Companies such as Caterpillar are turning junk into gold by giving their reclaimed parts a new lease on life.

Nothing is as symbolic of American industrial might than the sprawling Ford Motor Co. plant on the River Rouge in Dearborn, Mich. It was a city unto itself, covering 15 million square feet, with its own power plant, hospital, and smokestacks reaching to the sky. A boat slip once welcomed freighters from all corners of the world bearing wood, metal, soybeans, and other raw materials destined for Ford's steel mills, glassworks, and plastics foundry. But Henry Ford's genius wasn't just scale: It was organizing labor in a hyperproductive way -- one that took advantage of the world's seemingly endless supply of cheap natural resources.

That plant was the apotheosis of modern manufacturing. But we all know what has happened to Ford, and U.S. industrial companies generally, since the glory days of the early and mid-20th century. Labor has become virtually a global commodity. All the Model T-era organizational innovation, and all the subsequent productivity drives, still run smack into the reality that workers come at a tenth of the price in other countries. What's the use?

In fact, there's another way to compete. Consider a much more humble operation, a Caterpillar Inc. plant in Corinth, Miss., a small town in the state's northeast corner. The operation consists of a clutch of long, narrow low-rise buildings in an industrial park. Inside, it all looks like a fairly typical engine factory, except things actually move a bit slowly, and everything is happening in reverse. Indeed, the whole point of the plant is not to put things together but to pull them apart.

Every day, about 17 truckloads worth of used diesel engines -- some almost as big as Hyundais -- and other parts are dumped at a receiving facility. The filth-caked iron carcasses are then broken down by hand. One engine usually takes two workers, surrounded by buckets, hammering and drilling for half a day, until they've plucked the engine clean of every last bolt and chucked each component into its own bin. It all must be salvaged, because even the puniest screw will be reused to assemble a "like new" engine. "If they throw anything away," says facility manager Tony Miller, an accountant by trade, "they just throw money in the trash."

This is the beginning of a process called remanufacturing. The simple twist is that this process places as much focus on wringing productivity out of physical materials as out of labor. As a general rule, 70% of the cost to build something new is in the materials and 30% of it in the labor. Remanufacturing asks: Why not work on the larger component?

People have been rebuilding things as long as there have been tools, but a small cadre of forward-thinking companies have spotted opportunity anew in the process. Big companies that do it include General Electric and Xerox, and smaller outfits such as carpet maker Interface and oil and gas services company Hanover Compressor do it, too. Lately none has been embracing remanufacturing as aggressively as Caterpillar.

All these companies are reclaiming products after they've been used one or more life cycles. They then start the manufacturing process over again with materials that are essentially free -- with all the energy costs already baked right in. The business model becomes only more compelling as metals and minerals hover near record prices, and as oil -- the lifeblood of industry -- flirts with $70 a barrel.

Remanufactured products can cost, on average, half of what new ones do, and the business can be terrifically profitable for companies that do it well. At Caterpillar, the "reman" operation's margins so impressed company brass that they made the business a separate division last year. The unit racked up more than $1 billion in sales in 2005 and is expected to grow 15% annually for the next several years.
at least. That's a sliver of the $36 billion heavy equipment giant's overall revenue picture. But remanufacturing is one of Caterpillar's fastest-growing divisions.

**The Cost Advantage**

For all the dirty work involved -- mining trash for gold, essentially -- there's an elegant appeal to remanufacturing. The would-be discards become fodder for the next product life cycle, eliminating waste and closing the loop on the system. That happens to make it quite an environmentally friendly business process, championed by greenies as a "sustainable" business model. And at a time when many expect high natural resource costs to persist, companies such as Caterpillar firmly believe that remanufacturing gives them a long-term advantage over companies that continue to start from scratch each time.

It's appropriate that Miller, the facility manager, and his boss, division Vice-President Steven L. Fisher, have backgrounds in finance, not operations: Remanufacturing befits a thrifty disposition. The basic question managers must consider is: How much does a new widget cost vs. a remanufactured one?

To see how the economics work, consider one of the more prosaic examples from Caterpillar's reman operation: the fuel injector case, a little groove-headed piece of metal that helps spray fuel into a diesel engine's combustion chamber. The cases would usually come back into the reman facility pretty beaten up, the grooves worn down after half a million miles of use. "For years we just threw them in the scrap bin," says Fisher. "The part costs about $3." But engineers found a way to reconstitute the groove to like-new condition. Fisher explains: "We actually take a laser [and use it to] put metal inside that groove, and then remachine it. It costs us 50 cents. And we're doing about a million of these a year."

For all of the old-school manual labor involved in remanufacturing, there is a startling amount of research involved. An ad hoc research and development unit occupies a broad swath in the middle of the Corinth plant, where metallurgical engineers puzzle over how to resuscitate all sorts of engine parts. Processes they've developed are in use all around them: Behind one door, a machine pelts a cylinder head with a high-velocity aluminum spray to smooth minute imperfections. Around another corner, a welder pours molten iron onto a cracked engine block.

**Second Lives**

Even with all those man-hours, remanufacturing pays off. Robert T. Lund and William Hauser, two engineering professors at Boston University, recently surveyed more than 270 remanufacturers. They found that, on average, labor and overhead represented about 60% of the costs to produce remanufactured goods. That's nearly a complete inversion of the traditional cost breakdown between labor and materials. In most cases, according to managers that do it, the overall cost usually runs less than 70% of building a brand new product.

At its core, remanufacturing is as much a service business as a product business. For the process to work, companies can't just forget about their products once they are shipped from the factory. Instead, they have to form a replacement relationship with customers.

