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News that Inspires

Designing for the Circular Economy
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What do you do with a toaster when you no longer want it? Until recently, no one thought about that question until the toaster was ready for the scrap heap. Today, advocates of the circular economy suggest that the best time to address end-of-life issues is when a product is first being designed. It's at that point that it has the greatest potential for circularity. If the designers of your toaster had thought about it not as a disposable appliance but as a product with value worth preserving, your options would be considerably enhanced.

That, in fact, is what the designers at the London-based Agency of Design (AoD) did. As part of a project that "looked at the end of life of electrical products and designed alternative ways to make the most of the material that they embody," the AoD design team took on the challenge of rethinking the humble toaster. They came up with three different approaches, each of which, says the company, "embodies a different strategy to designing circularity from the outset."

Designing for Longevity

AoD began by attacking the planned obsolescence that has dominated product design for so long. Knowing that aluminum recycles "with no loss of its material properties" and that the material is likely to remain valuable to recyclers for the foreseeable future, the design team worked to make every part of the first toaster, known as the Optimist, out of aluminum, "starting off with 100% recycled content and knowing that it can be infinitely recycled into other products at the end of its life."

To maximize the product's longevity, AoD designers looked for a design "so simple that there was nothing to break." The Optimist ended up with very few moving parts and with heating elements — the shortest-lived components in a toaster — that were simple to remove and replace.

The design team also considered the perceived value of the toaster to owners who would relish its longevity. The toaster was given a "rough surface texture, allowing it to grow old gracefully" and its birth date was cast into the aluminum so owners could enjoy celebrating its service year after year. The Optimist even included a simple toast counter so that, "When you hand the toaster down through the generations, your children will know you've enjoyed 55,613 rounds of toast!"

The greatest challenge to making such a long-lived product is coming up with a workable business plan. Ever since the term "planned obsolescence" was coined during the Great Depression, the U.S. and much of the world's economies have relied on the disposal and replacement of products with defined lifespans. As author Giles Slade notes in Made to Break, planned obsolescence has become "a touchstone of the American consciousness."

The lighting industry has been grappling with this question since the long-lived L.E.D. bulb was first introduced into the residential market in 2008. According to J.B. MacKinnon in his New Yorker article, “The L.E.D. Quandary: Why There’s No Such Thing as ‘Built to Last’,” the answers so far have been less than inspiring. Some companies are returning to planned obsolescence by creating ever-cheaper lightbulbs with ever-shorter lifespans, while others got out of the residential lighting business. In October of 2015, for example, MacKinnon notes that General Electric “broke up G.E. Lighting to leave behind a rump firm — the light-bulb division, essentially — that would be easy to sell off.”

While there are still some markets left for lighting with built-in obsolescence — most notably the automotive sector — the industry is actively pursuing other ways to make longevity pay. A shift is already underway, at Phillips for instance, from selling lights as a product to selling lighting as a service. It’s a growing trend, according to the recent Navigant Consulting “Third-Party Management of Lighting Systems in Commercial Buildings: Global Market Analysis and Forecasts” report.

Companies are also looking to build in smart technology that distinguishes their L.E.D. product from others and offers opportunities for continuing updates. In the commercial realm, G.E., for example, is developing streetlights that alert authorities whenever a built-in sensor detects gunshots in the area. As for the residential market, MacKinnon quotes Philip Smallwood, the director of L.E.D. and lighting research for Silicon Valley-based Strategies Unlimited: “Lighting is the perfect medium for you to insert the other connectivity products to fill the house, because you use light everywhere.”

Regulation may also help pave the way for business models based on long-lived products. Tim Cooper, a design professor at Nottingham Trent University and editor of the book Longer-Lasting Products, sees possible solutions in government regulations that penalize obsolescence or reward longevity. But as Cooper recognizes, regulations follow culture, and the throw-away culture has been notoriously slow to change.

