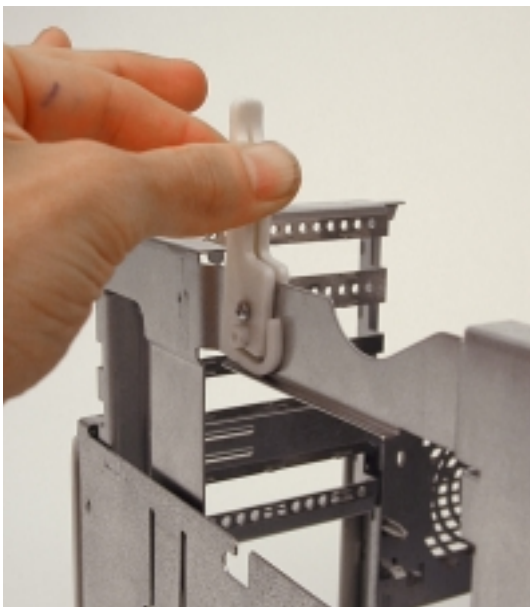


Innovative Fasteners

Fasteners are not only critical to optimizing product functions, but also to the ultimate disposal and recycling of that product. A number of manufacturers are developing ingenious fasteners that give products unique and useful DfE features. Some of these fasteners are easily detached for quick disassembly to allow products to be upgraded or repaired with ease or recycled at the end of life. Other types of fasteners replace hazardous adhesives that were being used to join parts. Over the longer term, these types of fasteners can make the product an asset and a resource instead of a costly waste at the end of its usefulness. These are some examples of the new efforts that have begun to improve the environmental attributes of products through fastener design and selection.

The lever on this Dell computer circuit board rack not only acts as a connector but also serves as a handle. Simply by pressing in on two buttons, one on each side of the cover, then lifting the cover up, the entire cover can be removed without the use of any tools. IBM Corporation uses a dart connector to hold acoustic foam in place on computer front panels instead of using an adhesive. This eliminates exposure of workers to adhesive fumes and the need to dispose of leftover glue as hazardous material. The foam can also be easily detached from the plastic panel for recycling.



The lever on this Dell computer circuit board rack not only acts as a connector but also serves as a handle.

A product designed to be readily taken apart can be repaired or upgraded with ease. At the end of its useful life, the product can also be quickly and economically disassembled for reuse or recycling of parts.

Manufacturers are developing new innovative fasteners to meet this need for ease of disassembly. In addition, through the ingenuity of product design teams, new environmentally compatible uses are being found for existing connectors.



A dart connector, which replaces the use of an adhesive, holds acoustic foam securely in place on the inside of an IBM computer front panel.

By following simple guidelines for fastener selection and use, products can be designed that are both functionally superior and environmentally preferable. The resulting new attributes can decrease manufacturing costs and create a competitive edge for the product in the marketplace.

The clever “push button” fastener on a Dell personal com-



This Dell computer cover is opened by simply pushing two buttons on either side of the cover. No tool is required and the connectors are integral to their corresponding parts.

puter cover is one example of a unique and functional product feature. Simply by pressing in on two buttons, one on each side of the cover, then lifting the cover up, the entire cover can be removed without the use of any tools. IBM Corporation uses a dart connector to hold acoustic foam in place on computer front panels instead of using an adhesive. This eliminates exposure of workers to adhesive fumes and the need to dispose of leftover glue as hazardous material. The foam can also be easily detached from the plastic panel for recycling.

Some innovative connectors are designed for multiple purposes. In one of the Dell personal computer models, a lever not only acts as a connector for a rack that holds a number of circuit boards, but it also serves as a handle for pulling the rack out for repair, upgrades, or disassembly. When the lever is down, it locks to hold the rack securely inside the computer chassis. When the lever is lifted, the lock releases and it can be used as a handle to lift the rack out of the chassis.

Types of Fastening Methods

In addition to the development of new types of fasteners, it is important to consider how existing connectors can be used to enhance the environmental attributes and manufacturing efficiency of a product. In the world of fasteners, there are a number of ways that the parts making up a product can be fastened or connected together.

