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## **Driving Sustainability Through a Hybrid Manufacturing Strategy**

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A leading company in the area of sustainability, Xerox has introduced new terms and processes to green manufacturing including operations reversal, delayed configuration, delayed differentiation, zero landfill, tear-down and clean, re-use, re-manufacture, and re-assemble. How do you turn a big steam liner of a plant, with diverse manufacturing areas and a union workforce, into a model of sustainability that is financially viable?

### ***DocuTech... a case study***

First introduced in 1988, Xerox's DocuTech product is a large digital on-demand production press with a typical lifecycle of 3-6 years. Xerox quickly found that several customers who wanted this equipment for their businesses could not afford the large capital outlay of \$250-\$500k to purchase equipment, so Xerox started leasing its product. This led to a challenge – after 3-4 years, the products started to come back and the new product had changed. Xerox's challenge then became "how to develop an architecture that can sustain through evolutions of product development?"

There were marketing concerns – even if Xerox could develop the architecture, how do you market green? At one time, companies that remanufactured products would be at a marketing disadvantage as it was a way for the sales team from a competing company to differentiate itself as "using only new parts". But this is changing rapidly. There are new regulations to meet, a greater awareness of green manufacturing, and creating zero landfill in your processes. When you can divert print cartridges from landfills and back to the manufacturer for re-use, employees and customers feel good about green. Customers in our current environment, especially European customers, now ask, "What do you do at the end of the life of that product?"

Xerox ships the old printing systems (known as “hulks”) back to one of two plants for tear-down and clean, where it is de-paneled and disassembled for spare parts, recycled, or reclaimed and cleaned. Because the working condition that the “hulks” arrive in cannot be guaranteed, to insure quality they strip the raw frame down to the lowest point they can and supplement with new parts.

One of the first re-manufacturing challenges was in cleaning the parts. The old method used solvents to clean difficult to remove toner, but this method created environmental and health issues. Instead of outsourcing the problem, Xerox solved it through new technology, dry ice blasting, which uses pelletized, frozen dry CO<sub>2</sub> to clean parts. Xerox has also utilized new methods to reduce the amount of energy needed for manufacturing, reduce direct greenhouse gas emissions, and other indirect effects. For instance, toner that was made through a crushing process is now gravity grown, which reduces energy use by 25 percent. Digital technology makes machines smarter and last longer, and includes diagnostics that reduce technician site visits because machines are self-correcting. Upgraded software is distributed through the Internet (no technician visits, no CDs mailed, no packaging).

The next issue was meeting demand under the new manufacturing conditions. With the DocuTech Finisher module alone, there are nine product configurations to meet customer needs, all with different processes, bills of materials, and labeling requirements equal to the full production line. Initially when rebuilding, you might have different configurations in various states of rebuild with various inventories available. How do you manage to meet customer orders in a timely fashion while remaining “green”? Answer: delayed differentiation. The printing systems are built to a core configuration, after which customization using pre-assembled kits is added to produce the printing system ordered. This process of semi-finished product built to a forecast and completed when actual demands are realized is known as delayed differentiation.

Delayed differentiation reduces line conversion time, the time it takes to convert the line from producing one type of product to the next, from 400 minutes to 100 minutes. It eliminates increased WIP (work-in-process) values because you are not pushing machines built to forecast off the assembly line to produce actual orders, taking parts from new inventory or from other machines to complete orders. By delaying the final configuration of equipment, configuration response time now equals the sum of installing configuration specific components only. This also makes employee training easier with faster competency response times, as most of the employees are trained on the core configuration, and the better skilled employees work the end of the line in the customization areas. As the same function is done most of the day in most of the line, it’s easier to balance the line.

Delayed differentiation required operations reversal, a re-sequenced assembly procedure that moves operations with greater variance to occur later in the assembly cycle. When you bring your design partners into this mix, you can add even greater efficiencies.

There were cultural challenges within the plant to overcome. Sales and marketing only wanted to know if you got the product to the customer and if the customer was delighted. Data drove decisions for the salaried staff. Spaghetti diagrams and validated simulation models that were walked through the line for verification of real times for processes were needed for buy-in. The model had to show the gaps and how to fix them. The union staff were concerned that the changes were meant to reduce cycle time and therefore reduce labor. Xerox managers were able to convince them that upper management wanted to get more work in, be more efficient, and be a greater benefit to customers. Manufacturing needed to get involved in the new modular architecture design process, and is now the glue between different design groups and are needed to evaluate what is returning and what can be re-used.

Marketing now uses remanufacturing as a tool to gain revenue and talk to customers about socially- and environmentally-conscious methods used in Xerox's processes, and waste diverted for environmental and social benefits. Xerox understands that they will never be the low cost manufacturer. So, instead they use their strengths of flexibility, in terms of product configuration, delivery time, and plant location, to build closer customer relationships. When customers visit Xerox's state of the art customer experience center, they can also tour the plant to see Xerox's sustainable manufacturing processes first-hand, and customers often want to replicate it in their facilities.

Other companies are slowly getting into the new game, but remanufacturing adds a lot of complexity to manufacturing. It requires better raw materials, higher upfront costs, highly precise manufacturing techniques with tighter tolerances and some over-engineering the first time around because you know you have to reclaim parts later. Rebuilding translates to 80 percent of direct materials costs because you need to add standard labor hours. It's no longer an easy manufacturing process vs. using all new parts.

Benefits of the new hybrid strategy include: faster response to actual customer demands, reduced finished goods inventory levels, streamlined build sequence/assembly process, reduced process variability that drives consistency and improves quality with a 68 percent reduction in configuration unique defects, and 24 percent improvement in overall quality performance.

Xerox now has a recycle rate of 96 percent for worldwide equipment recovery and recycle operations, with over 2.0 billion pounds of waste diverted from landfills through equipment reuse and recycling programs, and over 2.8 million copiers, printers and multifunction devices recovered through remanufacturing efforts since 1991. Xerox is ISO 14001 and 27400 certified, and audited on quality – remanufactured equipment must have the function of a purely new machine. Xerox is compliant with the ROHS Initiatives and part of the Green World Alliance, and Xerox is making profit.