Part of the reason reman is so successful at Caterpillar is that the Peoria company knows exactly where all of its equipment is. It sells exclusively through its own network of 200 dealers worldwide, who keep close tabs on their customers and their goods. So when a customer is ready to replace an engine or part -- what Cat calls "cores" -- Caterpillar can track the used piece and know when it will get to Mississippi. "[If you] get 10,000 cores back one day, and then nothing for three weeks, it's hard to run an operation," says Fisher.

To manage the logistical challenge, Cat relies on a simple principle, one that Fisher likens to the old Coke bottle deposits you would make at the grocery store. When a customer replaces a crankshaft, say, he's offered a remanufactured one for about half the price. But he'll be charged in full unless he
turns in an old crankshaft that can be fed back into the remanufacturing loop in Corinth. In fact, until a
turned-in part is inspected and certified as remanufacturable, the customer won't get the half-price
credit. Corinth is kept well-fed enough to pump out about 75 remanufactured engines or engine blocks
a week.

In essence, customers are given an incentive to become Caterpillar's partner. They're actually creating
assets, in the form of the returned cores, for their supplier. In return, they're quickly getting a low-cost
replacement, so they can keep their fleets running with little downtime. "If you're doing this in small
volumes, it is hard to justify the investment in systems and technology and everything to make sense
out of it," says Fisher. "But Cat Reman [is] getting 2 million units back each year, so you can make
this kind of investment and it does make sense."

Designed to Last

For Caterpillar, one of the most important steps in the remanufacturing process happens long before
the used engine hits the sorting facility in Corinth -- even before the thing is built new in the first
place. That's because Cat's product designers must explicitly consider the ease with which it can be
remanufactured. In fact, there's a "reman" box on Cat's product development checklist. "We actually
have reman engineers working with the new engineers, saying, 'You know, if you put another 10-
thousandth of [an inch of] metal on that, we can get two lives out of that,'" Fisher says. "It may cost a
dollar more when we produce it new. But we'll get two or three or four more lives out of it, because of
designing it to be remanufactured."

It's another way that remanufacturing thinking upends conventional manufacturing wisdom. Most
companies would consider spending more up front to extend a product's life a colossally stupid idea.
But Caterpillar is turning it into a competitive advantage. As Paul Hawken, an author on sustainability
issues, puts it: In reman, "you design for utility, which is how useful is this when it comes back, rather
than how useful is it going out."

Not for Fashion Victims

For Caterpillar, remanufacturing has a powerful logic. That's why it has designs to roll up companies,
big and small, that rebuild everything from railcars to auto parts. In fact, Cat Reman almost doubled
its size with the $1 billion acquisition of Albertville (Ala.) railcar servicer Progress Rail Services
Corp. in June. Cat's products are capital goods -- tools in the service of heavy industry. There's little
value in Cat's world for fashion. Customers don't care what an engine looks like as long as it can
power their tractor-trailer. Moreover, the diesel engine, though indeed a complicated wonder, isn't a
technology-intensive good. Cat can reliably expect engines, or railcars, to be reasonably similar 15
years from now.

That's why it's hard to imagine Apple Computer Inc., for instance, getting into the iPod remanufacture
business -- even though it is technologically and commercially possible. The iPod is a perfect
marriage of fashion and technology. The look should continue to be sleeker with each iteration, and
the console should probably be smaller. The first version, circa 2000, already looks like a clunky
antique compared with smaller, more powerful video iPods. Apple can't reuse the plastic casing, since
the size and finish keeps changing.

But even if Apple could remanufacture the iPod, why would it want to? Like most consumer
companies, its business model is built on the idea that people can be persuaded to throw away
perfectly functional goods and buy stuff they want but don't actually need. "[Industrial] design was
specifically invented to convince people that the washing machine, the car, or the refrigerator they had
was out of fashion," says Walter R. Stahel, an economist at the Product-Life Institute, a research and
consulting firm in Geneva, Switzerland. "Fashion is something you cannot remanufacture."

That's why it's not surprising that the largest remanufacturer in the U.S. is the Defense Dept. In the
military, function resoundingly trumps form. Nabil Nasr, an engineering professor at the Rochester
Institute of Technology, estimates that the Pentagon spends about $15 billion every year to extend the
life of its goods. In a time of war, equipment needs to get out to the field. And rather than order all
new tanks, planes, armored vehicles, and the like, or wait for ordered products to be built, much of the arsenal will simply have to be rebuilt to last another 20 years. The process is a natural fit. "The armed forces are always forced to have a system that also works if suddenly there is a shortage of resources," says Stahel. "Consumer society doesn't even think about the shortage of resources."

But industry might. It's not that companies will soon confront a dearth of natural resources. But the impact of high commodity prices is already rippling through the production cycle. At Interface, which reclaims carpet, "the prices of raw material… have increased 100% since we started this effort," says Stuart Jones, a vice-president there. "So just sitting here doing nothing, the economics get better almost daily as oil goes up."

Environmental laws also may force companies' hands. The European Union has rules that put companies on the hook for the post-consumer waste their products cause. So far, only modest recycling initiatives have bubbled up in the U.S., but most suspect this will change. Steven Fisher at Caterpillar thinks remanufacturing -- which has as its goal the complete elimination of waste from its system -- gives Cat a good head start. "The only thing we send to the landfill from Corinth is food scraps from our cafeteria," he quips.

Most companies, though, aren't used to thinking that the things they expel -- waste, products, resources -- have value. But to sustainability expert Hawken the growth in remanufacturing symbolizes "a long-term shift away from labor productivity toward resource productivity." Economics, not environmental concerns, is the driving force. "It's not like you're doing it because you're a nice guy or because you think the EU shouldn't have so much chronic unemployment. You do it because you just look at the numbers."