Modular Design: Replacing Parts, not Products

Another way of extending product life is to use a modular approach that allows owners to replace parts without having to replace the entire unit. This was the second strategy AoD took to rethinking the toaster. The Pragmatist model was designed with modular toasting slots that could be joined together to make any sized toaster a customer wanted. The modular design also made it possible to unclip a faulty toasting slot so it could be exchanged without interrupting the owner’s ability to keep making toast. And AoD designed these modules to be “thin enough to fit through a letterbox, making the return process as easy as possible for the consumer.”

The Ellen MacArthur Foundation highlights another example of modular design where performance is far more critical. Noting that ambulances were being sold at auction after just a few years, DLL, a global provider of asset-based financial solutions, investigated and found that it was the high cost of maintaining chassis components, such as the engine and gearbox, that led owners to return the vehicles.

The most valuable part of the ambulance, the large box that housed all the medical equipment and carried the patient, was generally in fine condition. DLL reduced customer costs by 20% and doubled the useful life of the vehicles by designing a patient-care module that could be easily removed and remounted on a new chassis.

Design for Disassembly

Modular construction allows for disassembly by the individual, but is of little use to a company looking to extract value from products in volume. For their third toaster design, the AoD designers set out to create an inexpensive toaster that could be quickly and easily disassembled without degrading the component parts or mixing their materials. The solution was a toaster put together with snap-fit joints that contained small pellets. Placed in a vacuum chamber ("a cheap piece of capital equipment," says AoD), the pellets expand, pop open all the joints, and leave a disassembled product.

The AoD strategy is similar to a concept known as Active Disassembly using Smart Materials (ADSM), pioneered by Joseph Chiodo of Active Disassembly Research. Using "memory materials," which hold a shape until they reach a trigger temperature (either hotter or colder than normally encountered), Chiodo created screws and other kinds of connectors.

Once the product is heated or cooled to the trigger temperature, all of the screws lose their threads and the product falls apart without any damage to the component parts. Temperature is not the only means of triggering the change. As with the toaster, a change in pressure can work, or disassembly can be triggered by "microwave, infrared, sound, computer and robotic control, electric current or magnetic fields," according to the Active Disassembly website.

Plastics for a Circular Economy

Plastic poses one of the biggest challenges to the circular economy. It is ubiquitous, made from petroleum and takes hundreds of years to decompose. According to a 2016 report by the World Economic Forum, "The New Plastics Economy: Rethinking the Future of Plastics," plastic packaging is of particular concern. "After a short first-use cycle, 95% of plastic packaging material value, or $80 billion to $120 billion annually, is lost to the economy. A staggering 32% of plastic packaging escapes collection systems, generating significant economic costs." In fact, says the report, "The cost of such after-use externalities for plastic packaging, plus the cost associated with greenhouse gas emissions from its production, is conservatively estimated at $40 billion annually — exceeding the plastic packaging industry's total profits."

One of the reasons plastic recycling rates are so low is because two or more incompatible types of material are often combined together to achieve the qualities needed for specific packages. According to Jeff Wooster, global sustainability director at Dow, the plastic pouches used for everything from frozen food to laundry detergent pods, offer a good example.

They are traditionally made of polyethylene terephthalate (PET), laminated to a film made of polyethylene. Using these two different plastics gives the pouches both "a nice glossy look, and stiffness that lets it stand up on the shelf," says Wooster, and "the ability to run at high speeds on packaging machines." It also makes the pouches impossible to recycle.

To solve this problem, Dow scientists came up with a new packaging structure that meets all the product design specifications but is made not of PET but of two types of polyethylene instead. "By combining different types of polyethylene that are compatible with each other," explains Wooster, Dow created a stand-up pouch that can be recycled in supermarket bins along with plastic shopping bags. One of the first applications of the innovative material was as the pouch for Seventh Generation dishwasher pods. The

primary uses for the recycled polyethylene are new shopping bags, which retain much of the product's original value, and wood-plastic composite lumber, which effectively puts the plastic back to good use for at least 50 years.

The stand-up pouch is far from Dow's only contribution to the circular economy. Another innovation announced in the fall of 2016 is a product made of polypropylene-based olefin block copolymers. In the past, post-consumer streams that included polypropylene and polyethylene were difficult to recycle. Dow's innovation makes it possible to combine these two commonly used resins into a host of products — including rigid containers and drums, household containers, industrial tanks, kayaks, and flexible packaging — all of which "offer upcycling opportunities for recyclers and brand owners," according to the company.

