracing. Supports for the base, shown in Figure 15, of the I-beam were also

created to cancel out the moment caused by the sum of the forces acting on the complete structure.

A strong foundation in Statics and failure analysis was needed to ensure successful lifts of three loads on the final lift day. Calculations in Appendix B done by the team predicted a maximum lift of ##### lb<sub>f</sub>. Performance of the crane exceeded expectations raising loads of ##### lb<sub>f</sub>, ##### lb<sub>f</sub>, and ##### lb<sub>f</sub> on the day of evaluation. Total cost of the structure with base supports was \$##### which gave the truss a performance ratio of #####. This ratio attained by the team was the second highest value of cranes, from Appendix W, that lifted on December 11, 2006. Construction of the design produced a structure different than what was planned through incorrect calculations in regards to the shorter plastic members. One of the aluminum alloy members was not parallel to the horizontal as intended. The assembled structure obtained a higher performance ratio than the predicted value of ##### (Appendix V). Strain gauge readings obtained during the initial lift of ##### lb<sub>f</sub> allowed the team to calculate the failure load for the truss and proved to be instrumental. Results from strain and failure calculations in Appendix S indicated a load of ##### lb<sub>f</sub>, greater than the maximum available on the final lift day. This ensured the team that the crane could successfully support ##### lb<sub>f</sub> despite the miscalculation of member lengths. Optimization of the third design family was successful based upon the ##### lb<sub>f</sub> lift and minimized the cost of the structure compared to competitors' designs (Appendix W).

## **Acknowledgments**

The team would like to express appreciation for the contributions made by the Sophomore Engineering Clinic Fall 2006 faculty and additional personnel throughout the Hoistinator Design Project. The engineering faculty includes Dr. James Beard, Dr. Eric Constans, Dr. Donald Dahm, Dr. William Ridell, and Dr. Paris Von Lockette. Lectures given by the afore mentioned include a strain gauge demonstration, introduction to Statics, concepts within the project, plastic manufacturing process, failure analysis of pin connections, and computer program tutorials. These lectures have built the foundation from which the team has been able to successfully optimize a truss structure. The team would like to specifically recognize Dr. Constans who was readily available to answer questions and help with any difficulties that were encountered. In addition to the engineering professors, Dr. William Wolff, Mr. Chuck Linderman, and Mr. Aaron Nolan have been instrumental in the advancement of the project goals. Dr. William Wolff has assisted with all writing tasks and has helped the team flourish in their technical writing skills. Mr. Linderman has provided an introduction to project lab equipment including the milling machine, shear, horizontal saw, and vertical saw. Without knowledge of this equipment the team would have had great difficulty machining the truss materials. Team members were assisted in the actual application of the strain gauge by Mr. Nolan. The team would like to express additional gratitude to all faculty not mentioned specifically by name.