Types of Connections

Discrete Fasteners
(separate connector from the part)

THREADED	NON-THREADED
screws	nails, tacks
nuts & bolts	retaining rings
studs	rivets
hooks	keys
spring toggle	pins
bolts	clips, staples
turnbuckles	snaps

Integrated Fasteners
(molded into the part)

LOCATORS	LOCKS	COMPLIANT
stop	cantilever hook	cantilever spring
lug	trap	crush rib feature
pin in hole	snaps	
wedge in slot	ball & socket	

Bonding

- energy bonding
- welding
- brazing
- solvent bonding

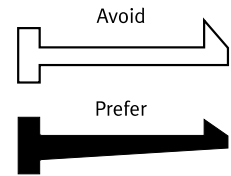
Other

- Velcro
- crimping
- seaming

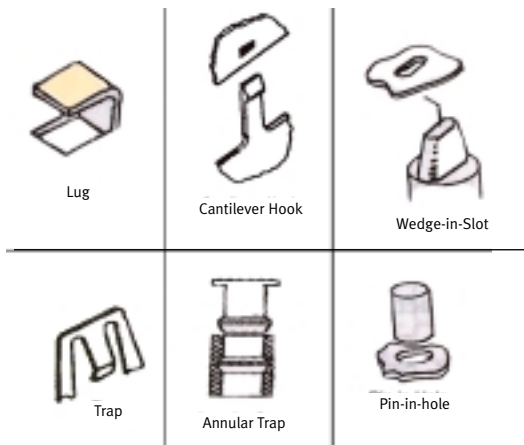
Selecting the right type of fastener for the right application can enhance the environmental attributes of a product.

Snap Fit Fasteners

Typically snap fit fasteners are easily joined together without the use of tools. There are many types of snap fit fasteners, ranging from cantilevers and annular snaps to traps and darts. With slight modifications, these connectors can be designed for repeated assembly and disassembly.



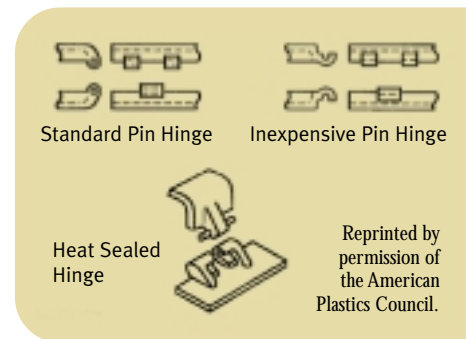
A tapered cantilever hook is more likely to withstand repeated disassembly and assembly, which facilitates repair or reuse.



For example, the inclusion of a flat head top on an annular snap will allow it to be engaged and disengaged repeatedly without the use of a tool. A cantilever hook that is tapered is more likely to withstand repeated assembly and disassembly. Snap fit flaps found in radio and calculator battery compartments are good examples of fasteners that can be opened and closed repeatedly. The use of reusable snap fit fasteners allows a product to be opened easily for repair and upgrades or for disassembly to recover recyclable components when a product is no longer useful.

Molded-in Hinges

Hinges are useful in providing ease of access to parts of a product for repair or upgrades. There are a number of types of integral or “molded-in” hinges. If hinges need to be attached, they should be attached with ultrasonic energy or with plastic rivets made of the same type of plastic to facilitate recycling. Hinges can also be very reliable since some can be flexed up to a million times without failure.



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Welding and Energy Bonding

Use of adhesives on plastic parts contaminates the materials for recycling. Welding plastic parts together is a good alternative method of bonding where an immobile strong connection is needed. If the two plastic parts are made of the same thermoplastic material, ultrasonic welding can melt plastic together to form a strong bond. It is important to make sure that plastic parts are of the same resin type before they are welded together. If the parts are made of dissimilar plastic resins, they will most likely not be able to be recycled at the end of product life.

Focused infrared welding is useful in joining thin-walled parts to thick-walled parts without plastic distortion. Solvent bonding, where an organic solvent is applied to the plastic parts, should be avoided since the solvent can act as a contaminant and workers are exposed to a hazardous material.

General DfE Guidelines for Fastener Use

Recommendation	Advantage
Use the least number of different types of connectors as possible.	Minimizes the number of tools that are needed when disassembling the product for repair, upgrades, or disassembly.
Use plastic fasteners made from the same resin type as the part.	Facilitates recycling of the product.
Use fasteners that can be removed without tools.	Facilitates ease of repair, upgrade implementation, and disassembly for recycling.
If metal fasteners are used, they should be of the same head type, magnetic, and have integral washers.	Magnetic fasteners of the same head type with washers are easily disconnected, then separated out magnetically during the recycling process.
If screws are used, use coarse threads versus fine threads.	Screws with coarse threads take less time and energy to remove.



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The PowerMac G4 computer has a swing-open door that allows easy access to all components for repair and upgrading. This is an example of a unique application of common connectors — a latch connector on one side is coupled with a hinge connector on the other side, to form a door that when opened greatly facilitates access to internal components.

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