



Aiming for Sustainable Manufacturing Reborn Copy Machines and Multifunction Machines

Reused parts washed with water

“Inverse manufacturing” may be an unfamiliar term to those not conversant with environmental issues. The term describes a revolutionary approach focusing on reuse instead of recycling. A manufacturing industry that aims for a sustainable society must turn to inverse manufacturing.

Manufacturing with Minimal Use of New Resources

Fuji Xerox's reuse of copy machine and multifunction machine parts is one part of the Integrated Recycling System, a production system it has created. This system has been established to minimize the use of new resources during manufacturing, as a way for Fuji Xerox to combat resource depletion.

What methods are available for minimizing the use of new resources to most effectively reduce the impact on the global environment? The conventional answer was thorough material recycling. However, material recycling consumes a lot of energy in order to turn items back into raw materials, and incurs many other problems, such as the usage of chemicals. With reuse, collected parts are used with few changes. If reuse can take the place of recycling, there is no telling the degree that impact on

the global environmental can be reduced.

Fuji Xerox has made it a policy to prioritize the Integrated Recycling System well into the future, a future where resource depletion will likely be a more serious problem. The company is waging a never-ending battle to create a new manufacturing style for a sustainable society.

Cardboard boxes are being unloaded from a truck. Written on their sides are the model names of new products, but instead they contain collected used copy machines. Once returned to the plant, each copy machine is checked against the information on its complete history after shipment, which is managed in a database. When the copy machine has been checked and found to operate normally, it is loaded onto an automatic conveyor which takes it to the disassembly process.



Hirota: "There are a lot of issues for which we have no answers. We are all trying to answer them by a process of trial-and-error."

When the copy machine enters the disassembly process, the database information is used to separate its reusable parts from parts to be recycled into component resources. The reusable parts are washed and dried, and if needed, repaired or repainted. Then they are sub-assembled into a unit, given a quality inspection and delivered to the assembly line. On the assembly line, the parts are processed just as if they were parts from a brand-new parts supplier.

Doing the Same Work as a Parts Supplier

This is the "inverse manufacturing" plant at Fuji Xerox's Ebina Center (Kanagawa Prefecture). Unlike the scrap factories of the past, the scene is no different from a plant manufacturing new products.

"We do the same work here as a parts supplier," says Yoko Hirota, an employee of a Fuji Xerox partner who has worked here for the roughly nine years since the Integrated Recycling System started.

As she explains, the plant she works at does more than just carry out disassembly. It also handles some of the functions of a production line. Hirota's job is to take parts that have been removed from collected equipment and judged reusable, and sub-assemble them into a unit so that they can be installed in new equipment. She says: "In terms of the long-term outlook for the planet, reuse is the best way to utilize resources. Working at this plant has made me understand how difficult but valuable this task is." The work done by this plant is known as asset recovery—the recovery of items that still have value, to bring them back to life.

Turning Products from "Used" into "Good as New"

There are two big challenges for asset recovery: (1) developing the technology needed to evaluate part life and the assure quality, and (2) designing products with parts that can be reused.

To take on these challenges, Fuji Xerox has set up a special team to isolate the specific issues to be tackled according to function. In addition to development/production divisions and sales divisions, the team has recruited its members from sources further afield, such as distribution companies, parts suppliers, etc. Masatsugu Kawaguchi, an employee in charge of production technology and a member of the Parts Reusable Technology Team, attributes much of the team's effectiveness to its wide variety of members. He says: "Sharing the know-how of parts suppliers and studying problems together has allowed us to solve problems that Fuji Xerox could not solve alone."

The first issue the team worked on was how to separate reusable parts from parts to be materially recycled. Parts can have many problems, including short service lives, damage such as wear, dirt, or scratches, incompatibility with multiple models, or being difficult to disassemble. Kawaguchi mentions the importance of separating parts. "Our goal is to provide products with quality that is as good as new, not used products. To reach this goal, we have had to work on gaining a thorough understanding of part life."

The service life of new manufactured parts can be known in advance, so if the length of time a copy machine was used is



Kawaguchi: "The detailed research results we have accumulated have been turned into quality assurance standards."

known, its parts can be separated when it is collected. But in practice, it is not that easy, as actual conditions of use vary. Two copy machines used for the same length of time could have logged different amounts of use, and could have been installed in different environments. And while in use, copy machines can receive replacement parts during periodic maintenance or repairs. Obtaining this type of detailed information is usually not possible.

