# Design for Repair and Upgrade

Companion to the video: Script and Illustrations

We've looked at ways to make your product easy to disassemble so that it can be recycled and remanufactured. It turns out that making something easy to disassemble also makes it easier to repair and upgrade.

Repair is a key sustainability strategy, because it allows your products to keep living even after some of its components break or wear out. This also saves money for the consumer and reduces warranty costs for the manufacturer.

How can you ensure your products are easy to repair? Well, let's look at a laptop again.
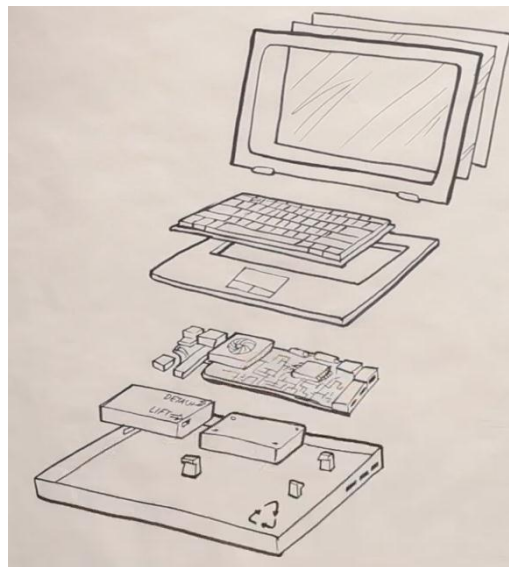

First, you need to be friendly to those who do the repairs by including good instructions. Make diagnostic tools and documentation freely available, or even open source.
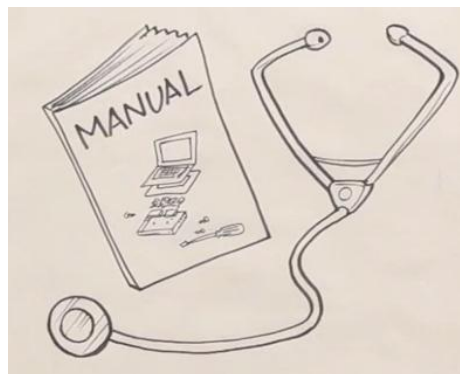
Exploded drawings and animations make great documentation. Autodesk's Inventor Publisher software can make these easy to create, and can even make documentation interactive.

It's also important to label and number your parts - and visually distinguish them wherever possible. The easier it is for people to navigate your hardware, the better.
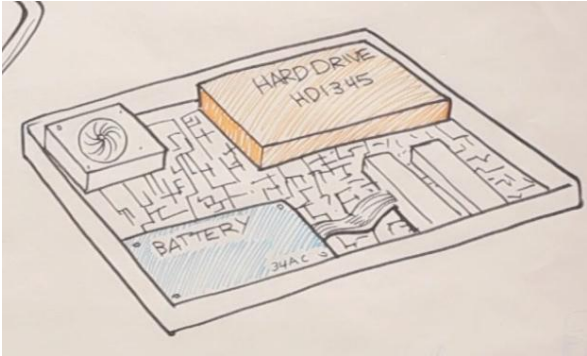
You especially want to design easy access to things most likely to break, or need replacement or maintenance -- like the battery or keyboard.
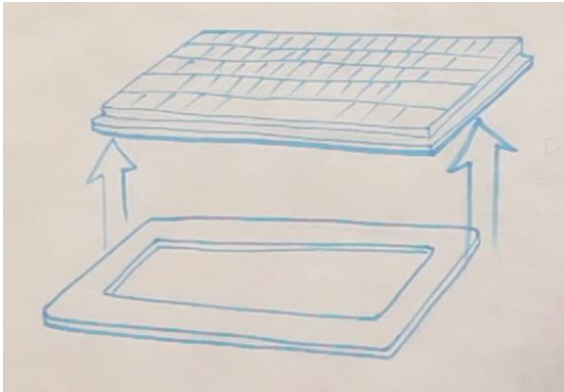

Next, you want your assemblies to be modular and to favor smaller separate components. If your user yanks on the power cord the wrong way, allow them to replace just that connection - and not have to scrap the entire motherboard too.
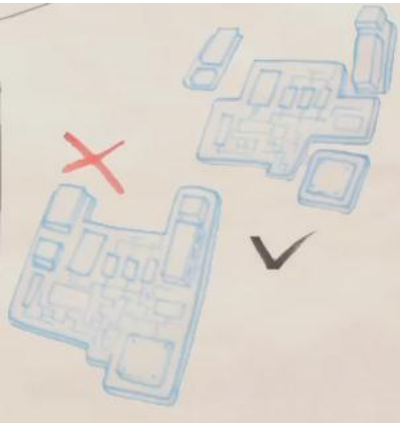
Even with the right assemblies, most products get scrapped because replacement parts are either too expensive or are too hard to find.

