



GEORGIA INSTITUTE OF TECHNOLOGY

The George W. Woodruff
School of Mechanical Engineering

Ph.D. Qualifiers Exam - Spring Quarter 1998

Design
EXAM AREA

Assigned Number (DO NOT SIGN YOUR NAME)

- Please sign your name on the back of this page—

Please print your name here.

The Exam Committee will get a copy of this exam and will not be notified whose paper it is until it is graded.

George W. Woodruff School of Mechanical Engineering
Georgia Institute of Technology

DESIGN QUALIFYING EXAM

Spring 1998

We are interested in learning what you know and your ability to reason in the formulation and solution of design problems. If you find the question or any part of this exam confusing, please adjust the question, explicitly rephrase it, and state your assumptions.

Read the entire exam first. Allocate your time carefully so that you cover all three parts of the exam: Realizability, Analysis, and Methods.

ORALS

We will conduct the oral exam by first giving you the opportunity to state how design fits into your research activities. If you do not do an adequate job on this written exam, we may ask you to discuss it during the oral exam.

THE PROBLEM

Your goal is to design a system to clean the white boards at the front of a typical Georgia Tech classroom. Cleaning is to be done on the demand of the instructor, and can occur during class.

You have been hired as a consultant to determine the feasibility of developing such a white board cleaning machine. The system should be reliable, quick, unobtrusive, and inexpensive. It should clean the entire board.

Note, some classrooms have two boards next to each other. You need to deal with the cleaning of one of these at a time; you do not need to make provision to clean both with one system, although you can if you like. For example, the professor might be writing on one board, while having the other cleaned. It should be easily activated or operated by a typical Georgia Tech professor. Any form of energy typically available in the classroom can be used, no other forms can be brought in.

Realizability

- a) *Meet customer needs:* Develop an initial set of design specifications for the board cleaner. Develop a function structure for your system. Show how your functions can be grouped into subsystems. Define the interfaces between your subsystems in terms of material, energy, and signal/information flows.
- b) *Select concept for further development:* Select the key subsystem and generate 3 concepts for it. Identify the physical principle upon which each is based. Identify the criteria upon which you will select a concept for further development. Select a concept for further development.
- c) *Preparation for engineering analysis:* Provide a layout sketch of your design and label the main components and modules. (Note: we are looking for your ability to embody your conceptual ideas, not for a comprehensive design. We are looking for enough detail to answer Step (d).)

Engineering Analysis

- d) *Dimensioning:* Take any component of your system. Outline your approach to developing an appropriate analysis model for this component. Include equations and a free-body diagram.

Method

- e) Critically evaluate your design process (Steps a through d). If you had two weeks, instead of two hours, what would you have done differently, and why? Ground your response in a recognized approach to design (e.g., Pahl & Beitz, the Decision Support Problem Technique, etc.).