Comprehensive History Information System Creates Quality

Many of the customers that use Fuji Xerox copy machines have total service contracts with the company. Under this system, customer engineers visit the site periodically, or as needed, to perform work such as maintenance and parts replacement on the customer's equipment. This work gives customer engineers an up-to-date understanding of the condition of this equipment, and this information is collected at the company's data center and stored in a database. This gathered and stored information on the usage frequency and total failure rate of each part can be used to determine the service life of parts using a statistical method known as Weibull analysis.

The next issue the team focused on was how to determine whether parts selected for reuse can guarantee the same level of quality as new parts. Since it is difficult to make this determination for some parts using conventional measurement methods, the team decided to try a departure from existing technologies. Using methods such as motor wear checking

by acoustic emissions, the team determines whether a part can be reused or not based on their own original quality standards. "The information and know-how we have accumulated within the company from our detailed research is the basis for the standards we have created," says Kawaguchi.

Processes ranging from disassembly to cleaning have also presented challenges. For example, collected copy machines are fairly dirty inside, coated with toner or dust. Kawaguchi describes how they are processed. "The basic method we use is minimal-environmental-impact shower cleaning, but for units that cannot be washed in water, we have come up with the cleaning method of using jets of fine dry ice."

The team has also worked on developing several other technologies. There is a technology for repairing/replacing only the short-service-life or non-reusable parts of substrate, an inspection equipment technology for checking results of repairs, a technology that strips and recoats just the worn areas of rubber parts such as rollers, and a technology for painting outer covers.

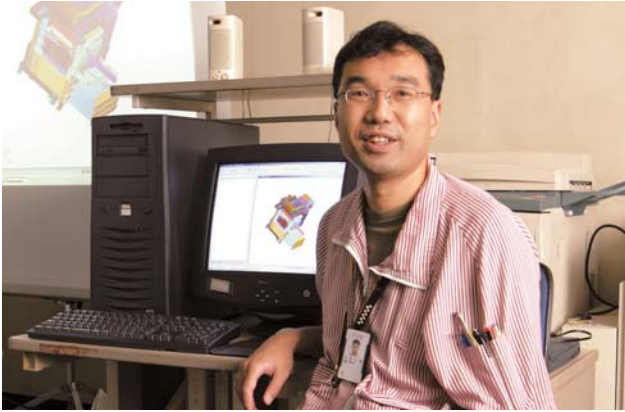
While it has been nine years since their work began, team members are still working together, sharing their know-how and facing each new challenge. The victories they have achieved are daily shaping the evolution of production lines for reused parts.

Platform Design Enables Multiple-Model Part Reuse

Discovering new ways to increase reusable parts requires work starting at the part design phase.

The platform concept begun in 2000 has been an effective tool for this phase. The concept involves grouping equipment component functions into modules. Combining these modules lets Fuji Xerox efficiently provide products that can meet a wide range of demands.

Although designed for more effective and efficient development at a lower cost, the platform concept is also highly effective for part reuse, and has helped increase the number of parts and units that are reusable over several generations and models. Shiro Yamahashi, Mechanical System Development, who is responsible for design says: "Conventionally, part reuse has meant using parts from the same generation or family. Fuji Xerox worked on using common parts in several models, and succeeded in 2003." By the end of 2004, models designed using the platform concept will start returning to the plant at the end of their life cycle. "I think the



Yamahashi: "The biggest challenge we are facing now is work on core components that are harder to reuse."



Kobori: "Can we really make them the same quality as new products? Will they actually sell?"—these concerns proved groundless."

benefits of greater reuse should gradually start being seen this year," Yamahashi says confidently.

Yamahashi is now working on the platform for the optical image reader that drives copy machines. He says that research done over the past few years has enabled part life to be extended up to 300% or more. "There are still a lot of challenges to address, such as dealing with production in China, and how to reuse core components." If developing part separation technology is the first phase and designing platforms is the second phase of Fuji Xerox has just now entered the third phase of working on reusing optical components and other core components, an area that previously was seen as being difficult. The practical know-how created by the challenges successfully met by Fuji Xerox engineers is reflected in the "Design Guidelines" and inherited through continual revisions.

Reuse is Key to Environmental Issues

Fuji Xerox's Integrated Recycling System has today become a production system in its own right. The study for the establishment of the system began in 1993. Then-president Akira Miyahara had a vision of "reducing environmental impact by reusing parts from collected equipment and providing them to customers." A project began to produce equipment with reused parts that would guarantee the same quality as new products. Underlying this project was the realization that new resource inputs could only be reduced by a limited amount through recycling. Miyahara believed that reuse held the key for dealing with environmental issues.

