

INVESTIGATING THE DESIGN, MANUFACTURE, AND ENGINEERING OF HARD DISK DRIVES

Introduction

Today's hard drives cost less than a pair of sneakers, yet they are high-precision, high-speed, high-reliability devices capable of storing the equivalent of over 150 million pages of text. They spin at speeds up to 15,000 rpm, three times the speed of most automobile engines. The read/write heads literally fly only a few microns above the surface of the spinning platters and can be moved into position with micron accuracy within a only a few milliseconds. They are also small, as small as inch across, which is almost amazing considering that only 20 years ago they were 17 inches across, weighed over 30 pounds, required half a kilowatt of power to operate, but could store only 5,000-10,000 pages of text, for the tidy sum of \$4,000 to \$10,000.

How better to learn more about how these electro-mechanical wonders work than to take one apart. And how better to figure out how each part was made and how the whole thing was assembled than to examine each part, note the materials used, try to determine if it was machined, or cast, or pressed into shape, or how the electrical components were attached to the circuit boards. Also, by taking a hard drive apart one can gain a better appreciation for how the whole thing was mass produced, how this high-precision and high-speed were married to low cost. And once you think you understand how the hard drive was made, try reassembling it.

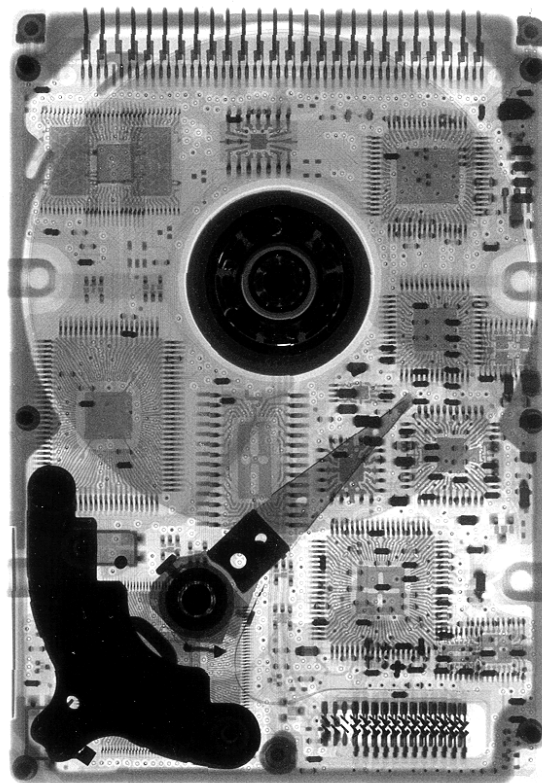


Figure 1 X-ray radiograph of a 2³/₄-inch hard disk drive.

Finally, what do we know about the people who design and manufacture devices like this? What about the science, the fundamental knowledge, required to develop the multiple coatings on the platters, or the tiny read/write heads? What about the design of each component? What about the stress and strains on mechanical parts, or the inertia involved in quickly positioning the heads to the selected track, the incredibly precise timing involved in reading and transferring the data from the spinning disk, to the data buffers, and to the computer's memory, and all the other techniques employed to ensure that hard drives virtually error free for 5, even 10 years or more of service.

In this activity we will take apart a hard drive, examine its parts, and consider how it was mass produced. We will also think about the skill and knowledge required to design and manufacture them, with special attention paid to the roles of different engineering disciplines involved.

Objective

Gain a better understanding of the design, manufacture of hard disk drives, and role of various engineering disciplines in producing these devices.

Equipment and Materials

- Hard drives, one for each student.
- Stereo-zoom microscope for examining the smaller parts.
- Basic hand tools, such as screw drivers, torx drivers, pliers, needle nose pliers, small wrenches.
- DC power supply, use to power up the hard drive to see if the platters spin.

Procedure

- Carefully and methodically disassemble your hard drive.
- Examine each part, from the tiny screws to the larger motors and platters. What material was it made of, and why? How was it made? Which engineering disciplines were involved in designing and making each part?
- Make a sketch showing how the major parts went together (an assembly drawing).
- If time permits, try reassembling your hard drive. Do you have any parts left over?

Analysis

1. Select one part from your hard drive and describe its function, what it was made of, and how you think it might have been made.

2. Identify a component, subsystem, process or fundamental principle that an engineer or scientist in the following disciplines would have made a major contribution to:

Materials _____

Mechanical _____

Electrical _____

Computers _____

Physics _____

Chemistry _____