SP.722 (D-Lab) Spring 2005
Session #36 notes

Design for Assembly

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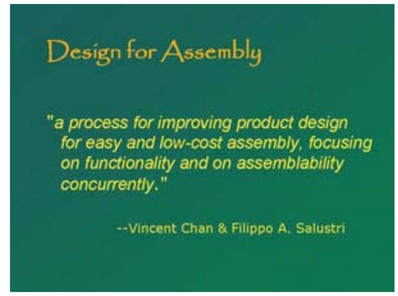

Background

When assembly is taken into account during the design process, several good things should happen. Quality and reliability are improved because there are fewer parts, and the device is simpler to put together.

In the U.S., one often tries to limit number of jobs required. This goal does not necessarily fit in developing countries. Scale may be different because transportation challenges lead you to a more decentralized manufacturing model. Finally, hand workmanship means less strict standardization (less repeatability).

Assembly methods include

- Manual assembly
- Fixed automatic assembly
- Flexible automatic assembly

What considerations affect the choice of methods? For manual assembly, the cost is fixed per unit regardless of the production volume. Fixed automatic assembly (i.e. injection molded part), the more units produced, the closer you get to just the cost of the materials (spreading fixed tooling costs and capital). Robotic or flexible assembly allows capital costs to spread across multiple uses, making cost per unit non-linear at lower volumes.

Hands-on Assembly Exercise

Groups of two students disassemble and then reassemble two items – a small keychain flashlight and a container of dental floss. How long does it take to take all the pieces apart? What's the part count? What do you notice about the way the parts fit together?

The flashlight had 18 pieces. Takes 1-5 minutes to take apart, and 6 minutes to "infinite" (i.e. parts broke during disassembly) to put back together. Note in particular the challenges posed by six very small screws.

Floss container took just a few seconds to disassemble, only 3 or 4 parts. The case has several segments, hinged, making assembly much easier. No tools needed.

What does this say about principles of good Design for Assembly:

- Connected pieces or segments
- Small parts are harder to work with
- The fewer tools required, the better
- Any clues to alignment are helpful
- Deformable parts are a problem
- Snap-fit assembly (vs. screws) reduces part count, simplifies assembly.

Design Guidelines for Manual Assembly.

Try to make it so there's only "one way" – e.g. one sequence or one orientation for things to happen. Don't hide important parts. Try to make everything self-aligning.

Jigs and fixtures for manufacturing are quite helpful. If you take care with the jig, then each manufactured part is easily made, as it inherits the quality of the jig. (Photos courtesy of DISACARE. Used with permission.)

Continuing…imagine what a pain it would be if 3 of six screws where Philips head, and 3 were slot head screws.

Loose wires are particularly prone to getting tangled during assembly.

Design Guidelines for Automated Assembly

Reduced part count: floss container used to have a separate "lid" snapped in, but that's not needed. Instead, the entire package can be made from a single hinged piece of plastic.

Ask: does one part need to move relative to other parts during actual use? If not, maybe it can be manufactured as a single segmented part.

Use the largest, heaviest part as base, and start there, so you don't have to flip it the device part-way through.

Avoiding flexible/fragile parts and precise orientation is a stronger need for automated assembly. Strive for a low center of gravity, making the object stable during assembly process.

Other DFA Suggestions

Rather than have 15 separate parts, make modules of 5 parts each and then combine the resulting three modules.

If you see several screws of different lengths in your design – can they all be the same length?

Color coding for multiple types of a part is helpful. The colored bands on electrical resistors are a classic example, but can apply to other components too.

Avoid having to reorient the assembly as you proceed; you don't want to reach around the back. And always try to eliminate fasteners.

If you can't eliminate fasteners, make sure they're accessible and your tools can get to them. Flats (flat surfaces for secure joining between components) are essential.

If orientation matters, make sure the part isn't symmetrical leading to accidental reversing.

Q: Please say more about how and why fasteners are useful, vs. eliminating them.
A: Snap fit is easier for plastic, but you can also spring-load metal for a snap-fit effect. Snap fit can be completely inappropriate if you expect the joint to be disassembled and reassembled.