New technologies can learn from mature markets

By Daniel W. Steeneck

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What do Class 8 trucks and cell phones have in common? Their end-of-life (EOL) strategies are shaped in large part by each product's characteristics as well as current market conditions.

These factors have long been part of the reverse channel, but how relevant are they in the booming market for wearable technology devices, or wearables? Market analyst IDC estimates that 91 million wearable devices were shipped in the third quarter of 2015—an increase of almost 200% over the same period a year ago. The industry needs effective EOL strategies as it grows rapidly, and governments tighten regulations covering the handling of used electronic products.

Research underway at the MIT Center for Transportation & Logistics suggests that companies producing wearables should learn from established markets if they want to develop innovative ways to recover the value of used parts and products.

Best option

Used products are handled in a number of ways at the end of their useful lives, including landfilling, recycling, reselling, refurbishing, remanufacturing, and parts salvage. In combination these activities comprise the closed-loop supply chain (CLSC).

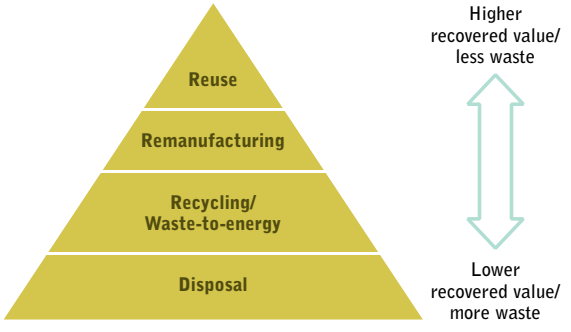
From a waste management perspective, these options are often represented as a hierarchy (see Figure 1). Options that retain the form and function of items (e.g. reuse and remanufacturing) are considered to be the best choices, while those that reclaim material and energy (e.g. recycling and waste-to-energy) are less desirable. Destroying the product (disposal) is the lowest in the pecking order of handling options.

Remanufacturing is a major activity in industries such as aftermarket automotive parts, heavy equipment, and military systems. The U.S. Trade Commission estimates that the industry grew 15% between 2009 and 2011 to at least $43 billion in the U.S., and some estimates put the remanufacturing industry's value as high as $100 billion.

Much of this growth comes from the increasing attention paid to environmental sustainability. Recovering the value of EOL products conserves resources and lowers energy consumption; remanufacturing a product requires about 25% of the energy consumed to manufacture it. This is one reason why governments in Europe are shifting the responsibility for managing EOL electric and electronic products to the producers of products.

FIGURE 1

Hierarchy of EOL options



Source: Daniel W. Steeneck, MIT Center for Transportation & Logistics

An economic argument in favor of remanufacturing is that related activities such as product disassembly create jobs for small businesses.

Complex choices

Despite these advantages, choosing an EOL strategy that includes remanufacturing is not straightforward. The optimal mix of methods varies according to the type of product and the dynamics of the market.

Consider Volvo, a major large truck and construction equipment manufacturer. Rather than remanufacturing its Class 8 trucks, Volvo's subsidiary, Dex Truck Parts, recovers used trucks from the open market and disassembles vehicles to obtain spare parts. Additionally, Volvo regularly remanufactures recovered Class 8 truck transmissions, engines, and exhaust gas recirculation valves, as well as construction equipment. The company has adopted this combination of approaches in response to market demand and the nature of the products involved.

In the cell phone recycling industry, EOL strategy has evolved over time. Historically, cell phones were recovered from consumers and then resold or the valuable metals were reclaimed. More recently, the rate of technological change, or the "clockspeed" (a term coined by Charles Fine in his book *Clockspeed: Winning Industry Control in the Age of Temporary Advantage*), of smartphones slowed, resulting in a strong market for smartphone parts that did not exist before. However, by the time cell phone recyclers realized this, falling commodity prices had rendered material reclamation unprofitable, forcing them to look for alternative recovery methods. They shifted their EOL strategy to include recovery and the sale of spare parts.

Components of EOL programs

These examples show that although the best EOL strategies are product-dependent, approaches can change in line with shifting market conditions.

The factors that determine the optimum approach to recovery fall into four broad categories.

Costs and Revenues. When considering your product's value recovery strategy, numerous costs and revenues must be determined related to the product, its parts, and the closed-loop supply chain. These include costs related to new production, product collection (includes logistics and buy-back costs), product disassembly, reassembly for remanufacturing, replacement part for remanufacturing, part salvage values (either material reclamation or part resale), and faulty part disposal cost. These costs and revenues are dynamic and can dramatically affect EOL strategy (recall how mobile phone and commodity prices affect part salvage values).

