Task: In a group of two, you will dissect an “Oral-B CrossAction Power” electric toothbrush with replaceable battery and inspect and partially dissect a “Crest SpinBrush PRO-CLEAN” electric toothbrush with replaceable batteries. You are required to take the products apart (as far as possible without breaking them), sketch them, determine how they operate, and reassemble them so they work. Additionally, an “Oral-B CrossAction Rechargeable” electric toothbrush will be passed around during the studio period.

Materials: 1 - Oral-B CrossAction Power electric toothbrush (undissected); 2 - Crest SpinBrush PRO-CLEAN electric toothbrushes (one dissected, one undissected). Note: as of August 2006, the price of both types of toothbrushes is $6.89. 3- Oral-B CrossAction Rechargeable electric toothbrush (undissected). Note: As of January 2007, the price of the rechargeable Oral-B is $12.84.

Tools: Screwdriver, ruler, roll of tape

Before starting, read Guide to Mechanical Dissection and the Teardown articles. When performing this studio keep a record of how you dissect the product, so that you can reassemble the device and make it work. You should sketch the parts as you remove them and the manner they relate to one other. Digital photos are not acceptable for your written report, so it is best to make hand sketches. You may wish to label each part with a piece of tape.

Procedure for Mechanical Dissection

- Observe the operation of the device and define its functional specifications.
- Hypothesize about what mechanisms make the device work.
- Dissect and study the inner workings of the device.
- Compare to predictions and look for suggestions for improvement and redesign.

Dissection Guide: The following will guide you in what to look for when you take apart the electric toothbrush. As you proceed with your dissection, please keep the following in mind:

- Keep a good record of what you are doing.
- Keep track of all the parts and update a bill of materials as you go along.
- Be as specific as you can with function and material.
- Make sure you understand how the internal parts work.

Dissection Steps: These refer to the Oral-B toothbrush, unless otherwise noted.

1. Operate the device
   Observe the sequence of operations to make it work.
   What indicates how to operate the device? Are they clear?
   Observe how it works.
   Sketch the brush / brush head motion(s)
   List the customer needs and engineering specifications.
   List the sequence of operations and determine the overall function, required inputs, and outputs of the system (i.e., treat the device as a Black Box).
2. Take off the brush head carefully – (do not disassemble the brush head)
   How did you get the brush head off? Was it easy to remove? Is the brush head meant to be replaceable? How do you know? Is this obvious without consulting the directions?
3. Operate the device without the brush head attached
   What do you see happening?
4. Remove the bottom of the device by unscrewing it
5. Remove the battery
   Observe how the device tells you which way to put in the battery.
6. Remove the battery/motor subassembly – Do not disassemble the subassembly
   How did you remove the subassembly? Why are the snap fits located where they are?
7. Put the battery back in the battery/motor subassembly
8. Operate the subassembly
   Record your observations about its operation, turning on/off, etc.
9. Remove the “see-saw” switch
   What happens?
10. Remove the battery
11. Bend the motor out a bit to get a good look at it. Do not disassemble the subassembly.
    What markings do you see on the motor? Notice the lack of wires – why? What replaces them? Why?
12. Remove the metal shaft – Do NOT remove the white plastic part from the shaft.
    How did you do this?
   Compare the drive mechanism of the Oral-B toothbrush that you dissected to that of a Crest toothbrush. Do NOT disassemble either of the dissected or undissected Crest toothbrushes.
   Operate the Crest SpinBrush PRO-CLEAN electric toothbrush and observe its operation. Observe the operation of the subassemblies provided. You may non-destructively take apart the complete Crest toothbrush. Untwist the Crest toothbrush head to remove and replace it. A schematic of the drive train of the Crest toothbrush is shown in figure 12 of US patent #6,932,216. For the purposes of this studio, the drive mechanism is defined as from the motor all the way to the brush bristle holders (the plastic parts into which the bristles are inserted), inclusive.
   Compare the Oral-B battery electric toothbrush with the Oral-B rechargeable toothbrush. What differences are there? Why? How does this toothbrush get recharged? What design feature ensures that the toothbrush will sit correctly in its charger?