So design replacement parts to be reasonably priced and easily available. It also helps to standardize across models or product lines.
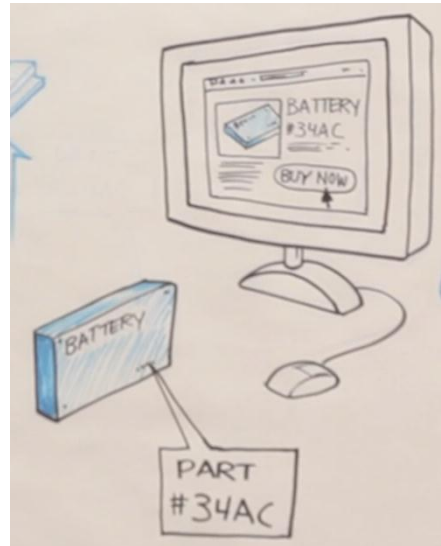

Together with disassembly, these strategies will make your product convenient and affordable to repair, which will make it more likely to stay in use and satisfy your customers longer.


No matter how easy a laptop is to repair, it's hard to keep it from becoming obsolete as new technologies roll out. Millions of pounds of fully functional electronics are scrapped every year. But you can intervene here too, by designing your products to be easy to upgrade.

The key is to make your product as modular as possible - easy for the end user to expand its functionality or swap out a component. Most computers already treat RAM this way, but you can do it everywhere.
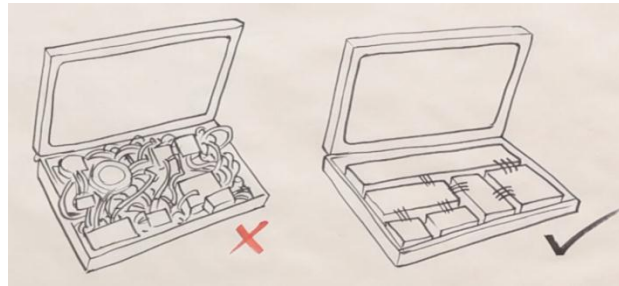
This gives users flexibility to allow for new components you can't even see coming yet.
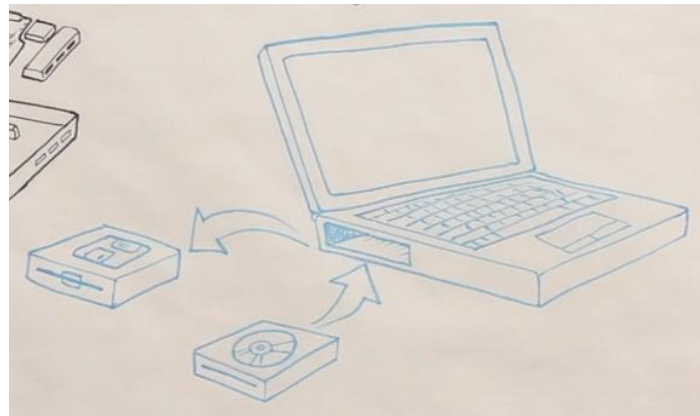
Sticking with standard connections (like USB) means you'll be able to accommodate several generations of peripherals, whatever shape they take.
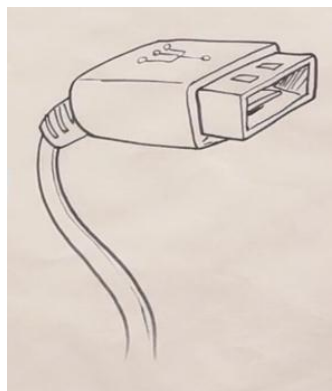
Recognize this cable here? It's an RS-232 connector. It was first used in 1962, and it wasn't until 2005 that it started disappearing due to obsolescence.

The technological landscape changes fast. These strategies will help your products keep up.

Making your designs upgradable is often the same as making them easy to 'hack'. The true meaning of the word 'hack' is to expand something's capabilities beyond what was originally envisioned.

Watching your most enthusiastic users modify your products can help you design better, more useful, models in the future.

Make magazine has a list of principles for designing for repair and upgrade. They call it the "Maker's Bill of Rights." Check it out!

You can extend a product's life enormously by making it easy to upgrade and repair. Still, eventually its life will come to an end; and that's where recycling and remanufacturing come in. It's up to you to make all of these steps easy for those who'll handle your product.
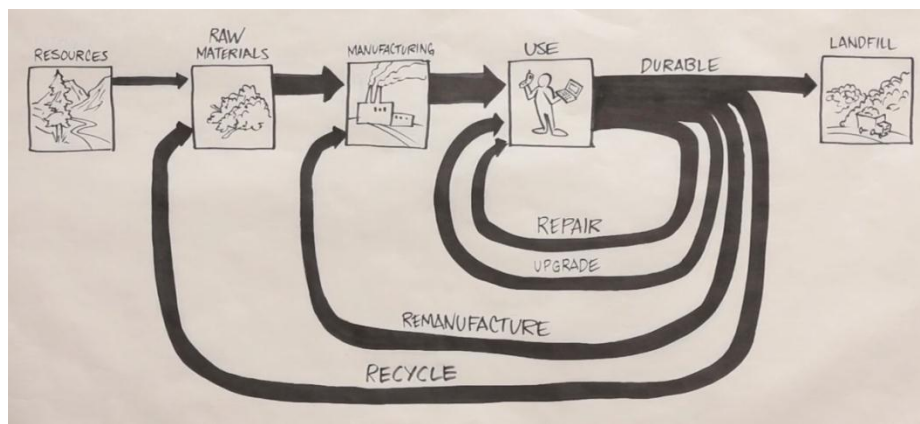
Designing this way can help you make products that perform better both for users and for the planet. If enough of us do this, we might one day even eliminate waste entirely.