Products That Track Themselves

A surprisingly simple idea is driving still more innovation that supports the circular economy: keeping track of what you own. Digital technology, including the "internet of things," is making it possible for companies to design "intelligent assets" that can report back their location, availability and condition. The ability to channel, accumulate, and process this information as "big data" is enabling companies to maximize the value of these assets over time.

Caterpillar, for instance, is using on-board sensors that monitor its equipment in the field, combined with predictive diagnostics, to extend the life of its products. The technology allows the company to move from repair-after-failure to repair-before-failure and to improve maintenance based on how a machine is being used — all of which saves customers downtime and expense.

IBM has used similar technology to develop a comprehensive analytics asset called the Reuse Selection Tool, to help product managers choose the next optimal use for a product. Now in prototype, the tool ingests a vast range of granular data — including information about the equipment's modularity and reuse potential, regulations, market price, cost of remanufacturing, and supply and demand — enabling the product manager to decide on a per-unit basis whether to remanufacture, recycle, or scrap. It is also exploring the possibility of using cognitive computing, pioneered by the Watson system, to help interpret the data.

A new business-to-business sharing platform, FLOOW2, takes a simpler approach. Instead of relying on intelligent assets that keep track of themselves, it has created a Craigslist-type marketplace where companies can advertise equipment, facilities, and make them available for rent rather than purchase. Such collaborative consumption is already powering the sharing economy at the consumer level. FLOOW2's innovation is to extend the idea to the business world.

Designing Products that Use CO^2

One of the primary goals of the circular economy is to prevent the average global temperature from rising 2°C above preindustrial levels. According to the International Energy Agency, achieving this goal will require an investment in renewable energy and energy efficiency of $1 trillion a year for the next 34 years, a three-fold increase in the current level of investment. "It's not happening," says Bernard David, senior fellow at IGEL and chairman of CO^2 Sciences, Inc. Even with all the activities on the horizon, the amount of carbon dioxide staying in the atmosphere will mean an unacceptable increase

in global warming.

One potential solution to this problem is carbon capture and sequestration (CCS), which buries the greenhouse gas underground. But the strategy is not yet technically feasible. "Most current CCS techniques are uneconomic because they consume too much energy to sequester the carbon, so they have yet to be deployed at scale," reports a recent GreenBiz article, "Seven Companies to Watch in Carbon Capture and Storage."

The Global CO^2 Initiative, also a brainchild of Bernard David, takes a different approach. Instead of simply burying the gas as a destructive waste product, the initiative aims to transform the global economy through new inventions and investments to use as much as 10% of global CO^2 to make useful, profitable products at scale. A market assessment by McKinsey & Co. identified 25 potential products, representing a market that could reach $1 trillion by 2030. Each of these products is at a different level of readiness, which the initiative grades on a nine-point scale. "In order to have a meaningful impact," says David, "you have to get all these things to a level 9."

Cement is the lowest hanging fruit. One process, already in use, promises to reduce the industry's CO^2 emissions by 70%, both by capturing the gas in the cement and by dramatically reducing emissions during curing. Since cement manufacturing accounts for 7% of CO^2, David says, "Potentially, with that one industry, we can reduce CO^2 emissions by 5% annually."

The initiative, which was launched in January 2016, is working to build "a whole ecosystem to create at scale CO^2-based products," David explains. It's a monumental task, but in October 2017, less than a year after it began, the initiative released a draft "Roadmap of the Global Commercialization Potential of Carbon Capture and Utilization Technologies through 2030." A full roadmap was released in Marrakesh, Morocco, in November 2016 at the Conference of Parties meeting held to advance the Paris Agreement on Climate Change.

As the initiative roadmap suggests, the way forward is paved with possibilities. There will undoubtedly be potholes and detours as companies rethink product design with circularity in mind. But thanks to the design strategies mentioned above, and others not yet imagined, the journey towards a circular economy is off to a strong start.