Reassembly: Put the toothbrushes back together so that they operate correctly. Note: the Oral-B toothbrush goes together easier with the battery removed.

Topics to address as part of your report:
   Describe how the Oral-B toothbrush operates: Describe how its subassemblies operate together to produce the toothbrushing action. Describe the interactions and interfaces between the subassemblies.
   Suggest how the Oral-B toothbrush subassemblies are assembled. Be sure to consider the symmetry/asymmetry of the components. Suggest how the subassemblies are assembled into the final assembly. Suggest ways to modify the product’s design to improve the assembly processes. Suggest ways to reduce the number of components and subassemblies.
   Are there screws in the Oral-B toothbrush? Are there screws in the Crest toothbrush?
How often will the Duracell AA MN1500 battery in the Oral-B toothbrush need to be replaced (days)? Is this a reasonable amount of time? Compare your answer to the battery change interval given in the Oral-B toothbrush insert. Discuss. (We are looking for you to perform calculations using equations, as well as finding the answer in a look up table or figure - discuss your two answers and their accuracy.) See studio web page for additional, useful information.

Compare the drive mechanism of the Oral-B toothbrush that you dissected to that of the Crest electric toothbrush. Do both toothbrushes produce the same brush / brush head motion(s)? Discuss the difference in the drive trains and the resulting brush motions. Which is superior from a manufacturing/assembly standpoint? Which do you consider a better design?

Compare the original and rechargeable Oral-B toothbrushes. Given the price increase for the rechargeable toothbrush and the cost to replace batteries, when can the consumer expect to break-even with the more costly toothbrush? Base your answer on your battery life calculations and estimates of toothbrush life. Do you think it is worth the extra cost for the consumer?

**Deliverables due at the end of the studio:**

1. Reassembled, working product
2. Tools
3. Cleaned up work area

**Deliverables due at the beginning of studio the following week:**

1. Report containing nominally dimensioned sketches, explanations, and observations. Reports should include a maximum of three pages of writing, plus any number of figures and tables. See specific details below and the outline on the final page of this document.
2. Completed studio team evaluation form.

**Text:** Describe the toothbrush rather than how and what you learned by doing the assignment. Be straight-forward in your writing and just describe the toothbrush, leaving out any opinions on what a wonderful product it is or what a terrific job the toothbrush designers did, unless specifically asked. At a minimum, include a paragraph on function, one on materials, one on assembly processes, and one or two on the additional questions you have been asked to answer. Be sure to reference your drawings and bill of materials.

**Figures:** Do a two-point perspective drawing (isometric view) of the un-dissected toothbrush showing as much detail as you think is appropriate (utilize phantom view to show internal parts, as necessary). Do isometric drawings of at least two other interesting parts or subassemblies.

**Bill of Materials (BOM):** A complete bill of materials for the Oral-B toothbrush using the format described in the Guide to Mechanical Dissection. Use a spreadsheet or a word processor. Use a font size which gets it all on one page. Landscape or portrait format, your choice. Be as specific as you can in identifying materials. For example, state the kind of plastic polymer, not just that it is plastic. If uncertain, tag the candidate material with “(?)” on your BOM. Be professional. Remember to organize your BOM by subassembly.

Special thanks to Prof. Will Durfee of the University of Minnesota, for the concept of this exercise and for some of the materials contained within.
Suggested report format for the dissection studio project
Description and evaluation of a design

As you prepare your report, you should first review the available instructions and examples. Then you should determine which format sections are of most importance in this project report.

For the dissection studio project, you are asked to examine and analyze a device or system. You should format your reports to present the device you examined and to evaluate its good and bad points, as reflected in the suggested outline below:

Abstract

Introduction
   State the assigned task.

Device Overview
   Illustrate, present, and describe the device that was examined.
   Describe how the device works.

Methods and Results
   Evaluate the device, explaining its strengths and weaknesses.
   Suggest changes to the design to address weaknesses.

Closing

Please submit 2 copies of this report