Consumer characteristics. Consumer characteristics include changing demand for new and used/remanufactured products and their parts, and the nature of product usage that includes the item's useful life and the willingness of the customer to return the unit. The clockspeed of a product is defined by these consumer characteristics. High clockspeed products have low future demand, so speed of product acquisition and resale is critical to value recovery. In many cases, this type of product should be designed for ease of disassembly and material recovery since there is relatively little demand for the product at the time of recovery. On the other hand, the demand for low clockspeed products will remain stable. These items can be excellent candidates for remanufacturing and parts salvage for the aftermarket (recall, the slower clockspeed of smartphones is creating a strong spare parts market for these devices).

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Product design. The durability of each part of a product determines how many components from recovered products will be reusable—a critical factor dictating value recovery strategy. There is a durability/cost trade-off for each part that must be considered. In many cases, a part's durability will fall into three categories:

- Minimal. Parts only last as long as one warranty period, and will be replaced if the product is remanufactured.
- Remanufacturable. Parts are durable enough to allow a sufficient number of units to be recovered to meet market demand.
- Maximal. These durable parts are built to last, and every unit has sufficient value to make both remanufacturing and resale viable.

Additionally, whether or not the product has an integrated, modular, or parts-based design plays an important role in determining the ease of disassembly and re-manufacturability. Integrated designs are the least desirable from this standpoint, while modular and parts-

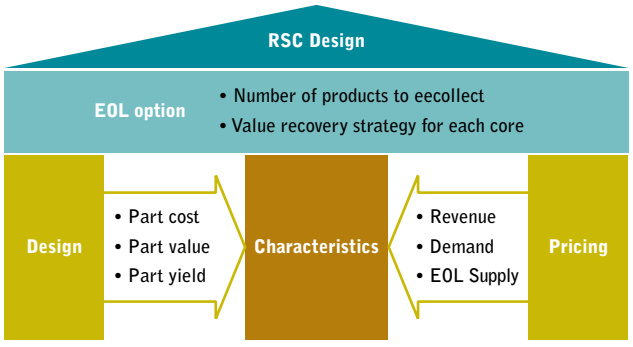
based designs are the best.

Product pricing. New products supply the markets for used and remanufactured products. Additionally, new and used/remanufactured products can compete for the same customers. The balance between expanding a market through value recovery, and cannibalizing the new product market, must be considered. This is accomplished through appropriate demand/revenue management based on product pricing.

These factors represent the pillars of the EOL strategy decision, and therefore, the overall design of the closed-loop supply chain. Figure 2 presents this relationship in terms of available EOL options, and the product's characteristics, design, and pricing. Note that these features, in turn, dictate the CLSC design.

FIGURE 2

Pillars of an EOL strategy



Source: Daniel W. Steeneck, MIT Center for Transportation & Logistics

Even without taking product design and pricing factors into consideration, the framework in Figure 2 explains why Class 8 trucks and cell phones currently exhibit similar EOL strategies. Both have a strong market for used products, and the aftermarket parts market is very strong as well. Thus, the products will be resold if possible, and the remainder disassembled and the parts resold. However, the framework can also be used prescriptively, especially for new markets such as that for wearable devices.

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Learning the lessons

Given the expected proliferation of wearable products such as Fitbit and Apple Watch gadgets, what should be done with these (currently) high clockspeed products when they reach the EOL phase?

The more mature cell phone market offers some clues. Many consumers have drawers that are brimming with old phones. According to a 2008 survey by Nokia some 44% of used cell phones were discarded in this way; only 3% were recycled, and the rest were resold or used as hand-me-downs. A 2010 estimate by the U.S. Environmental Protection Agency puts the recycling rate for cell phones at just 10%.

Wearables manufacturers can avoid a similar fate for their products by designing first-generation models for easy disassembly with value recovered through material reclamation (because such parts will have minimal durability). This might require more collaboration between trading partners early in the design process. And they should create collection systems designed for material reclamation and resale to secondary markets. Potential recovery channels include:

- trade-in programs offered by manufacturers or retailers;
- online recyclers offering to purchase old wearables; and
- donation of wearables as medical devices.

However, these channels require the consumer to voluntarily return the product. A truly effective closed-loop supply chain for wearables (or any product) can only be realized if the seller or OEM retains control of the lifecycle of the product.

Again, wearables companies can learn from established markets where companies have achieved this level of control with specially designed sales programs. Examples include "power-by-the hour" programs for aircraft engines, managed print services adopted by Xerox, and, more recently, T-Mobile's Jump cell phone leasing offering.

Hopefully the wearables industry will learn from past experience, and develop innovative EOL solutions that are aligned with changing market conditions. In doing so, they will capture a huge opportunity to redefine EOL operations and derive significant value from used products.