In those less environmentally aware days, some doubts were

raised concerning the advancing of the project, despite the directives of top management. Mutsuo Kobori, Group Manager of the Business Planning, ARM (Asset Recovery Management Unit), played a role throughout the establishment of the system. He says: "Some people questioned whether we would be able to make products with exactly the same quality as new products. Other people worried that even if we could make these products as good as new, customers would still ask for discounts since they would not actually be new. But all these fears were groundless." He adds that when the project was getting underway, there were several difficult obstacles to overcome, making it seem an impossible goal.

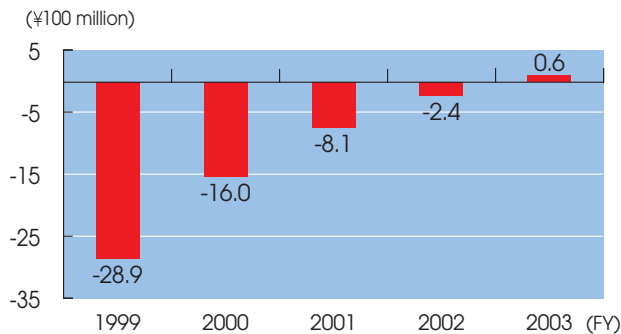
Since becoming the first company to announce a copy machine made with reused parts in 1995, Fuji Xerox has to date (March 2004) released 73 models and over 230,000 units of copy machines and digital multifunction machines using reused parts, achieving a reuse rate of 54% (by number of parts). This has reduced the quantity of new resource inputs by 2,200 tons, and CO₂ emissions by 13,900 tons-C (FY 2003), compared to the levels that would exist if the same number of copy machines had been manufactured without reuse.

Thorough Recycling of Non-Reusable Parts

Conventional materials recycling (mostly of iron and other metals) has not been able to completely eliminate discarded scrap, making landfill necessary. Fuji Xerox has aimed at "infinite zero landfill." In autumn 1998, the company con-

■ Integrated Recycling System Achieves Profitability

By steadily expanding production of copy machines and multifunction machines with reused parts, the system achieved its first environmental accounting profit.



firming it could achieve this goal by enlisting the aid of nationwide recycling partners to separate used product parts into as many as 44 categories and process them using the latest recycling processes. Since February 1999, the company has begun implementing this process for non-reusable parts at the Ebina Center, systematizing processes such as disassembly, sorting, and resource recycling into its management system. Fuji Xerox has also constructed “Ecoland,” a facility for researching and verifying the efficiency of disassembly and separation work. The company started its own disassembly and separation of used equipment in Tokyo, Kanagawa, and Yamanashi, and planned to expand this “zero landfill” system to the nationwide level. In August 2000, the company completed a national system to achieve its goal of “zero landfill” (except for process losses) for used products collected from customers. By enlarging the system in 2003 to cover the printer market in addition to just copy machines and multifunction machines, the company expanded, intensified and accelerated its response to resource depletion.

■ Integrated Recycling Systems Must be Profitable to Succeed

But Fuji Xerox was not satisfied with the results of these initiatives alone. Kobori describes how a new goal was set. “In 1993, We thought we had fully met the demands of the time, but some people in the company felt the Integrated Recycling System had to be profitable as a business area to truly succeed.” This challenge was included as one of the goals set for the Integrated Recycling System in 1995, the year Fuji

Xerox released the first copy machine incorporates reused parts. In 2002, the system came close to profitability, and in 2003 it reached this goal. After more than eight years of effort, Fuji Xerox established “harmonizing environmental aspect with social and economic aspects” which is a business model industry had long sought for the “century of the environment”

It has been a long time since the concept of inverse manufacturing was first proposed, and now the Ebina Center has become the plant that has made this concept a reality. The plant holds tours of its disassembly/production line to publicize the importance of its activities. More than 1,400 people took the tour in 2003 alone, and to date, nearly 10,000 people have learned about the Integrated Recycling System.

The specific successes that have come from Fuji Xerox’s intensive work on resource depletion are the result of keen insight on environmental issues and a corporate attitude of uncompromising, persistent inquiry into how companies should act to achieve fundamental solutions of such issues. Responding to today’s mass production for mass consumption, Fuji Xerox has cut off the flow of mass disposal that mass production creates through intensive work on the problem of resource depletion at manufacturing sites. The successes Fuji Xerox has had in this area will undoubtedly help companies improve their competitiveness, offering a new style of manufacturing for the resource-poor 21st century. Fuji Xerox has managed to create successful business areas from the so-called “venous industry” involving reuse and recycling on all its copy machine, multifunction machine, and printer manufacturing lines—a major achievement.

Another day of producing new copy machines with reused parts at the Ebina Center. ■